INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 14, No. 3, p. 1-8, 2019
http://www.innspub.net

RESEARCH PAPER OPEN ACCESS

Efficacy of botanical plant extracts against fruit and shoot borer *(Leucinodes orbonalis* G.) of eggplant (*Solanum melongena* L.).

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Article published on March 27, 2019

Key words: Eggplant, Botanical extract, EFSB.

Abstract

The study was conducted to determine the efficacy of Botanical Insecticide Extract against Fruit and Shoot Borer (*Leucinodes orbonalis* G.) of Eggplant (*Solanum melongena* L.) under field conditions, specifically aimed to; (1) determined which of the different botanical plant extracts is the most effective in controlling EFSB of eggplant; (2) determined the effects of developed Botanical extract products, on the yield performance of eggplant (*Solanum melongena* L.), (3) determine which of the different botanical plant extracts is the most effective in controlling EFSB of eggplant *and;* (4) determined the phytochemical constituent of all the botanical extract used in the study. It was laid out in a Randomized Complete Block Design (RCBD) with 6 treatments replicated 4 times. Among the test plants evaluated, generally Hot chilli and *Lantana* was the most effective providing the highest reduction on EFSB followed by, *Cubeba seriboa, Curcuma Longa* respectively, however, it was revealed that all the tested samples shows par to the standard check. It also shown that all treatment significantly lowered on shoot and fruit infestation of EFSB as compared to untreated control check. The highest marketable fruit yield was obtained by Hot chilli, followed by *Lantana camara*, standard check, *Curcuma Longa, and Cubeba seriboa* as compared to untreated control check respectively. The percent gain over control was least with *Curcuma Longa*. From this study, it was concluded, and recommend that plant products are one of the most reliable/viable bio- rational options in pest management practices especially on the control of lepidopteran insect pest like the EFSB.

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Introduction

Like many other crops, eggplant is more susceptible to damage by several insects and diseases that attack from seedling to fruiting. Unfortunately, the production of marketable eggplant is compromised due to infestation of damaging insect pests commonly known as the eggplant fruit and shoot borer (*Leucinodes orbonalis*); that inflicts damage to both shoots and fruits that causes of serious damage to the crop (Srinivasan, 2009). The loss caused by this pest varies from season to season depending upon environmental factors as reported by Gangwar and Sachan (1981). Growers rely heavily on chemical pesticides to protect their eggplant crop. The excessive uses of pesticides are high costs and have potential harm to human health and environment. Frequent use of pesticides also will lead to myriad problems which include to insect pest's resistance to the chemicals, resurgence of target pests, pesticide residues, and destruction of beneficial fauna (Srinivasan, 2009).

This study aims to develop botanical insecticide that can be a novel alternative and effective solution against the EFSB damaging insect pests of eggplant. This will help reduce the use of synthetic pesticides thus, producing safer foods while making the agro ecosystem balance and sustainable. Result of the study provides information for an effective and environment friendly pest control program against eggplant fruit and shoot borer, thus, this study. The findings of this study provided vital information that contributes to the existing literature on the different botanical extract against insect pest of eggplant. It is also very useful to organic vegetable farmers as which provide basket of options to choose from the several available organic- based pesticides. Likewise, findings will serve as a tool for the development of botanical pesticidal products (granulated or activated) for commercialization. Through this research, significant reduction on the use and the sole reliance of synthetic pesticides is achieved thereby, reducing environmental contamination and health hazards.

Materials and method

Materials

Laboratory materials

Vials, scissors, ruler, funnel, beaker. Filterpaper, mortar and pestle, Funnel, beaker, sharp cutter, DSLR camera, Imarflex multi blender, muslin cloth.

Botanical products:

Fruit of Hot Chilli, rhizomes of *Curcuma longa,* leaves/flower of *Lantana camara, and Leaves of Cubeba seriboa.*

Field materials

Seeds of Morena (F1) variety of eggplant, from East-West Seed Philippines, knapsack sprayer, Ascend 50SC (insecticide), tools and equipment such as harrow, grab hoe, bolos, shovel, and record book.

Experimental Procedures

Research Design, Treatments and Lay-out

The experimental unit was laid out in a Randomized Complete Block Design (RCBD). The total lot land area was 500sq meter divided into four blocks representing the replications. Each block were subdivided into five plots. The distance between replications and treatments was one meter. The distance between rows was 75 cm and 50cm in between hills

The treatments were as follows:	Rated/plot
T_1 –Positive control	1.5 tbsp on 8L (commercial RR)
T_2- *Curcuma longa*	250g (Fresh) + 80% ethanol + 20ml H_2O
T_3- *Cubeba seriboa*	250g (Fresh) + 80% ethanol + 20ml H_2O
T_4- *Lantana camara*	250g (Fresh) + 80% ethanol + 20ml H_2O
T_5- *Capsicum sp.*	250g (Fresh) + 80% ethanol + 20ml H_2O
T_6- *Negative control*	No application

Preparation of Botanical extracts

Two hundred fifty (250) grams of *Curcuma longa,* rhizomes was chopped into small pieces. The chopped rhizome was macerated into 80% ethanol and 20% of water and stored 24 hours. The mixture was sieved to obtain uniform extract and then filter with muslin cloth. Crude extract rhizomes of *Curcuma longa* was kept under low temperature in the refrigerator until it was used. The same procedures with the leaves and flowers of *Lantana camara, Capsicum frucetense and Cubeba sureboa.* The plant extracts were separately concentrated using rotary evaporator at 60°C under vacuum for 1 hour, this was done at the Research Department of Cagayan State University, Andrews Campus.

Analysis of the Extract

The botanical extracts were submitted to the Standards and Testing Division ITDI- DOST, Bicutan, Taguig at the Department of Science and Technology Taguig, Manila for the and phyto analyses of the extract.

Insect Field Release

Ten (10) third instar larva were released on the field prior to the application of all the treatments.

Efficacy Testing of Botanical Extract on Field Trial

An appropriate amount of each crude extract will be diluted with water and then stirred to get a good homogeneity (extract mixture concentration). The formulated botanical extracts were applied using a backpack knapsack sprayer. An application of treatments was employed late in the afternoon starting from 15 days after transplanting.

Cultural Management of Eggplant

Seedling preparation

Seeds of Morena (F1) variety was sown in the polyethylene plastic to facilitate easy maintenance of the seedlings and for efficient transplanting without disturbing the root system.

Land Preparation

An area of 500 m^2 was used in the study. The field were ploughed three times at two weeks interval. Harrowing was done immediately after ploughing and the soil was pulverized to eliminate and control weeds.

Transplanting of the seedling

Seedling was watered to soften the soil in the polyethylene to prevent root damage on seedling during pulling. Incorporate 500g vermin compost/hill before transplanting the plant. The plot size is 2.50m × 3.50m with a spacing of 75cm and 50cm between hills. Transplanting was done at one month old seedlings in the late of afternoon to prevent wilting of the crop.

Cultivation

The surroundings of plants were cultivated with the aid of the hoe and bolo to allow better aeration of plant roots. Cultivation was done 30 days thereafter or when weeds were notice.

Weeding

Weeding was done to prevent competition between the crop and weeds for nutrients, water, and sunlight. Weeding was done as often as necessary.

Organic fertilizer application

Split application of vermin compost with a rate of 50gm/hill was done to the plants by ring method 5cm away from the base of the plants and then covered with soil during the vegetative stage until the start of fruiting stage.

Irrigation

Water is one of the essential elements in plant growth and development, thus watering will be employed whenever necessary to maintain favorable moisture content of the soil. Water is given in equal amount to avoid bias result.

Harvesting

Harvesting was employed 4-5 times with an interval of 3-4 days upon the maturity of fruits. This was done by twisting the fruits upward. The harvested fruits will be weighed and counted. Marketable fruits were separated from non-marketable fruits.

Data Gathered

Shoot and fruit borer Degree of damage. Assessment of damage was obtained by using damage rating scale:

$$a.\ Shoot\ infestation\ percen = \frac{\text{Number of Infested shoots}}{\text{Total number of Shoot}} \text{ x } 100$$

$$b.\ \text{Fruit infestation percent (by number)} = \frac{\text{Infested fruit}}{\text{Total number of fruits}} \text{x } 100$$

$$c.\ \%\ reduction\ of\ infestation = \frac{\%\ \text{infestation of treated by treatments}}{\%\ \text{infestation of untreated control}} \text{x } 100$$

$$d.\ Protection\ over\ control = \frac{\%\ \text{bored fruit in control} - \%\ \text{bored fruits in treatment}}{100 - \%\ \text{bored fruits in control}} \text{x } 100$$

Number of shoot and fruit borer

The number of populations of shoot and fruit borer from the 10 sample plants were monitored one day

after the application of treatments. Eggplant fruit and shoot borer present on damaged shoots were counted. For eggplant borer, harvested fruits were examined for presence of borer holes. The borer population on eggplant fruits was determined at harvest. The number of entry or exit holes on the fruits was recorded. Damaged and healthy-appearing (without visible holes on outer surface) fruits were dissected and the larvae will be collected, counted and recorded.

Weight of marketable fruits

This data was determined by weighing all the fruits of all Representative samples plants/treatment that have no pathological and physiological defects.

Number of marketable fruits

This data was determined by counting all the fruits of all RS plants/treatment that have no pathological and physiological defects.

Number of non-marketable fruits

This data was obtained by counting all the fruits of all RS plants/treatment that have pathological and physiological defects or it did not conform to the size of the variety.

Computed fruit yield per hectare (kg)

This was obtained by getting the cumulative weight of the yield obtained from the different priming in the harvest area per plot. This is the basis by getting the projected yield per hectare using the given formula;

$$\frac{Actual weight x 10{,}000}{harvest area} = yield per ha$$

Observation/S

All abnormalities or pest occurs during the conduct of the study was recorded and documented, Assessment of damage was done using the NCT for vegetable manual:

Rating Scale	Description of Damage	
1	Highly resistant	none of the total plant population per plant was infected or infested
2	Moderately resistant	1-10% of the total plant population per plant was infected or infested
3	Intermediate	26-50% of the total plant population per plant was infected or infested
4	Susceptible	61-75% of the total plant population per plant was infected or infested
5	Very susceptible	76-100% of the total plant population per plant was infected or infested

Result and discussion

General Observations

Diseases Damage

Bacterial wilt was observed during the conduct of the study. On the observation it was showed that the degree of the yellowing of leaves cause by bacteria is moderately resistant at the range of 1-10% from the total plant population per infected or infested based on the Rating Scale Description of Damage set by NCT for vegetable manual.

Stand and Vigor of the Crop

It was observed that all plants in respective treatment had a vigorous growth during the wet season, However the growth of plants are stunted caused by the adverse effect of climate like drought resulting on the low yield of the crop.

Phytochemical Analyses

Table 1. Test Result on Phyto-chemical for Plant constituents of Capsicum sp., Curcuma longa, *Lantana camara*, and Cubeba siriboa.

	Capsicum sp.	*Curcuma longa*	*Lantana camara*	*Cubeba seriboa*
Sterols	(++)	(++)	(++)	(++)
Triterpenes	(-)	(++)	(++)	(++)
Flavonoids	(++)	(++)	(++)	(+)
Alkaloids	(++)	(++)	(++)	(++)
Saponins	(++)	(++)	(+++)	(++)
Glycosides	(+)	(+)	(+)	(+)
Tannins	(+)	(+)	(++)	(+)

Legend (+) Traces, (++) Moderate, (+++) Abundant, and (-) Absence

Table 1 shows the test result of Phytochemical screening for plant constituents, the test was done at DOST Industrial Technology Development Institute Standard and Testing Division, Gen. Santos Ave. Taguig City, Metro Manila, the test samples were analyzed to confirmed if they have positive traces on

Sterol, Triterpense, flavonoids, Alkaloids, saponins, Glycosides, and Tannins, the result are the following;
Sterol shows Moderate (++) result to all the samples given, sterols roles disrupt physiological processes in insects is not clear, but the incorporation into important and active tissues like the midgut, fat body, muscles, and the nervous system may have serious consequences especially on larval stage of insect (Behmer and Nes, 2003). Early research into insect sterol biology was conducted on grasshoppers, and in these insects find that extreme sterol metabolic constraints are a shared trait (Behmer and Elias 2000). Particularly fascinating, though, is that grasshoppers suffer high levels of mortality when they accumulate unmetabolized "bad" sterols above a certain threshold, even if the proper amount of a "good" sterol is obtained (Behmer and Elias 1999a, 2000).

On the other constituents the Triterpenes, only Capsicum shown a negative (-) result compared to the other samples, Moderate (++), results, studies shown that Plants natural products and essential oil components such as terpenes and phenylpropenes have been shown to have a significant potential for insect control. Effectiveness of this toxic substance was shown to the early study of Pungintore, Carlos R., *et al.* 2005, shows that these triterpenes acts as acute toxic compounds when were applied topically and/or incorporated into the food of the red flour beetle. Nevertheless, no activity related with the nutritional status of this insect was produced.

Another constituent is Flavonoid, were all the samples showed Moderate (++) result, Flavonoid function has many aspects of plant–insect interactions, but the responses of insects to these compounds vary greatly. This toxic substance the Flavonoids can contribute negative effect on the feeding behavior, survival, and development of insect especially on larval stage. A study conducted by Deepak R. Jadhav *et al* 2012, to test the effect of three flavonoids on growth and survival of *Helicoverpa armigera* (Hüb) and *Spodoptera litura* (Fab.). A set of experiments were carried out with varying concentrations of three flavonoids namely chlorogenic acid, quercetin and rutin at 23±1°C on growth, development and mortality of larvae of pod borer *Helicoverpa armigera* and tobacco caterpillar Spodoptera litura in artificial diets results indicate a delay in development and suggests that rutin interferes in with physiological processes in both insects at the time of molting.

On the other constituents the saponin, table showed *Capsicum* sp, *Curcuma longa*, and *Cubeba siriboa*, showed Moderate (++) traces, and Abundant (+++) trace was observed on *Lantana camara*. Studies showed that these substances are known by their toxicity to harmful insects (anti-feeding, disturbance of the moult, growth regulation, and mortality), another effect of saponins are the following they can be repellents, deterrents of reproduction, antifeedants, attack (with negative effect) inhibitors, antihormonal substances, toxins or insecticide, J. Harmatha *et al* (2000).

The glycosides, all the samples showed traces (+) of these toxic substance. Glycosides is a defense chemicals against herbivores and pathogens, since glycosides generally have bitter taste and have anti feedant and growth inhibitory activities against insects and;

Lastly, Capsicum sp, Curcuma longa, and Cubeba siriboa showed traces (+) tannins, while *Lantana camara* revealed Moderate (++) result. Tannins is a toxic substance that affect the feeding behavior of insect.

Fruit and Shoot Infestation

The result indicated that the botanical products were effective in reducing the degree of damage of fruit and shoot infestation. Statistical result revealed that that there was significant difference among treatment means. Treatment 6 is significantly different with all the remaining treatments, its indicates that Treatment 2,3,4,5, and the standard check were comparable to each other as reflected to table 2. Thus, all the plant extracts have a positive effect on the reduction against Fruit borer of Eggplant. Same result on the study of Obra 2014 and Patrict *et al.* 2013,

reported that all the mentioned plant product can decrease and suppress Eggplant shoot borer.

Table 2. Degree of Damage of EFSB of Eggplant as affected by Botanical Plant Extracts against Fruit and Shoot Borer (*Leucinodes orbonalis* G.) of Eggplant (*Solanum melongena* L.) under field condition.

	Fruit Infestation %	Shoot Infestation %	Percent reduction of Damage over Control	% Protection against control
T1- Positive Control	29.10^{b}	26.25^{b}	47.33^{a}	79.73^{b}
T2- Curcuma *longa*	28.43^{b}	28.75^{b}	51.56^{a}	75.55^{b}
T3- *Cubeba seriboa*	28.41^{b}	30.00^{b}	53.87^{a}	81.32^{b}
T4- *Lantana camara*	22.27^{b}	25.62^{b}	46.24^{a}	87.32^{b}
T5- *Capsicum sp.*	20.50^{b}	16.88^{b}	30.51^{b}	93.73^{a}
T6- Negative Control	59.11^{a}	56.25^{a}	--------	---------
Level of significant	*	*	*	*
Coefficient of Variation %	12.26	19.28	16.96	14.64
Test Statistic (LSD)	8.81	13.56	11.99	19.52

Means with a column having similar letters are not significantly different at 5% level by Least Significant Different (LSD).

Percent reduction of Population over control

Percent protection against control was high with the hot chilli 93.73% than the standard check 79.73%. The same was observed with *Lantana camara* 87.32%, *Cubeba seriboa* 81.32% and Curcuma longa 75.5%. The result shows that the efficacy of the botanical pesticide was comparable to standard check. And can this be used as basket of option in controlling EFB rather than using synthetic pesticide. The result obtained in the field experiments were accordance with the works of *Obra 2014,* who reported that plant product has been effectively used in controlling ESFB.

Percent Reduction of Damage over Control

Data on Percent reduction of Damage over control was high with *Cubeba seriboa* (53.87%) and Curcuma longa (51.56%) than the standard check with a mean of (47.33%). The same observation with *Lantana camara* (46.24%) and Capsicum sp. (30.51%).

Comparison among treatment means, Treatment 5 garnered the lowest reduction of damage with a mean of 30.51%, followed by Treatment 4, Treatment 1, Treatment 2, and treatment 3 with a means of 46.24%, 47.33%, 51.56%, and 53.87% respectively. Statistical analysis indicated a significant difference among treatment means. As reflected from table 2, treatment 5 was significantly different with all the remaining treatments. Thus, treatment 1, 2, 3, and 4, were comparable to each other. The result showed that all the insecticide given are positively in controlling ESFB, it may also use an alternative measure for synthetic pesticide, given that treatment 1 is comparable with Treatment 2, 3, and 4 in terms of safeness and environmental concern Treatment 2,3,4, and 5 are better than treatment 1.

Table 3. Yield performance of Eggplant as affected byBotanical Plant Extracts against Fruit and Shoot Borer (*Leucinodes orbonalis* G.) of Eggplant (*Solanum melongena* L.).

	Weight of Marketable fruit (t)	Weight of Unmarketable fruit (t)	Computed yield (tons/ha)
T1- Positive control	0.0036^{b}	0.0015^{b}	2.61
T2- *Curcuma longa*	0.0035^{b}	0.0015^{b}	2.55
T3- *Cubeba seriboa*	0.0036^{b}	0.0014^{b}	2.58
T4- *Lantana camara*	0.0037^{b}	0.0015^{b}	2.69
T5- Capsicum sp	0.0040^{a}	0.0012^{b}	2.89
T6- Negative control	0.0025^{c}	0.0024^{a}	1.83
Level of significant	*	*	-----
Coefficient of variation %	3.10	12.75	-----
Test Statistic (LSD)	0.25	0.47	-----

Means with a column having similar letters are not significantly different at 5% level by Least Significant Different (LSD).

Weight of Marketable fruit (t) and weight of Non-marketable fruit (t)

On the weight of marketable fruit, statistical analysis indicated significant difference among treatment means. The weight of the marketable fruits Capsicum sp. was significantly different with the negative control same explanation to the other plant pesticide including the standard check. Further explanation *Lantana camara*, *Cubeba seriboa*, and Curcuma longa observed that it was par with the standard check. It means that all the given plant pesticide has the capability to suppress ESFB resulting to high yield of eggplant.

Data on the weight of unmarketable fruit of eggplant analysis revealed significant different among treatment means.

The weight of the unmarketable fruit of the standard check 0.0015t/ha was at par with *Curcuma longa* 0.0015t/ha, *Lantana camara* 0.0015t/ha, *Cubeba seriboa* 0.0014t/ha, and *Capsicum* sp with a mean of 0.0012t/ha, respectively, further explanation that all the botanical extracts revealed comparable with the standard check. Negative control obtained the highest weight of unmarketable fruit is significantly different with all the other treatments including the standard check.

Computed fruit yield per hectare (kg)

Table 3 shows the computed yield (tons/ha) as affected by Botanical Plant Extracts against Fruit and Shoot Borer (*Leucinodes orbonalis* G.) of Eggplant (*Solanum melongena* L.). Result further shows that treatment 5 has the highest yield of 2.89tons/ha, followed by treatment 4, treatment 1, treatment 3, and treatment 2 with a yield of 2.69ktons/ha, 2.61tons/ha, 2.58tons/ha, 2.55tons/ha, and 1.83tons/ha respectively. Low yield contributed with the interaction of environment factors like temperature (high and low) and soil moisture resulting yields fluctuate during the priming period.

Cconclusion

As reflected to the result of the study it was concluded that botanical plant extract used were comparable to the efficacy of the standard check. Thus, it can be used as an alternative strategy in the management of EFSB in the Integrated Pest Management (IPM) Program for the insect attacking eggplant plants. Another reason is, botanical product are more safer to used, increase income to producers, reduced cost, thus conserving the natural enemies of the pest, no pesticide residue and it well fit to the organic crop production system. It was also recommending that the botanical product can be conducted/tested to other vegetable crops. Continuation of the study under in-vivo procedures should likewise be established, the LD_{50} of the botanical plant product and the Mortality time. Product development is recommended for commercialization to be part of the extension program of the campus for Good Agricultural Practices (GAP).

Acknowledgment

This study will not be completed without those persons who mold and inspired the main author; Dr. Ricardo Casauay, Prof. Andrea Flores, Prof. Yvette Medrano for their limitless encouragement insightful comments for the study, to Engr. Florentino M. Tomaneng *for* his unselfish suggestions and criticism for the betterment of the study, my infinite thank you to all of you. And above all, to God, my only stranglehold, with whom I have so much faith. I believe that all these are not impossible without the unremitting flow of His blessing, love and guidance; of whom I have acknowledged and engaged my whole trust and confidence. Dear Lord, thank you and I love you.

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