BIBLIOGRAPHY

LIGAT, JOAN V. APRIL 2012. Trapping of Slugs (*Agriolimax reticulates*Muller) Infesting Strawberry (*Fragaria* × *ananassa*Duch). Benguet State University, La Trinidad Benguet.

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ABSTRACT

The study was conducted at Entomology Experimental Area, Balili, La Trinidad Benguet to determine the density of Board trap that could collect substantial number of slugs infesting strawberry, to monitor the injury inflected by the pest in the strawberry fruits and to determine the effect of board trap to the yield of strawberry fruits.

The number of slugs were high on the 16 traps and lowest was in the 9 traps.

The 16 trap on the plots of strawberry fruits had the least slug's injury.

The strawberry plots with 16 had the highest marketable fruits and lowest non marketable fruits.

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INTRODUCTION

Slugs (*Agriolimax reticulates*Muller) are one of known pest of cultivated crops and as damaging pest in the production of strawberry fields and home gardens. Slugs feed on ripe fruits and produce rough holes that render the fruit marketable. They also feed on the leaves and effect of rasping feeding are ragged holes in the leaves. Slug's injury is sometimes difficult to diagnose. Smaller leaves may be eaten entirely, while only the edges leaves may be consumed (Getz, 1999).

The presence of slime trails often is the indication of slugs' activity. Slugs can be serving as insect vectors of bacterial and fungal disease of plants. The injury to plants which includes lettuces, carrots, Chinese cabbage and strawberry consist of chewed holes on the stem, flowers and fruits. These widely distributed to tropical and temperate zone (Drubble, 2003).

The pest emphasized by unique features as torsion, a twisting visceral mass in which in some instances, biologist hypothesized it as an adaptation that protects their head by allowing it to enter to the shell first during withdrawal from potential predators (Chapman, 1982).

Slugs are classified as Gastropods. They feed on a variety of plants materials that they ate by rasping with specialized mouthparts. They feed on mostly nights, although they occasionally are active on overcast or rainy days. During hot and dry seasons they may be temporarily inactive (Berg, 2003).

They can be found on the plant at night and in the early morning and under the plastic and mulch during the day and they are sensitive to dryness and will seek out of

moisture making the humid environment under the mulch of strawberries attracted to them.

Hence, the importance of the study guides and provide important information to farmers in establishing appropriate management and strategies in controlling pest such as sow bugs, earwigs and small insects and these are important to guide also in monitoring and controlling its population of insects.

The objective of the study is to determine the density of board trap that could collect substantial number of slugs infesting strawberry. To monitor the injury inflected by the pest in the strawberry fruits and to determine the effect of board trap to the yield of strawberry.

The study was conducted at the Benguet State University, Entomology Instruction Area at Balili, La Trinidad,and Benguet from October 2011 to March 2012.

REVIEW OF LITERATURE

Production of Strawberry

Strawberry (*Fragaria* × *ananassa*Duch) is a viable crop in most areas of the Philippines. Strawberry belongs to genus Fragaria in Rose family. They are low growing perennial herb that may live for many years. These plants have short roots and long slender stems and grow along the surface of the soil. They were propagated by cutting off and replanting the long runners produced by the plant. It can grow best in cool, moist climate and any kind of soil (Johnson, 2005).

Strawberry is one of the most number one crops planted by farmers and most grown crops in the municipality of La Trinidad.

As with any crop, producing strawberries organically entails a system approach to the whole farm rather than just substituting approved organic materials. Many practices are the same in organic and conventional strawberry production but the fundamentals approached to the soil husbandry and pest management. Some conventional system can maintain strawberry beds for five years for controlling weeds, disease and insects but organic growers rely on crop rotation (Sideman, 1999).

Reiger (2000) stated that the producers can thus higher returns from strawberries that from most other crop that's why farmers used synthetic fertilizers and pesticides and requires soil building and biological pesticides and requires soil building and biological pest control to maintain the quality of the plant to avoid lost. Farmers cannot afford to buy these insecticides due to high prices.

Morphology and Behavior of Slugs

Like other pulmunate land snails, slugs (*Agriolimax reticulates*) have two pairs of feelers on their head. The upper pairs light sensing while the lower pair is the sense of smell. The mantle is the respiratory opening, which easy to see when open but difficult to see when closed. Slugs moves by the rhythmic waves of muscular contraction. It simultaneously secretes a layer of mucus on which it travels, prevent damage to food tissues. Some slugs' species hibernate underground during the minter in the temperate climates, but in other species adults die (Muller, 2001).

Ecology of Slugs

Ligat and Colting (2003) cited that any slugs play an important role in ecosystem by eating dead leaves, fungus and decaying vegetable material. Slugs feed mainly also on variety plants as decaying plant matter and ripening fruit of tomatoes and strawberries. Other species of slugs ate parts of living plants. Some slugs are predators and ate other slugs and snails, or earworms. Most carnivorous on occasion also eat carrion including dead of their own kind.

Taxonomy of Slugs

The species of slugs requires a different length of time for the development of life cycle. Slugs' egg can be found outdoors during any month of year, most in spring and summer. Most species over winter as adults or nearly mature, during warm and wet climatic conditions the rate at which develop and thus making possible second vegetables, field crops and ornamental throughout the continent. They attacked seedlings of a number of crops, particularly alfalfa and strawberries (Metcalf, 1979).

Slug Natural Enemies

Wood (2001) cited that some slugs many natural enemies including ground beetles, pathogens, toads and birds but most rarely effective enough to provide satisfactory control in the garden. One predator found in some California gardens is a large Staphylinid beetle (Coleopterans) called the devil coach horse (OcypusOlens). Larval fireflies are also feeding on slugs.

Characteristics of Different Family of Slugs

Family Agriolimacidae, the grey filed slug, vey variable in color, creamy and rarely black spotted slugs. Family Limacidae, the great grey little slugs, measures (10-) 20cm), (4-8) in length and is generally a light grayish, with darker spots and blotches.

Family Arionidae, the black field slug. It can be recognized by its yellow sole and yellow mucus it produces. The black filed slugs can live up to one year. Family Philomycidae, the Palliser, relatively small and about 2.5 cm in length and they are dark and slimy appearance. These slug feed in lichen and not pest (Cameron, 2009).

MATERIALS AND METHODOLOGY

Materials

The materials that were used in the study were Styrofoam, Wooden Board, pen, note book, multipurpose container, pin, salt, mixing spoon, packing tape, plastic cover, strawberry runners, digital camera and other reference materials such as entomology books.

Land Preparation

A 250 square m^2 area consisting of 10 pilots was prepared and it was subdivided into five treatments. Cleaning digging the soil with the used of grab hoe and application of chicken Dung and Gypsum after planting a variety of Strawberry plants were appropriately done.

The planted strawberry was mulched with cogon grass intended to deprive grass growth.

Application of Board Trap

A prepared board trap (44 × 16 cm in size) of Styrofoam (Figure 1). Each trap replicated four times and were assembled at the field. The traps were place at the surfaced of the soil to concentrate slugs that seek shelter under them.

Traps were checked every morning and there were 176 Board traps used in trapping slugs infesting strawberry.

Figure 1. The board traps used in the trapping of slugs infesting strawberry.

Collection of Trapped Slugs

Monitoring the slug's population was donedaily early in the morning and for a period of four weeks for the collection of trapped slugs. The slugs were scraped off, scretonized and were drown in a salt solution or inside a multi-purpose plastic container after counting and recording. There were 10 plots and trap pest in each treatment had the 10 - 15 slugs was counted and were recorded and at the same time it was documented with the use of digital camera.

Monitoring the Injury Inflected by the Pest on Strawberry Fruits

The monitoring of the injury of strawberry cause by the pest was done through visual observation on the Strawberry fruits.

There were five treatments and it was replicated four times. The injury was based on the harvested fruits and the infected and good fruits was counted and separated. Using the Randomized Complete Block Design (RCBD). The number of Board traps and Area of plots covered were the following:

Treatment	No. of Board Trap	Area of Plots Covered (%)
T_1	16	100
T_2	13	80
T_3	9	50
T_4	6	30
T_5	0	Untreated

Effectiveness of Board Trap

The fruits were harvested twice a week in each treatment. The infected fruits and good fruits was separated and were counted and recorded and were weight in grams. The yield of strawberry fruits was noted by having the total number of infected and good fruits as well as their marketable and non marketable yield.

Data Gathered

1. Population of Slugs. The total number of Slug collected from the Board Trap.
2. Injury. The total number of strawberry fruits damaged by slugs.
3. Yield. Weight (g) of strawberry fruits after harvesting, (nonmarketable and non marketable).

Data Computed

1. Percent Injury = $\frac{\text{No. of infected fruits}}{\text{Total No. of Infected and Good Fruits}} \times 100$

RESULTS AND DISCUSSION

Population of Slugs

No significant differences on the mean total population of slugs were obtained as shown in the table 1. The 16 number of trap obtained the highest population of 477.Table 1 showthat under the untreated listed the lowest slug's population of 350.The different treatments were comparable to each other regardless of the differences in their means.

The 16 number of trap having the 119.2 means could decrease the population of slugs on strawberry fruits because it was the more traps used in trapping slugs infesting strawberry.Such results on the increasing slugs population could be attributed by the frequent weather conditions in which slugs prefers moist than dry area.

The Table 1 shows a non significant differences in comparable with the untreated having a mean of 87.5, while the 6 number of trap had a mean of 118.25, 114.75 for the 13 number of trap and 16 number of trap had a mean of 119.25.

Table1. The total population of slugs on the different number of traps from November 2011 to February 2012

NUMBER OF TRAPS	TOTAL	MEAN
16	477	119.25[a]
13	459	114.75[a]
9	447	111.75[a]
6	473	118.25[a]
Without Trap	350	87.50[a]

Means with the same letters are not significantly different at 5% level of significance by DMRT

Injury to Strawberry Fruits

Injury of fruits was noted by having the number of fruits infected by slugs. Results show that all the treatments under the 16 number of trap listed the lowest slug's injury having a total of 178. However, the 9 number of trap obtained the highest slugs injury having a total of 225(Table 2).

No significant differences to the injury of slugs on strawberry fruits (Table 2 and Figure 2-3). The different number of traps was comparable to each other in regardless of the differences in their means.

Slug's injury on the 16 number of trap with a mean of 44.50 noted the lowest injury of slug's infestation, followed by the 6 number of trap having 55.50 mean: 56.0 for the 13 number of board trap and untreated having a mean of 62.75.

Such results, 9 number of trap listed the highest number of slug's injury to the ripe strawberry fruits with a 63.75 of fruits infested.Hence, injury of slugs to strawberry plants consist of chewed holes in the fruits.

Table 2. The percent injury of strawberry fruits damaged by slugs from November 2011 to February 2012

NUMBER OF TRAPS	TOTAL	MEAN
16	178	44.50[a]
13	224	56.00[a]
9	255	63.75[a]
6	222	55.50[a]
Without Trap	251	62.75[a]

Means with the same letters are not significantly different at 5% level of significance by DMRT

Figure 2. Slugs Injury to Strawberry fruits

Figure 3. Slug's feeding to Strawberry fruits

Yield

The Table 3 shows significant interaction was observed on marketable yield of strawberry fruits. The 16 number of trap obtained the highest total of fruits harvested and highest yield having a total of 1237 and a 309.25 mean of fruits harvested.Results indicated that the 6 number of trap obtained the lowest yield having a total of 615 and a 153.75 mean of fruits harvested.

The more board trap used were the highest yield of fruits harvested and the least board trap used had the lowest yield fruits harvested.

Such results, 16 number of trapped obtained the highest marketable yield and were theone hundred percent area of plots covered of board trap.The 6 number of trap obtained the lowest marketable yield and were the thirty percent of plots covered of board trap.

Table 3. The marketable yield of strawberry fruits after 4 weeks application of board traps

NUMBER OF TRAPS	MARKETABLE (g) TOTAL	MEAN
16	1,237	309.75[a]
13	979	244.75[ab]
9	1,009	252.25[ab]
6	615	153.75[b]
Without Trap	673	168.25[b]

Means with the same letters are not significantly different at 5% level of significance by DMRT

The Table 4 shows highly significant were observed on the non marketable yield of strawberry fruits. The results indicated the increased of nonmarketable yield strawberry fruits. The marketable yield decreases accounted with the increased of non marketable yield of strawberry fruits.

Statistical analysis shows on Table 4 highly significant on the non marketable yield of strawberry fruits.

The Table 4 shows that 16 number of trap obtained the lowest yield having a total of 615 and a non marketable mean of 153.75. The 6 number of trap obtained the highest yield having a total of 1394 and a non marketable mean of 348.5.

Table 4. The non marketable yield of strawberry fruits after 4 weeks application of board traps

NUMBER OF TRAPS	NON-MARKETABLE (g) TOTAL	MEAN
16	615	153.70[c]
13	1,120	255.00[b]
9	1,204	309.00[ab]
6	1,394	348.50[a]
Without Trap	902	225.50[c]

Means with the same letters are not significantly different at 5% level of significance by DMRT

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted to determine the density of board trap could collect substantial number of slugs, to monitor the injury inflected by the pest in the strawberry fruits and to determine the effect of board trap to the yield of strawberry fruits at the Benguet State University Entomology Experimental Area, Balili, La Trinidad, Benguet from October 2011 to March 2012.

A 250 square meter area was prepared, subdivided in to five treatments and planted with strawberry plant. One week after planting, chicken dung and gypsum application followed by mulching of cogon grass were done as required. Regularly, monitoring of the population and injury of slugs on the strawberry was done daily and early in the morning.

Slug's infestation on every treatment was observed after one month in which, board trap application were started.

After the application, it was observed that board trap could be used in controlling slugs. Statistical analysis reveals that the different number of treatments to the population and injury of slugs were no significant differences to each other. All treatments from that of the untreated.

Strawberry fruits were then measured by observing the plants and by having the non marketable and marketable yield as well as the total number of injury of slugs on strawberry fruits.

There was an effectiveness of board trap to the yield of strawberry fruits.

Meanwhile, no significant differences were observed under the number of traps was comparable to each other in regardless of the differences in their means. As the board traps were applied, slug's injury to strawberry fruits decreases on the 16 number of traps comparable with the 9 number of traps which increase of slug's injury.

Furthermore, non marketable as well as the marketable yield of strawberry fruits obtained significant interaction.However, the 6 number of traps listed the highest marketable yield.

It was also observed that there was no damages effect of strawberry leaves it was only to strawberry fruits. Injury of slugs consists of chewed holes in the fruits.

Thus, board trap can be recommended as effective control of slugs and other insects such as thrips, cutworm and snails.

Conclusion

Based on the results, it was therefore concluded that 6 number of trap had the highest marketable yield of strawberry fruits and lowest on thenon marketable yield. Board trap made up of Styrofoam can control garden slugs.

Recommendation

For easier controlling population and injury of slugs to strawberry plant, 16 number of trap in trapping slugs is recommended.

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APPENDICES

Appendix Table 1. The total population of slugs on the different number of board traps

No. of Traps	POPULATION TOTAL R_1	R_2	R_3	R_4	MEAN
16	163	124	109	81	119.250[a]
13	154	130	107	68	114.750[a]
9	159	106	117	65	111.750[a]
6	155	128	111	79	118.500[a]
Without Trap	74	88	100	88	87.500[a]

ANOVA

SOURCES OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F 5%	TABULATED F 1%
Replication	3	10657.800	2552.600	9.0278	3.49	5.95
Treatments	4	2740.200	685.150	1.7408[ns]	3.23	5.41
Error	12	4722.200	393.517			
Total	19	18120.200				

[ns]-Not significant CV=17.98%

Appendix Table 2.The percentinjury of strawberry fruits damaged by slugs

No. of Traps	%INJURY				
	R_1	R_2	R_3	R_4	MEAN
16	71	39	37	31	44.500[a]
13	55	48	53	68	56.00[a]
9	65	53	68	69	63.750[a]
6	74	70	71	57	55.500[a]
Without Trap	65	59	54	73	62.750[a]

ANOVA

SOURCES OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	COMPUTED F	TABULATED F	
					5%	1%
Replication	3	1029.800	343.267	2.2538	3.49	5.95
Treatments	4	947.500	236.875	1.555[ns]	3.23	5.41
Error	12	1827.700	152.308			
Total	19	3805.000				

[ns-] Not significant CV- 21.84%

Appendix Table 3.The total marketableyields of strawberry fruits after 4 week's application ofboard trap

	MARKETABLE (g)				
No. of Traps	R1	R2	R3	R4	MEAN
16	328	183	372	354	309.25[a]
13	221	208	309	241	244.75[ab]
9	206	324	172	201	252.25[ab]
6	192	118	123	182	153.75[b]
Without trap	178	179	192	124	168.25[b]

ANOVA

SOURCES OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F Value	TABULATED F	
					5%	1%
Replication	3	4972.950	1657.657	2.2538	3.49	5.95
Factor A	4	66102.800	16525.700	4.2142*	3.23	5.41
Error	12	57056.800	3921.400			
Total	19	118132.550				

* - significant CV=27.75%

Appendix Table 4.The total non marketableyield strawberry fruit after 4 week's application of board trap

	NON MARKETABLE (g)				
No. of fruits	R_1	R_2	R_3	R_4	MEAN
16	191	102	113	209	153.7[c]
13	314	201	248	257	255.0[b]
9	280	224	302	398	301.0[ab]
6	276	378	382	408	348.5[a]
Without trap	298	198	197	209	225.5[c]

ANOVA

SOURCES OF VARIATION	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN SQUARES	F Value	TABULATED F	
					5%	1%
Replication	3	19911.750	6637.250	2.7914	3.49	5.95
Factor A	4	87859.000	21964.750	9.2376**	3.23	5.41
Error	12	28533.000	2377.750			
Total	19	136303.750				

** - Highly Significant CV=18.99%