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Efficacy of Ginseng (Panax ginseng) Root Extract against Eggplant's Fruit and Shoot Borers (Leucinodes orbonalis)

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Running title

Ginseng Root Extract Against Eggplant's Fruit and Shoot Borer

Abstract

Fruit and shoot borer (EFSB) is the most damaging insect pest of eggplant. Thus, effect of different concentrations of Ginseng root extract on EFSB under laboratory and field conditions were studied. The experiment was laid out using Complete Randomized Design with 6 treatments and replicated thrice. The treatments were: T1 - Control (water); T2 - 20% ginseng root extract; T3 - 40% ginseng root extract; T4 - 60% ginseng root extract; T5 - 80% ginseng root extract and T6 - 100% ginseng root extract. Under laboratory condition, % mortality of FBSB (5) was highest under 100% ginseng root extract. Eggplants applied with 100% Ginseng root extract had no damage at all from the FBSB while fruits under the control treatment and 20% ginseng root extract were extremely damaged inside and out and the FBSB managed to live inside the fruit. Under field condition, eggplants under the control treatment, 20% and 40% ginseng root extracts were extremely damaged inside and out (5), and the EFSB managed to live inside the fruit while fruits applied with 100% ginseng root extract were not damaged by FBSB (1.33). Marketable fruits (6.28 ton/ha) and economic yield were also highest (66.49%) in crops applied with 100% ginseng root extract. Hence, the higher the concentration of ginseng root extract applied to fruits, the lower the degree of damage up to no damage it does to plants. Thus, 100% ginseng root extract is effective against fruit and shoot borer.

Keywords: eggplant; fruit and shoot borer; ginseng root extract; field condition; laboratory condition

Introduction

Eggplant (*Solanum melongena* L.) is one of the major vegetable crops in the Philippines and in other parts of the world particularly in South Asia. It is also known as brinjal and aubergine but locally known as talong and comes in different shapes, sizes, varieties and colors (Jett, 2020). It is known for its high fiber, vitamins, minerals and antioxidants content which supports heart health, blood cholesterol, cancer, cognitive function, weight management and eye health (Ware, 2019). It has also the largest production area among the different vegetables in the Philippines with an average of 21.7 ha/yr from 2014-2019 [1] and accounts for 28% of the production amongst the most important crops in the country [2]. Hence, eggplant is considered as one of the major cash crops in the country.

The major pest of eggplant affecting largely its yield is the fruit and shoot borer (*Leucinodes orbonalis)*. The larval stage of this moth is responsible for the damage it inflicts on eggplants. They feed on leaves and go inside the shoots and stem creates a tunnel that results to wilting. They also feed on flowers which results to dropping and deformed fruits. However, most of the economic damage is on fruits in which they create a hole outside and tunnel inside with their excrement on it resulting to low quality fruits which are non-marketable [1, 3]. The yield losses due to FSB reached to about 80% [4].

To avoid these problems caused by EFSB, many of the farmers resort to using pesticides [4-6] as compared to other control and prevention measures such as manual picking and the use of pheromone traps which was proved to be ineffective [3]. Many of the eggplant farmers spray their crops frequently with different mixtures of insecticides to avoid EFSB damage which results to higher production cost and lead to health and environmental hazards. Insecticide residues on soil and fruits samples were

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detected on eggplant farms in Pangasinan, Philippines. The farm workers also experienced pesticide-related health hazards such as skin irritations, eye redness, muscle pains and headache [7].

Several researches were also focused on the use of genetically modified organism as effective control measure for EFSB. Though, studies proved that it is highly effective [3], its field trial was halted by the Supreme Court and nullify the existing biosafety guidelines due to moral and social concerns [8-9]. With this scenario, the use of natural pesticide from ginseng root extract was conceptualized. Studies have shown that ginsenoside, the most important component isolated from *Panax ginseng,* exhibits a variety of biological activities. It is already being used for human infections caused by endoparasites, including protozoa, nematodes, trematodes and cestodes. It has been proven that polyacetylenes from ginseng (*Panax ginseng*) have significant cytotoxic activity against T.b brucei but are hardly toxic to human cells. It also has anti-fungal and anti-microbial properties [10]. Thus, with its potential as natural pesticide, its effectiveness on EFSB was investigated.

Materials and methods

Test crop used in the study

Morena F1 variety was the test crop used in the study. It is long, purple, Cylindrical, and with Excellent fruit quality [11].

Experimental design and treatments

This experiment was laid out using Complete Randomized Design (CRD) with 6 treatments replicated 3 times in laboratory condition. Under field condition, the experiment was laid out in Randomized Complete Block Design (RCBD) with 3 blocks and divided into 6 plots. The following are the treatments: T1-0% Control (Water); T2-20% Ginseng roots extract; T3-40% Ginseng roots extract; T4-60% Ginseng roots extract; T5-80% Ginseng roots extract and; T6-100% Ginseng roots extract.

Preparation and laying out of plots

The area was plowed and harrowed twice alternately at one week interval. It was plowed at a depth of 15 to 20 cm and harrowed twice to break the clods and level the field. A well-pulverized soil promotes good soil aeration and enhances root formation. The total area for the field experiment was $378m^2$.The distance between blocks and plots was 1 meter. The distance between hills is 0.5 m. Distance between replicates was 1.0 m.

Seedling preparation and transplanting

Seeds were sowed on seedling trays. Sowing medium used was one part vermicompost, one part garden soil obtained from the floodplain of Brgy. Talolong, Lopez, Quezon and one part carbonized rice hull (CRH). The garden soil was drenched with boiling water before mixing with CRH and vermicompost. Before sowing, seeds were soaked in clean water overnight. It was sow instantly on the morning with one seed per hole at a depth of 0.5 cm. It was covered with soil thinly and sprinkled with water. Four months after sowing, eggplant was transplanted in the prepared plots on the afternoon. Vermicompost was put into the hole before planting. One seedling per hill was planted in the plots.

Collection and preparation of ginseng root extract

Ginseng roots with its lower stem were gathered and washed. The first layer of its covering/skin has been peeled off. It was then finely chopped; water was added with half of the weight of the roots and boiled. Then it has been put inside a blender to be mixed thoroughly. The extract was collected using a cloth strainer. To make different concentrations, the extract was diluted by adding water.

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Laboratory testing of ginseng root extract against EFSB

Under laboratory condition, 5 ml of each of the treatments were put in the petri dishes. Twenty EFSB larvae were put in the petri dish for each of the treatment and were monitored after every 10 minutes, 20 minutes, 30 minutes and 1 hour.

Eggplants were also put on each petri dish. 20 ml of each treatment was sprayed on the eggplants. Ten EFSB larvae were inoculated on each eggplant and were monitored after a day.

Field testing of ginseng root extract against EFSB

Ten instar EFSB larvae were released in the field before the application of each treatments. Ginseng root extract with different concentrations was prepared and put in a 16-liter knapsack sprayer and sprayed into the crops 15 DAT [12].

Cultural management for eggplant

Water management. If there is no rain, watering was done at 7, 21 and 30 days after transplanting.

Weeding. It was done 14 days after transplanting and was hilled-up 21 days after transplanting.

Fertilization. Complete fertilizer (14-14-14) was applied side-dressed 20 cm away from the base of the plant.

Pruning. Lateral branches or water sprouts were removed together with unnecessary leaves.

Harvesting. Harvesting was done 50 days after transplanting early in the morning while the fruits were tender and young. It was done twice a week. Damaged fruits were removed.

Data gathered

Under laboratory condition

Mortality. Mortality (%) of eggplant was determined after 10 minutes, 20 minutes, 30 minutes and after 1 hr.

Under field condition

Marketable yield. Fruits considered marketable were weighed using a weighing scale.

Non-marketable yield. Damaged fruits due to EFSB were weighed.

Insect incidence. Percent damage was computed using the ff. formula:

$$\%\ \text{damage} \quad \frac{\text{Number of Non-Marketable fruits}}{\text{Number of Total Yield}} \times 100$$

Degree of damage (for both eggplants tested in the laboratory and in the field). Eggplants applied with different treatments were observed a day after ginseng root extract application. They were assessed based on the following criteria:

5 - the eggplant was extremely damaged inside and out, and the EFSB managed to live inside the fruit

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4 - the eggplant's exterior was extremely damaged and has a slight damage inside, and the EFSB still managed to live in it
3 - the eggplant was slightly damaged exteriorly and interiorly, but the EFSB was not able to penetrate inside the fruit
2 - only the eggplant's skin/covering was slightly damaged
1 - the eggplant was not affected or damaged by the EFSB

Statistical analysis

The data on mortality was obtained through the following formula:

$$\text{Mortality (\%)} = \frac{\text{no. of dead fruit and shoot borers}}{\text{total no. of EFSB inoculated}} \times 100$$

The Analysis of Variance for CRD and RCBD was used for both the experiments under laboratory and field conditions. Further tests using Tukeys Test was used to compare the differences among means through Statistics for Agricultural Research (STAR) software.

Results and Discussion

Mortality of fruit and shoot borer using different concentrations of ginseng roots extract under laboratory condition

Ten minutes after the application of treatments, EFSB in water (control), 20%-60% ginseng root extract (GRE) had no mortality while those applied with 80% and 100% ginseng rot extract had 6.6% and 20% mortality and statistically significant with each other (Table 1). Twenty minutes after application, again no mortality was observed in those EFSB applied with20%-60% GRE and is not statistically significant with the % mortality of ESFB applied with 80% GRE(20%). However, the latter was not also statistically significant with those applied with 100% GRE (40%). Forty minutes after GRE application, again no mortality was observed under the control and EFSB applied with 20 and 40% GRE. While those applied with 60% had 20% mortality, 80% GRE had 40% mortality and 100% GRE had 66.66% mortality which was statistically significant with the rests of the treatments. Sixty minutes after the treatment application, again EFSB under the Control treatment and applied with 20% GRE, no mortality was observed. While, those applied with 40%, 60%, 80% and 100% GRE had 20%, 46.6%, 66.6% and 100% mortality. The results were significantly different from each other and shows that the higher the concentration of ginseng root extract, the higher the mortality (%) of EFSB (Fig. 2). It might be because *Panax ginseng* has steroid glycosides and triterpene saponins called Ginsenosides. It is use mainly by plants for defense against certain pathogens such as bacteria, fungi and other microorganisms [13]. It is also genuinely bitter thus, prohibits some animals and insects to devour the plants. It is known that ginseng is rarely attack by insect pests [14] and the presence of ginsenosides could be the reason for the 100% mortality on the FSB applied with 100% ginseng root extract.

Table 1. Mortality (%) of EFSB after Treatment Application.

TREATMENT	(%) MORTALITY OF EFSB AFTER 10 MINUTES	(%) MORTALITY OF EFSB AFTER 20 MINUTES	(%) MORTALITY OF EFSB AFTER 40 MINUTES	(%) MORTALITY OF EFSB AFTER 60 MINUTES
T1- Control (Water)	0.00 b	0.00 b	0.00 c	0.0 e
T2- 20% Ginseng root extract + 80% Water	0.00 b	0.00 b	0.00 c	0.0 e
T3- 40% Ginseng root extract + 60% Water	0.00 b	0.00 b	0.00 c	20.0 d
T4- 60% Ginseng root extract + 40% Water	0.00 b	0.00 b	20.0 bc	46.6 c

T5- 80% Ginseng root extract + 20% Water	6.6 b	20.0 ab	40.0 b	66.6 b
T6- 100% Ginseng root extract	20.00 a	40.0 a	66.6 a	100.0 a

In a column the same letters indicate that the values are not statistically different by Least Significant Difference Test (P>0.05). CV = coefficient of variation

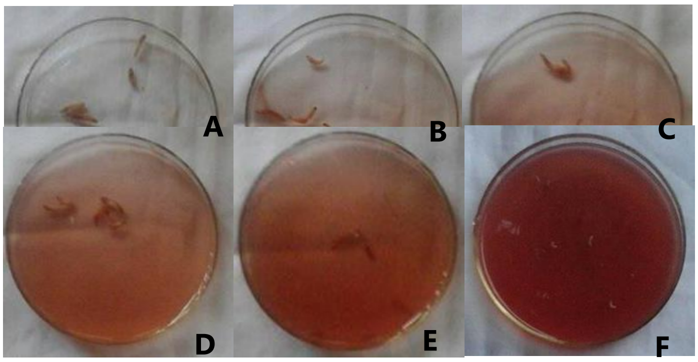

Fig. 2. Fruit and shoot borers applied with different concentrations of ginseng root extract under laboratory condition. A – Control; B – 20% GRE; C – 40% GRE; D – 60% GRE; E -80% GRE and; F – 100% GRE.

Degree and percentage of damage caused by eggplant's fruit and shoot borers under laboratory and field conditions

Under laboratory condition (Table 2), eggplants under the control treatment (water) and those applied with 20% GRE had the highest degree of damage since the fruits were extremely damaged inside and out and the EFSB managed to live inside the fruit. Fruit applied with 40% GRE had 4.67 degree of damage which is not statistically significant with that of the control and 20% GRE. Eggplants applied with 60% and 80% GRE had a degree of damage of 3.0 and 2.33 respectively which is not statistically significant with each other. The fruits were both slightly damaged exteriorly and interiorly, but the FSBs were not able to penetrate inside the fruit. Conversely, eggplants applied with 100% GRE the eggplant was not affected or damaged by the EFSB

Under field condition, same with the degree of damage inflicted by FSB under laboratory condition, no significant differences were observed on the fruit under the control treatment and those applied with 20% and 40% GRE respectively. While those applied with 60%and 80% GRE degree of damage on the fruit was not statistically significant with one another, that the fruits applied with 60% GRE were slightly damaged exteriorly and interiorly, but the EFSB were not able to penetrate inside the fruit. Meanwhile, fruit's skin was slightly damaged when applied with 80% GRE. Just like the fruits under laboratory condition, those applied with 100% GRE had 1.33 degree of damage and generally no damage done by FSB were observed on the crop.

It only shows that the higher the concentration of Ginseng root extract, the lesser chances for FSB to damage the eggplant. Again, it might be because of the high levels of Ginsenoside molecules (>3%) [14] which are naturally bitter that discouraged the FSB from consuming and damaging the eggplant. It was also reported that gingenosides could inhibit larvae from feeding and hamper oviposition [14].

Table 2. Degree of damage caused by FSB in eggplant applied with ginseng root extract

Treatment	Degree of Damage		% Damage (Field)
	Laboratory Condition	Field Condition	

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T1- 0% Control	5.00 a	5.00 a	73.87 a
T2- 20% Ginseng root extract + 80% Water	5.00 a	5.00 a	73.42 a
T3- 40% Ginseng root extract + 60% Water	4.67 a	5.00 a	69.78 a
T4- 60% Ginseng root extract + 40% Water	3.00 b	3.33 b	61.18 b
T5- 80% Ginseng root extract + 20% Water	2.33 b	2.33 bc	53.79 c
T6- 100% Ginseng root extract	1.00 c	1.33 c	33.51 d

In a column the same letters indicate that the values are not significantly different by Least Significant Difference Test (P>0.05). CV = coefficient of variation

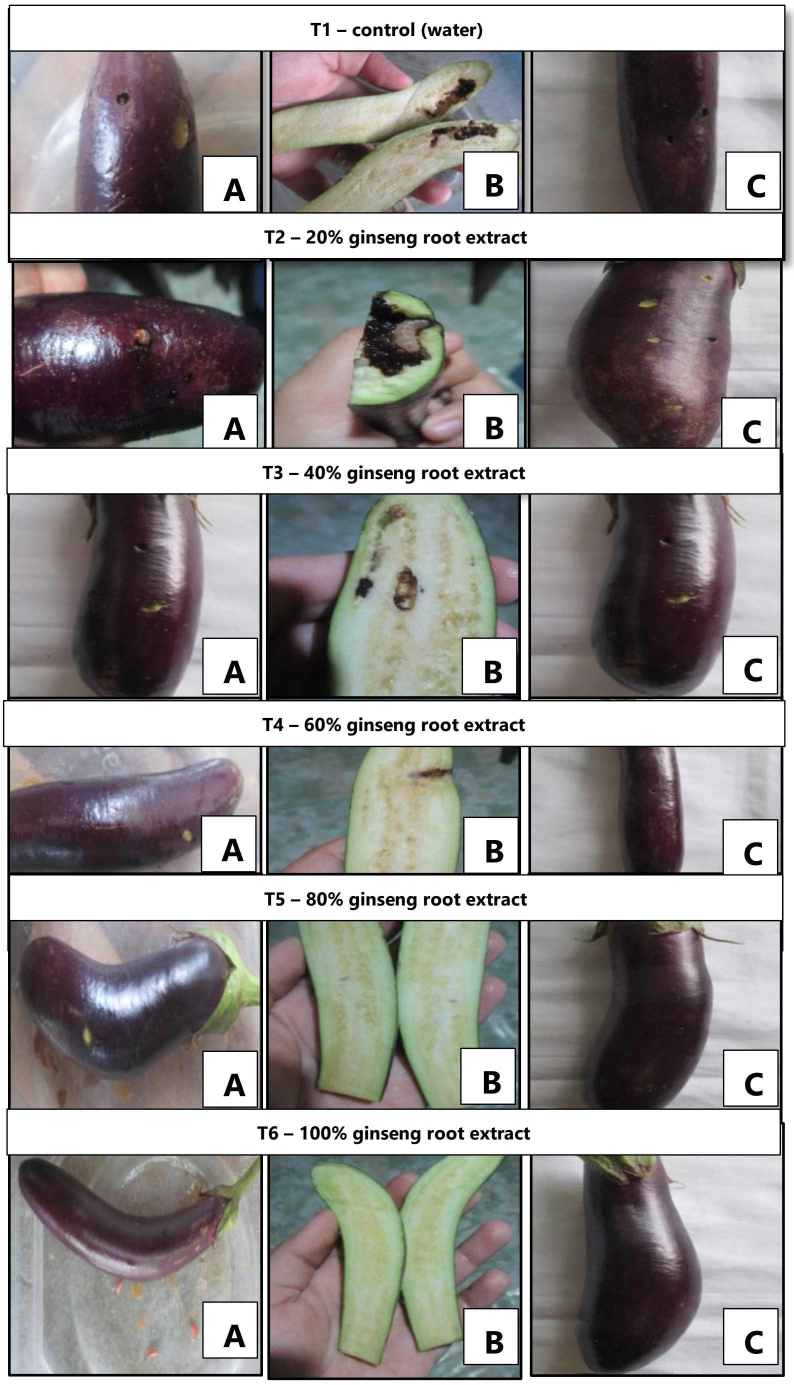

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Fig. 3. Eggplants applied with different concentrations of GRE under Laboratory (A, B) and Field Conditions (B, C)

Yield of eggplant applied with different concentrations of ginseng root extract

Yield and yield components of eggplants were obtained (Table 2) and among the different treatments, fruits applied with 100% GRE had the highest weight of marketable fruits (6.28 tons/ha) thus, lead to higher economic yield and statistically significant with the rest of the treatments. While, fruits with the highest weight of non-marketable fruits were those under control treatment and not statistically significant with fruits applied with 20% GRE. In terms of total yield, fruits applied with 100% GRE had the highest yield.

Most farmers in the Philippines rely to heavy use of pesticide to reduce of not eliminate the damage caused by FSB on eggplants (Francisco, 2014). The usual yield of eggplant is 9.95 [15] tons/ha and the total yield reached for fruits applied with 100% GRE was 9.71 ton/ha. Damage on the fruits were not totally eradicated as seen in the weight of non-marketable fruits but at least reduced as compared with the yield obtained from other fruits applied with lower concentrations. As the concentration increases, the weight of marketable fruits and the economic yield (%) also increase and the weight of marketable fruits decrease. This just mean that GRE is an effective natural pesticide against fruit and shoot borer and its effectiveness is concentration dependent. The study coincides with the result of Duza et al. [12] where the efficacy of botanical extracts is comparable with that of pesticide. All the botanical extracts they used contains high amount of saponins [12]. Genginoside is a saponin which is usually extracted from plants. Saponins are known to interfere feeding behavior of insects and disturb its developmental stages. It is also known that saponins is toxic to insects and could increase mortality [16]. Another study on the effects of saponins on larvae was evaluated and the results revealed that saponins could result to contact and stomach toxicity that could lead to larval death [17].

Table 3. Yield and yield components of eggplant applied with different concentrations of ginseng root extract

TREATMENT	Marketable Fruits(ton/ha)	Non-marketable Fruits(ton/ha)	Total Yield (ton / ha)	Economic Yield (%)
T1- Control (Water)	2.28 d	6.44 ab	8.71 bc	26.13 d
T2- 20% Ginseng root extract + 80% Water	2.35 d	6.47 a	8.83 abc	26.58 d
T3- 40% Ginseng root extract + 60% Water	2.66 cd	6.15 b	8.81 abc	30.22 d
T4- 60% Ginseng root extract + 40% Water	3.27 c	5.15 c	8.41 c	38.52 c
T5- 80% Ginseng root extract + 20% Water	4.95 b	5.21 c	9.45 ab	46.21 b
T6- 100% Ginseng root extract	6.28 a	3.43 d	9.71 a	66.49 a

In a column the same letters indicate that the values are not statistically different by Least Significant Difference Test (P>0.05). CV = coefficient of variation

Conclusions

The efficacy of ginseng root extract against fruit and shoot borer is concentration dependent. Higher mortality of fruit and shoot borer, lower degree of damage, lower percent damage, higher marketable and economic yield and lowest non-marketable yield was observed in crops applied with 100% ginseng root extract.

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