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ABSTRACT

The study was conducted at Buyacaoan, Buguias, Benguet from July to November 2010 to determine the number of *Spodoptera litura* Nucleopolyhedrovirus (SINPV) larvae effective against healthy common cutworm larvae, and to determine should SINPV has harm effect on adult *Diadegma*, a natural enemy of diamondback moth.

Thirty early second instar healthy cutworm larvae were released on the cabbage plants enclosed with nets and sprayed with the treatments which are as follows; 5, 10, 15, 20 SINPV larvae/ 16 li water. Selecron 50 EC at the rate of 3 TBSP/16 li water was the standard insecticide. As basis for comparison, untreated cutworm larvae were included.

The mortality of cutworm larvae on the standard treatment of Selecron was the highest equivalent to 76.67%, 71.11% on the SINPV treatment of 20 larvae/16 li water, 67.78% on the treatment of 15 SINPV larvae/16 li water and 36.67% on the treatment of 10 SINPV larvae/16 li water. The treatment of 5 SINPV larvae/16 li water has the lowest level of mortality equivalent to 28.89%.

The treatments sprayed with the rate of 20 and 15 SINPV larvae/16 li water were slightly damaged similar with the standard treatment of Selecron. The lower rates of SINPV applied were moderately damaged.

The two highest rates of SINPV treatments at 15 to 20 larvae/16 li water had the highest percentage of marketable yield equivalent to 83.00 and 89.67% comparable with the standard treatment of Selecron which was 91.67%. The marketable yield decreased significantly as the rates was reduced to 5 and 10 SINPV larvae/16 li water.

Mortality of adult *Diadegma* was not noted in all the SINPV treatments similar with the untreated but mortality of 100% was recorded from the standard treatment of Selecron.

It is concluded that SINPV at the rate of 20 and 15 larvae/16 li water has the efficacy against cutworm of cabbage comparable to Selecron 50 EC. SINPV is not toxic to adult *Diadegma*. SINPV is recommended for the control of cutworm in cabbage.

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INTRODUCTION

Common cutworm (*Spodoptera litura* Fabr.) is classified to belong to the order Lepidoptera; Family Noctuidae. It is one of the primary problems of the majority of vegetable growers. Cutworms have a very powerful mandible and this is use in damaging cabbage by cutting the stem and chewing the leaves. In the Philippines, the insect infests 28 agricultural crops. Aside for cabbage and related crucifers, other crops infested by the insect are tobacco in Ilocos region, onion in Nueva Ecija, peanut in Isabela, and beans and rice in many parts of the country (Gabriel, 1997).

In Benguet Province like in other parts of the country, cutworm is a serious problem. It is a problem in most semi-temperate leafy vegetables particularly cabbage. Chemical insecticide is the usual practice of controlling cutworms. But with the many disadvantages associated with its use, an environment-friendly method of controlling cutworms like *Spodoptera litura* Nucleopolyhedrovirus (SINPV) is one of the possible alternatives.

Microbial control or the use of viruses has been identified as both viable and promising alternative for the chemical control of cutworms. Local strains of the nucleopolyhedrovirus or cutworm have already been isolated and laboratory tested (Padua *et al*., 1999).

One of the microbial pathogens with insecticidal activity against cutworm is Nucleopolyhedrovirus (NPV). Studies for the efficacy of NPV against cutworm are many especially in the lowland areas. For example, in the study of Agsaoay in 1998, NPV was proven effective against cutworm of peanut and in asparagus as reported by Padua

(1999). It was likewise mentioned by Navasero and Navasero (2002) that NPV was effective against cutworm in egg plants. NPV are likewise cheap, environment friendly and harmless to human. But in some places here in Benguet especially in Buguias, the efficacy of SINPV was not yet tested.

The study aimed to determine the number of *Spodoptera litura* Nucleopolyhedrovirus (SINPV) larvae effective against healthy common cutworm larvae, and to determine should SINPV has harm effect on adult *Diadegma*, the natural enemy of diamondback moth.

The study was conducted at Buyacaoan, Buguias, Benguet from July to November 2010.

REVIEW OF LITERATURE

Biology of Cutworm

Miyahara *et al*. (1971), Rao *et al*. (1989), Schmutter (1969), Baker and Miller (1974) stated that female *Spodoptera litura* laid egg masses with around 1000-2000 eggs per mass. The eggs are spherical, somewhat flattened, 0.6mm in diameter and covered with hair like scales. Usually, it is pale orange, brown or white to dull or off-white in color. They hatch in about 4 days in warm conditions or 11-12 days in winter times.

During the dry seasons of 1995, IDM-CRSP gathered data on the major and minor insect pests and their natural enemies on rice vegetable system. Results of these efforts have led to the identification of *S. litura* (Fabr). As one of the pest of onion, common cutworm is one among the most economically important insect pests in the country. The newly emerged larvae gregariously feed on the soft leaf tissues. The damage done by this pest is exhibited by large feeding holes on the blades of mature and young leaves (Padua *et al*., 1999**).**

Nature of Cutworm Damage

Cabbage is one of the vegetables attacked by *S. litura*. The insect damage the stems, consuming the whole seedling, chewing the leaves of the plants in the open fields causing irregular holes and boring the developing heads with lace of larval excrements. If not controlled, the insect can reduce yield to as high as 50% to 100% (Cardona *et al*., 2007).

Microbial Control of Cutworm

Van Huis (1989) reported a number of entomopathogenic microorganisms (e.g., bacteria, fungi, protozoa, nematodes, and viruses) which are potential components in insect pest management like the NVP. Studies revealed that these entomogenous microbial agents can be potent instruments in reducing insect pest populations below economic threshold. Insect viruses and bacteria in particular have appreciably shown evidences as pest suppressive agents that could complement other control measures.

Pathogenicity and Toxicity test for SINPV

Ignoffo and Hiempel (1965) exposed guinea pigs and white mice to NPV of *Heliothiz zea* (Boddie) and H. *virescens* (Fabricius) to test the pathogenicity and toxicity of NPV. The virus was administered in the form of poly-inclusion bodies, free virus rods or polyhedral protein through inhalation and feeding. Intravenous, intradermal, intraperitoneal and intercerebral injections of the virus were also done. Except for one pneumonia-caused death, all the test animals showed normal weight gains. Also, no abnormalities were observed.

Podgwaite *et al*. (1979) estimated infectious *Lymantria dispar* NPV naturally occurring in leaf, bark, litter, and soil. Concentrations of the virus were then compared with the concentrations of the virus taken after NPV treatment of these plots. These

comparisons revealed that NPV is a natural component of the host's habitat and that further NPV application did not cause an increase in NPV load.

Jaques (1967) evaluated the persistence of NPV in soil. Soil samples of 6.4 x 10^{10}- treated plots contained 25% of the original infective virus after 5 years. A similar rate of decline in viral activity was noted in soils exposed to artificial conditions.

Lavina *et al*. (2000) reported that *S. litura* NPV is a unique and distinct isolate; further finger printing of the virus is currently being undertaken.

MATERIALS AND METHODS

Toxicity of SINPV Against Cutworm Larvae

Site Selection

The study was conducted at Buyacaoan, Buguias, Benguet, a place in Buguias where cabbage is widely planted and where the insect cutworm is one of the most injurious pest's insect. The research area were cleaned by the used of sickle and grab hoe. Plot making and chicken dung application were done before the one month old seedlings of the cabbage Scorpio variety were planted.

Preparation and Maintenance of Cabbage

Plants preparation was started by soaking the cabbage seeds for twenty four hours before seeding on plots. After four weeks of care and maintenance of the seedlings, they were transplanted in the study area. The application of the recommended rate of urea (46-0-0) and complete (14-14-14) were done during the early vegetative stage to improve the vigor of the plants and becomes more ideal for research purposes. Likewise, fungicide

was applied to prevent buildup of diseases. In watering the plants, sprinkler were used as seen in Figure 1.

Mass Rearing of Healthy Cutworm

Mass rearing of healthy cutworms was done at the laboratory room. Rearing was started with the collection of egg masses. Each egg mass were placed in separated containers as seen in Figure 2 to avoid the crowding that force larvae to develop cannibalistic behavior after they emerged. After emerging, they were feed on cabbage leaves. The reared larvae served as the test insects and they were released in the test cabbages direct in the field and for SINPV infection.

Figure 1. Watering of the cabbage plants after transplanting in the study area

Figure 2. Mass rearing of healthy cutworms on plastic containers in the laboratory

Mass rearing of *Spodoptera litura* NPV

Cutworms infected with virus (SINPV) were collected. Infected cutworms are characterized with bloated body with bad smell. Water was mixed with the collected SINPV, macerated and served as the inoculums. Leaves of cabbages dipped on the SINPV inoculums were offered to 2nd instar cutworm larvae. The larvae that were infected became the source of SINPV for the research.

Procedures for the Testing of the Treatments

The effects of the treatments were tested on healthy cutworm larvae released on cabbage plants in the open field but enclosed with nets. Plants were enclosed with nets to prevent larval escape. The nets are cube shaped with the dimension of 1.0 X 1.0 X 1.0 meters as seen in Figure 3. Thirty early second instar healthy cutworm larvae were released in each of the net cages. The treatments were laid out using the randomized

complete block design (RCB). The treatments were replicated three times. The SINPV treatments were applied through spray. Hand sprayer was used and the knap sack sprayer for the treatment of Selecron. The rates of treatments used were as follows:

$T_{1=}$ 5 SINPV larvae/16 li water

$T_{2=}$ 10 SINPV larvae/16 li water

$T_{3=}$ 15 SINPV larvae/16 li water

$T_{4=}$ 20 SINPV larvae/6 li water

$T_{5=}$ 30 ml Selecron/16 li water

$T_{6=}$ Untreated

The data gathered were the number of dead cutworm larvae. The dead cutworms were counted during the date of gathering after spraying. The degree of cutworm damage was likewise determined by using the FPA rating scale index. The details of the scale index are as follows: 1- sound or no damage, 3- slightly damaged, 5- moderately damaged, 7- severely damaged and 9- heavily damaged. The percent marketable yield was likewise recorded.

Figure 3. The treatments lay-out using a net designed in cube shapes. Inside the net cages were the treated cabbages and cutworms

Toxicity of SINPV on *Diadegma*

Rearing of *Diadegma*

A potted cabbage plants which are six weeks old were placed inside a parasite adult nylon net cage with a wooden board floor. The larvae of DBM were allowed to feed on the cabbage and emerge inside the cage until they become second instars. This stage of larvae was used in rearing with larval parasites by placing *Diadegma* pupae inside the cage allowing parasite adults to emerge. As a food source of newly emerge parasite adults, a plastic sheet that was sprayed with honey was hanged and sprayed with honey

solution daily. The door opening was covered with black cloth to avoid the escape of the parasite adults. After these processes, the old potted cabbage was replaced with new ones containing a numerous number of DBM that were second instars larvae. The exposed soil was covered with aluminum foil and cabbage leaves were placed on the cage surrounding the clay pot. This is to trap the DBM larvae descending from the plant when parasites try to oviposit. The DBM larvae were allowed to oviposit by the parasites within 24 hours. The cabbage plant with parasitized larvae were removed from the cage and all the leaves were carefully stripped, making sure that larvae do not fall off. Two to three of the leaves containing a numerous number of larvae were placed in a fresh 6 week old potted cabbage plant in a similar but parasite-free cage. At this time, all DBM larvae that have fallen from the leaves to the floor in the previous cage were transferred in the fresh cabbage plant. When the food supply from the old excise leaves was exhausted, the larvae migrated to the fresh leaves of the new plants.

The biomass of the 6-week-old plant provides enough food for larvae until pupation in 15 days. The pupae were carefully collected and stored at 8 to 10 °C. The pupae were stored at this temperature for 15 to 30 days without significant loss of viability.

Procedures for Testing

Ten *Diadegma* pupae were placed inside the container in each treatment. Each of the containers was covered with net to minimize the escape of the adult *Diadegma* after they emerged. After emerging, SINPV were sprayed through the net cover likewise on the bottom surface of the top cover of the container before it was placed to make sure

inside of the container were contaminated (figure 4). SINPV was observed if it has an effect to the parasitoid insects. Adult *Diadegma* were also tested in a container that was contaminated with chemical insecticide. The study was conducted using the completely randomized designed (CRD). Untreated adult *Diadegma* was included as the basis for comparison.

The data gathered were the number of dead adult *Diadegma* at 24, 48, and 72 hours after exposure from the treatment.

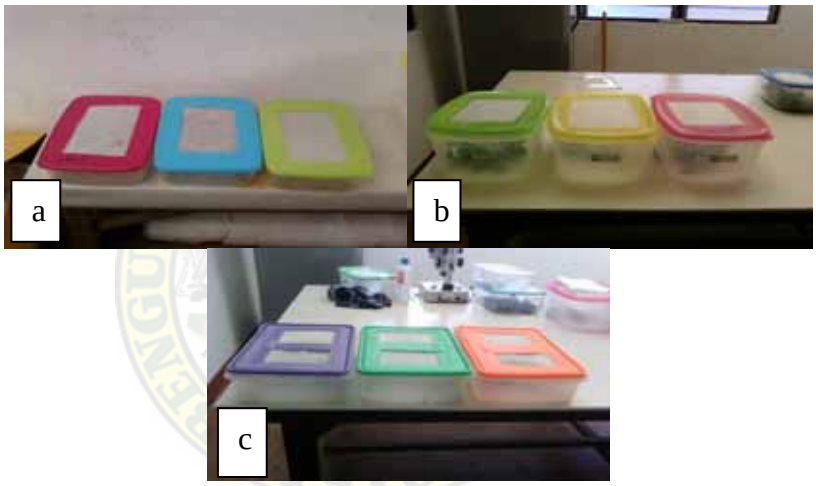

Figure 4. Treated adult of *Diadegma* with: a) 20 SINPV/16 li water; b) 30 ml Seleron/16 li water; c)Untreated

RESULTS AND DISCUSSION

Mortality Action of the Treatments

It is presented in the data Table 1 the mortality of cutworm larvae 3 and 6 days after the first treatment. It is clearly presented the far lower mortality in all the treatments of SINPV 3 days after treatment. The highest mortality was 11.11% which was recorded from the SINPV rate of 15 larvae/16 li water and 8.89% from the SINPV rate of 20

larvae/16 li water. The mortality decreases as the SINPV rates were reduced. The mortality of the standard treatment of Selecron was equivalent to 63.33% far higher than the SINPV treatments. This result is a clear indication that Selecron has quick mortality action against common cutworm which was absent from the treatments of SINPV.

Table 1. Mortality (%) of cutworm larvae 3 and 6 days after treatment of SINPV

TREATMENT (Rates)	FIRST SPRAY	
	3 DAT	6 DAT
5 SINPV/16 li H_2O	7.78[bc]	24.45[c]
10 SINPV/16 li H_2O	7.78[bc]	26.67[c]
15 SINPV/16 li H_2O	11.11[b]	57.78[b]
20 SINPV/16 li H_2O	8.89[bc]	64.44[ab]
30 ml Selecron/16 li H_2O	63.33[a]	67.78[a]
Untreated H_2O	0.00[c]	0.00[d]

Means in a column with the same letter are not significantly different at 5% level of significance by DMRT

*DAT- days after treatment

Effects of the SINPV Treatments

The mortality of cutworm larvae from the first until the third spray is presented in Table 2.

Mortality of cutworm larvae during the first spray. It is clearly presented in the data Table 2 the very low mortality of cutworms in all the SINPV treatments at the rates

of 5, 10, 15 and 20 larvae/16 li water. The highest so far for the 3 days assessment after spray was 11.11 and 8.89% which was observed from the 15 and 20 SINPV larvae/16 li water. The mortality decreased as the rate was reduced to 5 and 10 SINPV larvae/16 li water equivalent to 7.78 and 7.78%, respectively. While there was no mortality from the untreated, the mortality was 63.33% from the standard treatment of Selecron.

Six days after first spray, the mortality of cutworm generally increased in all the SINPV treatments. The highest which was noted from the highest rate of 20 SINPV larvae/16 li water was 64.44% followed by 57.78% from the 15 SINPV larvae/16 li water. The mortality from the two lower rates at 10 and 5 SINPV larvae were 26.67% and 24.45% respectively. The mortality from the standard treatment of Selecron was 67.78%.

Mortality of cutworm larvae during the second spray. The mortality of cutworm larvae further increased in all the treatments of SINPV and the standard treatment of Selecron. At 3 days after spray, the mortality was 68.89% from the highest rate at 20 SINPV larvae/16 li water, and 65.55% for the 15 SINPV larvae/16 li water. The mortality from the two lower rates at 10 and 5 SINPV larvae/16 li water was 35.56% and 28.89% respectively while a mortality of 73.33% was recorded from the treatment of Selecron.

Table 2. Mortality (%) of cutworm larvae during the first, second and third treatment application

TREATMENT (Rates)	1st SPRAY		2nd SPRAY		3rd SPRAY	
	3 DAT	6 DAT	3 DAT	6 DAT	3 DAT	6 DAT
5 SINPV/16 li H_2O	7.78^{bc}	24.45^{c}	28.89^{d}	28.89^{d}	28.89^{d}	28.89^{c}

10 SINPV/16 li H_2O	7.78^{bc}	26.67^{c}	35.56^{c}	36.67^{c}	36.67^{c}	36.67^{c}
15 SINPV/16 li H_2O	11.11^{b}	57.78^{b}	65.55^{b}	66.67^{b}	67.78^{b}	67.78^{b}
20 SINPV/16 li H_2O	8.89^{bc}	64.44^{ab}	68.89^{ab}	68.89^{ab}	68.89^{b}	71.11^{ab}
30 ml Selecron/16 li H_2O	63.33^{a}	67.78^{a}	73.33^{a}	75.56^{a}	76.67^{a}	76.67^{a}
Untreated	0.00^{c}	0.00^{d}	0.00^{e}	0.00^{e}	0.00^{e}	0.00^{d}

Means in a column with the same letter are not significantly different at 5% level of significance by DMRT

*DAT- days after treatment

Six days after second spray, the mortality of cutworm larvae from the highest rate of 20 SINPV larvae/16 li water was 68.89% and 66.67% from the rate of 15 SINPV larvae/16 li water. The mortality for the rates of 10 SINPV larvae/16 li water was 36.67% while in the lowest rate at 5 SINPV larvae/16 li water was 28.89%. The mortality from the treatment of Selecron was 75.56%.

Mortality of cutworm larvae during the third spray. The mortality of cutworm larvae (Figure 5) from the highest rate of 20 SINPV larvae/16 li water 3 days after the third spray was 68.89% and a mortality of 67.78 % from the rate of 15 SINPV larvae/16 li water. The mortality from the two lower rates at 10 and 5 SINPV larvae/16 li water were 36.67 and 28.89% respectively and 76.67% from standard treatment of Selecron.

Six days after the last treatment and last data gatherings, the trend of results were likewise more or less similar. The mortality from highest rate of SINPV at 20 larvae/16 li

water was 71.11% while the mortality from the three lower rates at 15, 10 and 5 SINPV larvae/16 li water were 67.78, 36.67, and 28.89% respectively. The mortality from the standard treatment of Selecron was 76.67%.

Figure 5. Appearance of infected cutworms caused by SINPV treatments

Degree of Cutworm Damage

The assessed damage in cabbage caused by cutworm is presented in Table 3. As early as the first treatment application, all the treatments of SINPV, the standard

treatment of Selecron and the untreated were rated slightly damaged. On the other hand, as time went by and the application of SINPV and the standard Selecron progresses, damage differences were noted. The highest rates of SINPV at 20 and 15 larvae/16 li water were slightly damaged comparable with the treatment of Selecron. The lowest dosage rate of SINPV at 5 larvae/16 li water was moderately damaged while the untreated was severely damaged.

Table 3. Degree of damage caused by cutworm as affected by the treatments

TREATMENT (Rates)	3 DAT	10 DAT	20 DAT
5 SINPV/16 li H_2O	3.00^{a}	3.00^{b}	5.00^{b}
10 SINPV/16 li H_2O	3.00^{a}	3.00^{b}	4.33^{bc}
15 SINPV/16 li H_2O	3.00^{a}	3.00^{b}	3.67^{cd}
20 SINPV/16 li H_2O	3.00^{a}	3.00^{b}	3.00^{d}
30 ml Selecron/16 li H_2O	3.00^{a}	3.00^{b}	3.00^{d}
Untreated	3.67^{a}	5.67^{a}	9.00^{a}

Means in a column with the same letter are not significantly different at 5% level of significance by DMRT

* The first treatment was applied 30 days after transplanting

* DAT- days after treatments

Marketable Yield (%)

The percent marketable yield is presented in Table 4. Highest marketable yield equivalent to 91.67% was recorded from the standard treatment of Selecron. Marketable yields equivalent to 89.67 and 83.00% were recorded from the treatments of 20 and 15 SINPV larvae/16 li water, respectively. Percent marketable yields were numerically lower in comparison with the treatment of Selecron but statistically, they were insignificant. The percent marketable yield from the 10 SINPV larvae/16 li water was 62.00% and 53% from 5 SINPV larvae/16 li water.

Due to severe damaged caused by cutworm, marketable yield was not harvested from the untreated.

Table 4. Marketable yield (%) as affected by the treatments of SINPV

TREATMENT (Rates)	MEAN
5 SINPV/16 li H_2O	53. 67[b]
10 SINPV/16 li H_2O	62.00[b]
15 SINPV/16 li H_2O	83.00[a]
20 SINPV/16 li H_2O	89.67[a]
30 ml Selecron/16 li H_2O	91.67[a]
Untreated	0.00[c]

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

Mortality (%) of Adult *Diadegma*

The mortality of adult *Diadegma* is presented in Table 5. It is clearly presented in the data table the absence of dead adult *Diadegma* from the treatment of SINPV similar with the untreated. The results imply that SINPV does not harm adult *Diadegma* when applied in cabbage for the control of cutworm. On the other hand, the standard Selecron is extremely toxic to adult *Diadegma* brought about by the mortality of the parasitoid to as high as 100%. The results likewise imply that the use of the said insecticide in the field for the control of DBM may endanger the parasitoid *Diadegma.*

Table 5. Mortality (%) of adult *Diadegma* after exposure from the treatments of SINPV and Selecron

TREATMENT	RATE	24 HAT	48 HAT	72 HAT
SINPV	20 larvae/16 li H_2O	0.00^b	0.00^b	0.00^b
Selecron	30 ml/16 li H_2O	93.33^a	100.00^a	100.00^a
Untreated	___	0.00^b	0.00^b	0.00^b

* HAT- hours after treatment

SUMMARY, CONCLUSIONS AND RECOMMENDATION

Summary

The study was conducted at Buyacaoan, Buguias, Benguet from July to November 2010, a place in Buguias where cabbage is widely planted and where the insect cutworm is one of the most injurious pest's insect. This study was conducted purposely to determine the number of *Spodoptera litura* Nucleopolyhedrovirus (SINPV) larvae effective against common cutworm larvae, and to determine should SINPV has harm effect on adult *Diadegma*, a parasitoid of diamondback moth.

Thirty early second instar healthy cutworm larvae were released on the cabbage plants enclosed with nets and sprayed with the treatments which are as follows; 5, 10, 15, 20 SINPV larvae/ 16 li water. Selecron 50 EC at the rate of 30 ml/16 li water was the standard insecticide. Untreated cutworm larvae were included as the basis for comparison.

The mortality of cutworm larvae from SINPV treatments was 71.11% at 20 larvae/16 li water, followed by 67.78% on the treatment of 15 SINPV larvae/16 li water and 36.67% on the treatment of 10 SINPV larvae/16 li water. The treatment of 5 SINPV larvae/16 li water has the lowest level of mortality equivalent to 28.89% while a mortality of 76.67 on the standard treatment of Selecron the mortality recorded was 76.67%.

The two highest rates of SINPV at 20 and 15 larvae/16 li water were slightly damaged comparable with the treatment of Selecron. The two lower dosage rate of

SINPV at 10 and 5 larvae/16 li water was moderately damaged while the untreated was severely damaged.

The two highest rates of SINPV treatments from 15 to 20 NPV larvae/16 li water had the highest percentage of marketable yield equivalent to 83.00 and 89.67% comparable with the standard treatment of Selecron which was 91.67%. The marketable yield decreased significantly as the rates of SINPV treatments was reduced to 5 and 10 SINPV larvae/16 li water. Marketable yield was not harvested from the untreated.

Mortality of adult *Diadegma* was not noted in all the SINPV treatments similar with the untreated. On the other hand, mortality of 100% was recorded from the standard treatment of Selecron.

Conclusions and Recommendation

It is concluded that microbial insecticide like SINPV has the efficacy against cutworm of cabbage comparable to Selecron 50 EC. The SINPV rate of 20 and 15 larvae/16 li water are effective against cutworm. SINPV is not toxic to adult *Diadegma*. SINPV is recommended for the control of cutworm in cabbage.

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APPENDICES

Appendix Table 1. Mortality (%) of cutworm larvae 3 days after the first treatment application

TREATMENT	RATES	REPLICATIONS I	II	III	TOTAL	MEAN
1	5 SINPV/16 li H_2O	6.67	6.67	10.00	23.34	7.78
2	10 SINPV/16 li H_2O	10.00	10.00	3.33	23.33	7.78
3	15 SINPV/16 li H_2O	16.67	10.00	6.67	33.34	11.11
4	20 SINPV/16 li H_2O	13.33	3.33	10.00	26.66	8.89
5	30 ml Selecron/16 li H_2O	56.67	63.33	70.00	190	63.33
6	Untreated	0.00	0.00	0.00	0.00	0.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	Pr > F
Model	7	8122.827217	1160.403888	52.52**	< .0001

Block	2	8.658033	4.329017	0.20	0.8252
Treatment	5	8114.169183	1622.833837	73.45	< .0001
Error	10	220.956833	22.095683		
CORRECTED TOTAL	17	8343.784050			

**Highly Significant Coefficient of variation = 28.52020%

Appendix Table 2. Mortality (%) of cutworm larvae 6 days after the first treatment application

		REPLICATIONS				
TREATMENT	RATES	I	II	III	TOTAL	MEAN
1	5 SINPV/16 li H_2O	30.00	16.67	26.67	73.34	24.45
2	10 SINPV/16 li H_2O	30.00	20.00	30.00	80.00	26.67
3	15 SINPV/16 li H_2O	63.33	50.00	60.00	173.33	57.78
4	20 SINPV/16 li H_2O	73.33	56.67	63.33	193.33	64.44
5	30 ml Selecron/16 li H_2O	63.33	70.00	70.00	203.33	67.78
6	Untreated	0.00	0.00	0.00	0.00	0.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	Pr > F
Model	7	11314.63462	1616.37637	70.78**	< .0001
Block	2	201.10990	100.55495	4.40	0.0425

Treatment	5	11113.52472	2222.70494	97.33	< .0001
Error	10	228.37163	22.83716		
CORRECTED TOTAL	17	11543.00625			

**Highly Significant Coefficient of variation = 11.89206%

Appendix Table 3. Mortality (%) of cutworm larvae 3 days after the second treatment application

TREATMENT	RATES	REPLICATIONS I	II	III	TOTAL	MEAN
1	5 SINPV/16 li H_2O	30.00	26.67	30.00	86.67	28.89
2	10 SINPV/16 li H_2O	40.00	30.00	36.67	106.67	35.56
3	15 SINPV/16 li H_2O	70.00	63.33	63.33	196.66	65.55
4	20 SINPV/16 li H_2O	76.67	66.67	63.33	206.67	68.89
5	30 ml Selecron/16 li H_2O	73.33	70.00	76.67	220.00	73.33
6	Untreated	0.00	0.00	0.00	0.00	0.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	Pr > F
Model	7	12600.31237	1800.14462	158.29**	< .0001

Block	2	93.80988	46.90494	4.12	0.0494
Treatment	5	12506.50249	2501.30050	219.96	< .0001
Error	10	113.71612	11.37161		
CORRECTED TOTAL	17	12714.02849			

**Highly Significant Coefficient of variation = 7.432534%

Appendix Table 4. Mortality (%) of cutworm larvae 6 days after the second treatment application

TREATMENT	RATES	REPLICATIONS I	II	III	TOTAL	MEAN
1	5 SINPV/16 li H_2O	30.00	26.67	30.00	86.67	28.89
2	10 SINPV/16 li H_2O	40.00	30.00	40.00	110.00	36.67
3	15 SINPV/16 li H_2O	70.00	66.67	63.33	200.00	66.67
4	20 SINPV/16 li H_2O	76.67	66.67	63.33	206.67	68.89
5	30 ml Selecron/16 li H_2O	73.33	76.67	76.67	226.67	75.56
6	Untreated	0.00	0.00	0.00	0.00	0.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	Pr > F
Model	7	13009.45188	1858.49313	122.27**	< .0001

Block	2	48.10743	24.05372	1.58	0.2529
Treatment	5	12961.34445	2592.26889	170.54	< .0001
Error	10	152.00377	15.20038		
CORRECTED TOTAL	17	13161.45565			

**Highly Significant Coefficient of variation = 8.455053%

Appendix Table 5. Mortality (%) of cutworm larvae 3 days after the third treatment application

TREATMENT	RATES	REPLICATIONS I	II	III	TOTAL	MEAN
1	5 SINPV/16 li H_2O	30.00	26.67	30.00	86.67	28.89
2	10 SINPV/16 li H_2O	40.00	30.00	40.00	110.00	36.67
3	15 SINPV/16 li H_2O	70.00	66.67	66.67	203.34	67.78
4	20 SINPV/16 li H_2O	76.67	66.67	63.33	206.67	68.89
5	30 ml Selecron/16 li H_2O	73.33	76.67	80.00	230.00	76.67
6	Untreated	0.00	0.00	0.00	0.00	0.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	Pr > F

Model	7	13345.32349	1906.47478	123.44**	< .0001
Block	2	45.62471	22.81236	1.48	0.2741
Treatment	5	13299.69878	2659.93976	172.23	< .0001
Error	10	154.44202	15.44420		
CORRECTED TOTAL	17	13499.76551			

**Highly Significant Coefficient of variation = 8.454654%

Appendix Table 6. Mortality (%) of cutworm larvae 6 days after the third treatment application

		REPLICATIONS				
TREATMENT	RATES	I	II	III	TOTAL	MEAN
1	5 SINPV/16 li H_2O	30.00	26.67	30.00	86.67	28.89
2	10 SINPV/16 li H_2O	40.00	30.00	40.00	110.00	36.67
3	15 SINPV/16 li H_2O	70.00	66.67	66.67	203.34	67.78
4	20 SINPV/16 li H_2O	80.00	70.00	63.33	213.33	71.11
5	30 ml Selecron/16 li H_2O	73.33	76.67	80.00	230.00	76.67
6	Untreated	0.00	0.00	0.00	0.00	0.00

ANALYSIS OF VARIANCE

SOURCE OF	DEGREE	SUM OF	MEAN OF	F VALUE	Pr > F

VARIANCE	OF FREEDOM	SQUARES	SQUARES		
Model	7	13656.11979	1950.87426	98.10**	< .0001
Block	2	45.62841	22.81421	1.15	0.3560
Treatment	5	13610.49138	2722.09828	136.88	< .0001
Error	10	198.86052	19.88605		
CORRECTED TOTAL	17	13854.98031			

**Highly Significant Coefficient of variation = 9.517965%

Appendix Table 7. Degree of damage caused by cutworm larvae 3 days after the treatment

		REPLICATIONS				
TREATMENT	RATES	I	II	III	TOTAL	MEAN
1	5 SINPV/16 li H_2O	3	3	3	9	3.00
2	10 SINPV/16 li H_2O	3	3	3	9	3.00
3	15 SINPV/16 li H_2O	3	3	3	9	3.00
4	20 SINPV/16 li H_2O	3	3	3	9	3.00
5	30 ml Selecron/16 li H_2O	3	3	3	9	3.00
6	Untreated	3	3	5	11	3.67

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	Pr > F
Model	7	1.55555556	0.22222222	1.00^{ns}	0.4834
Block	2	0.44444444	0.22222222	1.00	0.4019
Treatment	5	1.11111111	0.22222222	1.00	0.4651
Error	10	2.22222222	0.22222222		
CORRECTED TOTAL	17	3.77777778			

^{ns} Not Significant Coefficient of variation = 15.15229%

Appendix Table 8. Degree of damage caused by cutworm larvae 10 days after the treatments

TREATMENT	RATES	REPLICATIONS I	II	III	TOTAL	MEAN
1	5 SINPV/16 li H_2O	3	3	3	9	3.00
2	10 SINPV/16 li H_2O	3	3	3	9	3.00
3	15 SINPV/16 li H_2O	3	3	3	9	3.00
4	20 SINPV/16 li H_2O	3	3	3	9	3.00
5	30 ml Selecron/16 li H_2O	3	3	3	9	3.00
6	Untreated	5	5	7	17	5.67

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	Pr > F
Model	7	18.22222222	2.60317460	11.71*	0.0004
Block	2	0.44444444	0.22222222	1.00	0.4019
Treatment	5	17.77777778	3.55555556	16.00	0.0002
Error	10	2.22222222	0.22222222		
CORRECTED TOTAL	17	20.44444444			

*Significant Coefficient of variation = 13.68594%

Appendix Table 9. Degree of damage caused by cutworm larvae 20 days after the treatments

TREATMENT	RATES	REPLICATIONS I	II	III	TOTAL	MEAN
1	5 SINPV/16 li H_2O	5	5	5	15	5.00
2	10 SINPV/16 li H_2O	5	5	3	13	4.33
3	15 SINPV/16 li H_2O	3	5	3	11	3.67
4	20 SINPV/16 li H_2O	3	3	3	9	3.00
5	30 ml Selecron/16 li H_2O	3	3	3	9	3.00
6	Untreated	9	9	9	27	9.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	Pr > F
Model	7	78.00000000	11.14285714	27.86**	< .0001
Block	2	1.33333333	0.66666667	1.67	0.2373
Treatment	5	76.66666667	15.33333333	38.33	< .0001
Error	10	4.00000000	0.40000000		
CORRECTED TOTAL	17	82.0000000			

**Highly Significant Coefficient of variation = 13.55262%

Appendix Table 10. Marketable yield (%) as affected by the treatments of SINPV

TREATMENT	RATES	REPLICATIONS I	II	III	TOTAL	MEAN
1	5 SINPV/16 li H_2O	45	56	60	161	53.67
2	10 SINPV/16 li H_2O	53	60	73	186	62.00
3	15 SINPV/16 li H_2O	84	85	80	249	83.00
4	20 SINPV/16 li H_2O	90	87	92	269	89.67
5	30 ml Selecron/16 li H_2O	90	95	90	275	91.67

6	Untreated	0.00	0.00	0.00	0.00	0.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	Pr > F
Model	7	18061.00000	2580.14286	93.15**	< .0001
Block	2	93.00000	46.50000	1.68	0.2352
Treatment	5	17968.00000	3593.60000	129.73	< .0001
Error	10	277.00000	27.70000		
CORRECTED TOTAL	17	18338.00000			

**Highly Significant Coefficient of variation = 8.310125%

Appendix Table 11. Mortality (%) of adult *Diadegma* after 24 hours of exposure from the treatments of SINPV and Selecron

		REPLICATIONS				
TREATMENT	RATES	I	II	III	TOTAL	MEAN
1	20 SINPV/16 li H_2O	0.00	0.00	0.00	0.00	0.00
2	30 ml Selecron/16 li H_2O	90.00	100.00	90.00	280	93.33
3	Untreated	0.00	0.00	0.00	0.00	0.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	Pr > F
Model	2	17422.22222	8711.11111	784.00*	< .0001
Treatment	2	17422.22222	8711.11111	784.00	< .0001
Error	6	66.66667	11.11111		
CORRECTED TOTAL	8	17488.88889			

*Significant Coefficient of variation = 10.71429%

Appendix Table 12. Mortality (%) of adult *Diadegma* after 48 hours of exposure from the treatments of SINPV and Selecron

		REPLICATIONS				
TREATMENT	RATES	I	II	III	TOTAL	MEAN
1	20 SINPV/16 li H_2O	0.00	0.00	0.00	0.00	0.00
2	30 ml Selecron/16 li H_2O	100.00	100.00	100.00	300.00	93.33
3	Untreated	0.00	0.00	0.00	0.00	0.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	Pr > F
Model	2	20000.00000	10000.00000	Infty*	< .0001
Treatment	2	20000.00000	10000.00000	Infty	< .0001
Error	6	0.00000	0.00000		
CORRECTED TOTAL	8	20000.00000			

*Significant Coefficient of variation = 0

Appendix Table 13. Mortality (%) of adult *Diadegma* after 72 hours of exposure from the treatments of SINPV and Selecron

TREATMENT	RATES	REPLICATIONS I	II	III	TOTAL	MEAN
1	20 SINPV/16 li H_2O	0.00	0.00	0.00	0.00	0.00
2	30 ml Selecron/16 li H_2O	100.00	100.00	100.00	300.00	93.33
3	Untreated	0.00	0.00	0.00	0.00	0.00

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	F VALUE	Pr > F
Model	2	20000.00000	10000.00000	Infty*	< .0001
Treatment	2	20000.00000	10000.00000	Infty	< .0001
Error	6	0.00000	0.00000		
CORRECTED TOTAL	8	20000.00000			

*Significant

Coefficient of variation = 0