

Study on the Application of *Protaetia brevitarsis* Larva Excrement as Organic Fertilizer

Jungmoon Cha , Ohseok Kwon* 

School of Applied Biosciences, College of Agriculture and Life Sciences, Kyungpook National University, Daegu, Korea

ABSTRACT

This study was performed to assess *Protaetia brevitarsis* larva excrement as an organic fertilizer for corn cultivation. Furthermore, the study investigated insect communities in each treatment. In 2009, the corn growth rate was worst in soil treated with *P. brevitarsis* larva excrement and in 2010, the corn growth rate was worst in untreated soil. From the outcome of the study, *P. brevitarsis* larva excrement could be utilized as organic fertilizer for corn cultivation.

Keywords: Corn growth rate, Insect, *Protaetia brevitarsis* larva excrement

Introduction

The white-spotted chafer, *Protaetia brevitarsis* (Coleoptera: Cetoniidae), is a phytophagous insect. *P. brevitarsis* is found in Korea, Japan, Taiwan, China, Europe, and the east Siberia. The adults measure between 17 to 24 mm and are active during the day. They feed on pollen, and fluids of trees and fruits. The larvae live in corrosive soil like farmyard manure or haystack. In the fields, they appear from early July to late August. Some of them overwinter as adults, while most overwintering individuals are 3rd instar larvae (Park, 2002).

According to Dong-Ui-Bo-Gam, *P. brevitarsis* larvae have medicinal potential to treat liver cancer, liver cirrhosis, hepatitis, and accumulated fatigue. *P. brevitarsis* larvae have also been used as folk remedies to treat disease of the liver in Jeju Island, Korea. Recently, *P. brevitarsis* larvae were used to produce *Cordyceps* spp. and the study was designed to develop a preventative medicine against liver diseases (Park, 2002).

Since the recent increase in public interest regarding eco-friendly agriculture, the possibility of using *P. brevitarsis*

larva excrement as an organic fertilizer has been tested. In this study, investigation on the organic fertilizer applicability of *P. brevitarsis* larva excrement in corn cultivation was carried out.

Materials and Methods

Materials

Crop: White Sweet Corn (*Zea mays*)

White sweet corn (Chal Ok 4 Ho) was bought at Internet shopping mall (Fig. 1).



Fig. 1. White Sweet Corn (*Zea mays*).

Nursery bed soil

Nursery bed soil (Evergreen) produced by the Corporation Seoul Bio, consisting of cocopeat (55~65%), feat moss (18~24%), vermiculite (5~8%), zeolite (2~4%), perlite (9~13%), water-soluble fertilizer, wetting agent, etc. (Fig. 2), was used.

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*Corresponding author: Ohseok Kwon

e-mail ecoento@knu.ac.kr

 <https://orcid.org/0000-0001-9075-3994>



Fig. 2. Nursery bed soil (Evergreen).

P. brevitarsis larva excrement

The excrement of *P. brevitarsis* which was bred in Kyungpook National University, Ecological entomology Lab (Fig. 3) was used.



Fig. 3. *P. brevitarsis* larva excrement.

Others

Tapeline (7.5 m, Fig. 4), insect net (Fig. 5), electronic scale (CAS, Fig. 6), etc .



Fig. 4. Tapeline (7.5 m).



Fig. 5. Insect net.



Fig. 6. Electronic scale (CAS).

Methods

Corn growing in treated soil

Corn was cultivated in greenhouse located at Gunwi-gun, Kyungpook National University, Eco-friendly Agricultural technical education center. The soil was divided into 3 groups, namely, treated nursery bed soil (Exp2), untreated soil (control), and soil treated with *P. brevitarsis* larva excrement (Exp1).

In 2009, we planted 2 corn seeds in each treated soil, having 35 points. In each treated soil, width space was 5 points with 100 cm and length space was 7 points with 60 cm. A total of 70 corn seeds were planted in each treated soil on 29 Jun 2009 (Fig. 7, Fig. 8) and the corn was cultivated on 25 Sep 2009. In Exp2, we analyzed 20 packs of 50l nursery bed soil mixed with soil. In Exp1, we analyzed 20 packs of 10 kg of *P. brevitarsis* larva excrement mixed with soil.

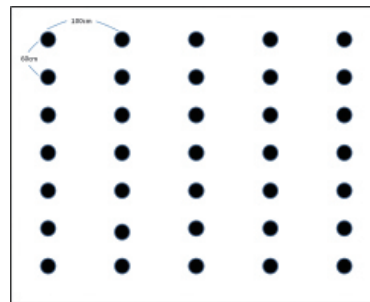


Fig. 7. Sowing outline in 2009.



Fig. 8. Sowing location in 2009.

In 2010, we planted 2 corn seeds in each treated soil having 20 points. In each treated soil, width space was 5 points with 100 cm and length space was 4 points with 60 cm. A total of 40 corn seeds were planted in each treated soil on 28 May 2010 (Fig. 9, Fig. 10) and the corn was cultivated on 28 August 2010. In Exp2, we analyzed 10 packs of 50l nursery bed soil mixed with soil. In Exp1, we analyzed 10 packs of 10 kg of *P. brevitarsis* larva excrement mixed with soil.

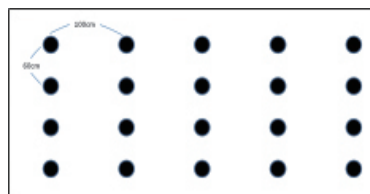


Fig. 9. Sowing outline in 2010.



Fig. 10. Sowing location in 2010.

Length comparison of corn from each treated soil

We measured the length of corn with a 7.5 m tapeline starting from the highest length of the corn. If the corn reached the ceiling of the greenhouse, the exact length was recorded. In 2009, the length of corn was recorded 11 times from 11 Jul to 25 Sep. In 2010, the length of corn was recorded 10 times from 24 Jun to 28 Aug.

Insect comparison in each treated soil

We selected corn from each treated soil for comparison of the insect population. In 2009, 10 corns were randomly selected and in 2010, 5 corns were randomly selected. Insects were collected using insect net and by hand. In 2009, the insects were collected 11 times from 11 Jul to 25 Sep and 10 times in 2010 from 24 Jun to 28 Aug.

Result

Length comparison of corn from each treated soil

In 2009, we compared the length of corn from each treated soil. On average, corn growth rate from Exp 2 was higher and corn growth rate from the control was higher than Exp1 (Fig. 11, Fig. 12, Fig. 13, Fig. 14). Corn bloom time was faster in Exp2. The corn yield was higher in control and corn yield from Exp2 was higher than Exp1 (Table 1, Fig. 15). However, empty heads of grain were reported in Exp2. We also compared the thickness of the corn roots and the following trend was observed Exp2 > control > Exp1 (Fig. 16).

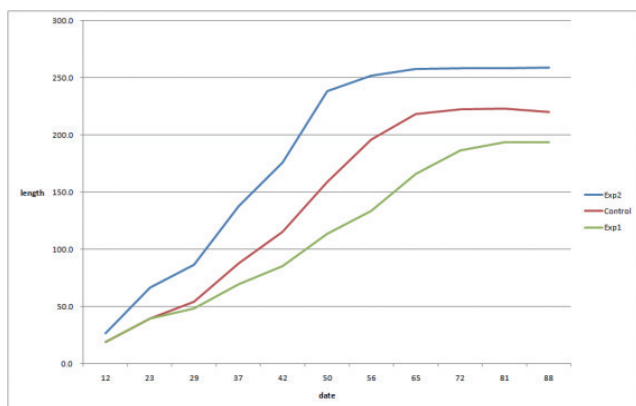


Fig. 11. Compare length of corn from each treated soil in 2009.



Fig. 12. Growth image of corn in July 22, 2009.



Fig. 13. Growth image of corn in August 18, 2009.



Fig. 14. Growth image of corn in September 18, 2009.



Fig. 15. Compare corn fruit from each treated soil (2009).



Fig. 16. Compare corn root from each treated soil (2009).

Table 1. Compare corn yield from each treated soil (2009)

	Exp2		Control		Exp1	
	Weight(g)		Weight(g)		Weight(g)	
S1	482	M1	235	B1	36	
S2	400	M2	476	B2	236	
S3	138	M3	506	B3	598	
S4	384	M4	778	B4	284	
S5	344	M5	570	B5	70	
S6	496	M6	402	B6	0	
S7	340	M7	718	B7	116	
S8	376	M8	484	B8	280	
S9	318	M9	288	B9	332	
S10	468	M10	546	B10	148	
S11	434	M11	368	B11	162	
S12	228	M12	560	B12	336	
S13	322	M13	156	B13	144	
S14	376	M14	678	B14	20	
S15	284	M15	60	B15	26	
S16	650	M16	174	B16	82	
S17	128	M17	172	B17	294	
S18	292	M18	124	B18	122	
S19	454	M19	598	B19	106	
S20	412	M20	354	B20	18	
S21	522	M21	68	B21	88	
S22	334	M22	324	B22	242	
S23	354	M23	210	B23	68	
S24	682	M24	360	B24	264	
S25	624	M25	676	B25	6	
S26	358	M26	52	B26	28	
S27	514	M27	256	B27	40	
S28	510	M28	454	B28	168	
S29	212	M29	312	B29	0	
S30	140	M30	334	B30	106	
S31	508	M31	22	B31	108	
S32	624	M32	158	B32	60	
S33	540	M33	486	B33	262	
S34	226	M34	516	B34	226	
S35	254	M35	316	B35	134	
Sum	13728	Sum	12791	Sum	5210	

In 2010, we compared the length of corn from each treated soil. On average, corn growth rate from Exp1 and Exp2 were similar. Corn growth rate for the control was least (Fig. 17, Fig. 18, Fig. 19, Fig. 20). The corn bloom time and corn yield were similar for Exp1 and Exp2. However, empty heads of grain were reported in Exp2 like in 2009 (Table 2, Fig. 21). We also compared the thickness of corn roots and the following order was recorded Exp2 >Exp1 > control. However, corn roots from treated soil were rotten. Therefore, the corn growth rate and corn yield were low as compared to year 2009 (Fig. 22).

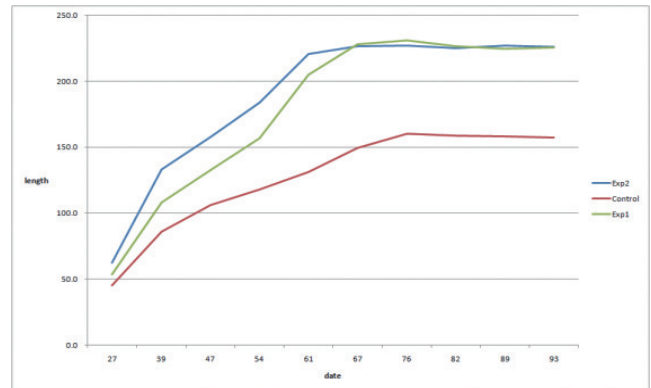


Fig.17. Compare length of corn from each treated soil in 2010 .



Fig. 18. Growth image of corn in June 24, 2010.



Fig. 19. Growth image of corn in July 21, 2010.



Fig. 20. Growth image of corn in August 18, 2010.

Table 2. Compare corn yield from each treated soil (2010)

Exp2		Control		Exp1	
Weight(g)		Weight(g)		Weight(g)	
S1	126	M1	6	B1	54
S2	102	M2	28	B2	112
S3	72	M3	26	B3	160
S4	0	M4	0	B4	166
S5	0	M5	0	B5	64
S6	146	M6	16	B6	118
S7	88	M7	0	B7	50
S8	256	M8	0	B8	202
S9	0	M9	0	B9	188
S10	32	M10	0	B10	100
S11	150	M11	26	B11	120
S12	230	M12	0	B12	74
S13	200	M13	0	B13	142
S14	12	M14	0	B14	162
S15	26	M15	0	B15	148
S16	104	M16	0	B16	66
S17	260	M17	0	B17	78
S18	214	M18	0	B18	80
S19	60	M19	0	B19	74
S20	0	M20	0	B20	42
Sum	2078	Sum	102	Sum	2200



Fig. 21. Compare corn fruit from each treated soil (2010).



Fig. 22. Compare corn root from each treated soil (2010).

Tables 3, 4, and 5 present the statistical analysis of corn yield in 2009. Table 3 showed that there was no significant difference ($P > 0.005$) between control and Exp2. Tables 4 and 5 showed that there was significant difference ($P < 0.001$) between the two groups. Tables 6, 7, and 8 present the statistical analysis of corn yield in 2010. Tables 6 and 7 showed that there was significant difference ($P < 0.001$) between the two groups. Table 8 showed that there was no significant difference ($P > 0.005$) between Exp1 and Exp2.

Table 3. Analysis of corn yield (g) in control and Exp2 (2009)

Group	N	Mean	SD
Control	35	365.457	205.225
Exp2	35	392.229	145.253
t = -0.630 df = 61.2 P = 0.531			

Table 4. Analysis of corn yield (g) in Exp1 and control (2009)

Group	N	Mean	SD
Exp1	35	148.857	128.863
Control	35	365.457	205.225
t = -5.288 df = 57.2 P = 0.000			

Table 5. Analysis of corn yield (g) in Exp1 and Exp2 (2009)

Group	N	Mean	SD
Exp1	35	148.857	128.863
Exp2	35	392.229	145.253
t = -7.415 df = 67.0 P = 0.000			

Table 6. Analysis of corn yield (g) in control and Exp2 (2010)

Group	N	Mean	SD
Control	20	5.100	10.021
Exp2	20	103.900	90.383
t = -4.859 df = 19.5 P = 0.000			

Table 7. Analysis of corn yield (g) in Exp1 and control (2010)

Group	N	Mean	SD
Exp1	20	110.000	48.964
Control	20	5.100	10.021
t = 9.387 df = 20.6 P = 0.000			

Table 8. Analysis of corn yield (g) in Exp1 and Exp2 (2010)

Group	N	Mean	SD
Exp1	20	110.000	48.964
Exp2	20	103.900	90.383
t = 0.265 df = 29.3 P = 0.793			

In 2010, corn growth rate, corn yield, and thickness of corn roots were inferior as compared to 2009, and this might be related to the difference in climatic conditions. As such, in 2010, there were more rainy days as compared to 2009 and the poor soil condition was related to the rotting of the corn roots.

In 2009 and 2010, the corn growth rate was best in Exp2, but there were lots of empty heads of grain. As a result, nursery bed soil successfully elongated the corn, but failed to properly develop the corn fruit.

In 2009 and 2010, the results were different for Exp1. In 2009, Exp1 recorded the worst performance for the studied criteria. In 2010, corn growth rate was similar for Exp1 and Exp2, but empty heads of grain were reported in Exp2, thereby suggesting that corn yield was better in Exp1 compared to Exp2. These findings support that *P. brevitarsis* larva excrement could be used as organic fertilizer.

Insect comparison in each treated soil

In 2009, we collected insects 11 times. According to cultivation time, different insects were observed. During early cultivation time, there were lots of Diptera. In middle cultivation time, lots of ants and aphids were collected and the presence of aphids was related to the occurrence of fungal disease. During the last time of cultivation, there were lots of *Spodoptera litura* larvae which damaged cornstalks and fruits, followed by presence of the insects in corn (Table 9, Table 10, Fig. 23).

Table 9. Number of insects in each treated soil (2009)

Class Treated soil	Class				
	Order	Family	Genus	Species	sp.
Exp2	8	18	19	19	5
Control	8	12	13	13	3
Exp1	5	11	12	12	4
Total	9	26	30	30	7

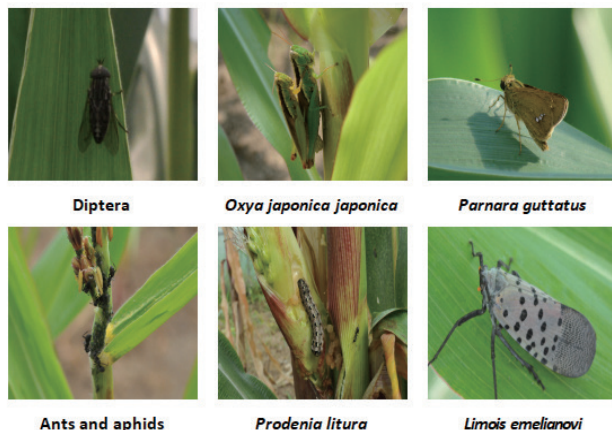


Fig. 23. Observed insects in 2009.

In 2010, we collected insects 10 times. There were lots of *Oxya japonica japonica* during cultivation time which damaged corns (Fig. 24). Also, we could observe *Cletus schmidtii*, *Atractomorpha lata*, etc (Table 10, Table 11, Fig. 25).



Fig. 24. Ankertrass of *O. japonica japonica* (2010).

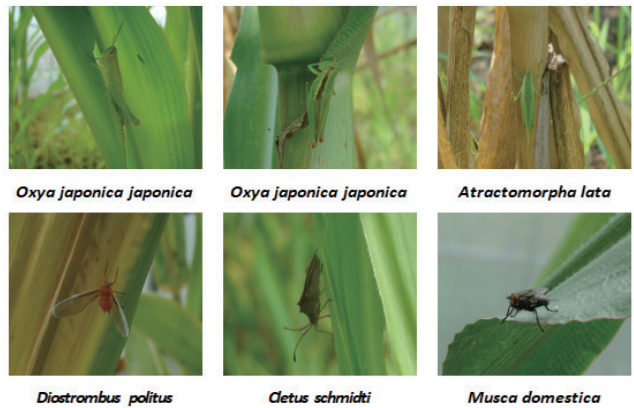


Fig. 25. Observed insects in 2010.

In 2010, we collected insects 10 times. There were lots of *Oxya japonica japonica* during cultivation time which damaged corns (Fig. 24). Also, we could observe *Cletus schmidtii*, *Atractomorpha lata*, etc (Table 10, Table 11, Fig. 25).

Species observed in 2009 were more than in 2010. The corns were damaged by *O. japonica japonica* in 2010 and it seems that the *O. japonica japonica* eggs were overwintering in greenhouse and hatched in 2010.

Discussion

This study was performed to evaluate the applicability of the *P. brevitarsis* larva excrement as organic fertilizer. The soil was divided into 3 groups, namely, treated nursery bed soil, untreated soil, and soil treated with *P. brevitarsis* larva excrement. We investigated corn growth rate and insect population in 2009 and 2010.

In 2009, we compared length of corn from each treated soil. Corn growth rate in Exp2 was higher. The nursery bed soil seems to properly elongate corn, but effective elongation of corn was observed in control. Corn elongati-

Table 10. List of insects during cultivation time

Taxonomy			Number of insects				
Taxonomy			Years			Sites	
Order	Family	Siencie	2009	2010	Exp2	Control	Exp1
Orthoptera	Pyrgomorphidae	<i>Atractomorpha lata</i>	1	2		2	1
Orthoptera	Acrididae	<i>Oxya japonica japonica</i>	3	30	10	7	16
Hymenoptera	Tenthredinidae	<i>Athalia rosae ruficornis</i>	2		2		
Hymenoptera	Formicidae	<i>Camponotus japonicus</i>	41			9	32
Diptera	Sarcophagidae	<i>Helicophagella melanura</i>	2		2		
Diptera	Sarcophagidae	sp2.	3		2		1
Diptera	Calliphoridae	<i>Phaenicia sericata</i>	3		1		2
Diptera	Muscidae	<i>Musca domestica</i>	1	2	3		
Diptera	Agromyzidae	<i>Chlorops oryzae</i>	3		1		2
Diptera	Tabanidae	<i>Atylotus horvathi</i>		1	1		
Diptera	Asilidae	sp6.	1		1		
Diptera	Asilidae	sp10.		1	1		
Diptera		sp3.	4		2	1	1
Diptera		sp4.	7		5	1	1
Diptera		sp5.	1				1
Diptera		sp8.		1	1		
Coleoptera	Chrysomelidae	<i>Altica caerulescens</i>	2				2
Coleoptera	Chrysomelidae	<i>Monolepta quadriguttata</i>	4			3	1
Coleoptera	Coccinellidae	<i>Coccinella septempunctata</i>	2	1	2	1	
Coleoptera	Coccinellidae	<i>Propylea japonica</i>	3			3	
Coleoptera	Elateridae	<i>Aeoloderma agnata</i>	1		1		
Hemiptera	Lygaeidae	<i>Nysius plebejus</i>	1			1	
Hemiptera	Coreidae	<i>Riptortus clavatus</i>	1		1		
Hemiptera	Coreidae	<i>Cletus schmidtii</i>		7	3	3	1
Hemiptera	Pentatomidae	<i>Dolycoris baccarum</i>	1	1	1		1
Homoptera	Delphacidae	<i>Sogatella furcifera</i>	1		1		
Homoptera	Aphididae	<i>Rhopalosiphum maidis</i>	62			15	47
Homoptera	Fulgoridae	<i>Limois emelianovi</i>	1			1	
Homoptera	Derbidae	<i>Diostrombus politus</i>		1		1	
Odonata	Libellulidae	<i>Sympetrum eroticum</i>	1		1		
Neuroptera	Chrysopidae	sp7.	1			1	
Lepidoptera	Noctuidae	<i>Prodenia litura</i>	22		15	7	
Lepidoptera	Noctuidae	sp9.		3	1		2
Lepidoptera	Hesperiidae	<i>Parnara guttatus</i>	2		1	1	
Lepidoptera	Pyalidae	sp1.	1		1		

Table 11. Number of insects in each treated soil (2010)

Class Treated soil	Order	Family	Genus	Species	sp.
Exp2	5	8	8	8	3
Control	2	4	4	4	0
Exp1	3	4	4	4	1
Total	9	11	11	11	3

on was less effective using *P. brevitarsis* larva excrement, but in 2010, corn growth rate was similar for Exp1 and Exp2. Different results were recorded in 2009, suggesting that *P. brevitarsis* larva excrement could be used as organic fertilizer.

Upon comparison of corn fruits from each treated soil, empty heads of grain were reported in 2009 and 2010 for Exp2. The nursery bed soil seems to be improper for the elongation of corn. Also, comparison of corn roots from each treated soil revealed that Exp2 was best in 2009 and 2010. Exp1 was the worst in 2009 and the control was the worst in 2010. Especially, in 2010, there were lots of rainy days as compared to 2009 and the soil condition was poor. Therefore, in 2010, the corn roots were rotten. Using proper nutrients and proper fertilizer is crucial in corn cultivation.

Since this study was performed in greenhouse, there were not lots of insects. In 2009, the insect population was different during cultivation time. In 2010, there were lots of *Oxya japonica japonica* during cultivation, resulting in lots of damaged corn. As a result, understanding the ecology and management of these insects is crucial to minimize crop damage.

Conflict of Interest

The authors declare that they have no competing interests.

Acknowledgments

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