ASOCIACIÓN PARA LA INVESTIGACIÓN DEL
DESARROLLO SOSTENIBLE DE LAS SEGOVIAS
ADESO "Las Segovias"

Nº RUC: 041295-9574
Nº Perpetuo: 616

Telefax: 0-7133550
Aptdo. 60 – Estelí

Ecological control of insect plagues, with small producers of garden vegetables in the Communities La Almaciguera, La Tejera, and La Laguna, in the department of Estelí

Engineer Freddy Miranda O y Sr. Dimas Cerrato Girón

Summary

This research was undertaken by ADESO "Las Segovias" through the association of small producers in the community La Almaciguera (APEPCA) in order to control an insect plague known as cabbage moth, plutella xylostella, which affects the principal vegetable gardens causing damages like foliage galleries, and the no florescence that is characteristic in vegetable gardens. When there are high levels of population (of cabbage moth) they cause a deterioration of the quality of products, causing this way, a loss to small and median farmers. This plague is mainly controlled with chemical products, which has as a result, the reduction of natural enemies, pesticide resistance, health problems for the producers and the consumers, and environmental damages. This is why the principal goal is to introduce and verify options of ecological control of insect plagues in vegetables like (cabbage, cauliflower, and broccoli), with producers of vegetable in the communities La Tejera, La Almaciguera, and La Laguna - department of Estelí-, to obtain products free of chemical wastes. To solve this problem, a process of training on development of knowledge, and skills on biological control for small producers, was developed, Establishing a host plague breeding, cabbage plant production, parasite breeding, and breeding sample control, under the environmental conditions of the farm El Tysay.

The results obtained in this research were: The used methodology of massive breeding of the parasite Diadegma Insulare, provide enough amount of parasite to be released in parcels and to supply the program of integrated control of plagues, for the control of Plutella Xylostella. The environmental conditions of temperature in a rank of (12-27^{o}c) and relative humidity of (32-80%) prevailing in El Tysey Area are suitable for the development of the breeding of this parasitoid. The percentage of parasitism in laboratory conditions reached an average of 79% and a maximum of 98%.

On the other hand, the percentage of parasitism in the parcels subjects to research was recorded; it has a 16% up to 83% increase due to releasing in the plots. The use of E insulare kept the incidence of the plague under the level of economical damage; hence the utilization of parasitoids during the dry seasons is profitable for small producers. It justifies that the producers accept to use the parasitoid as a biological alternative, since it assures a

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

production of broccoli and cabbage without chemical products. The utilization of Bacillus Zuringiensis is compatible with the utilization of parasitoids when the plagues' population reaches the level of economical damage. The training workshops improve the knowledge in the producers of the association, about the use of parasitoids. The predator bedbug Podisus Sp and the killer bedbug in producers' opinion feed with Leptofobia aripa, but the biggest population appears from August through December. Keeping a considerable number of the parasitoid D. insulare allowed the foreseen releasing in the plots subjects to research.

Introduction

A considerable part of Nicaraguan economy is based on agriculture; for internal use only, however, Nicaragua is exporting products like coffee bean, sugar cane, dairy products and meat. The production for auto consumption is represented by rice, beans and corn, which are basic products for the nutrition of Nicaraguan people, and some areas have specialized in the production of vegetables. In the particular case of vegetables, the main plague is plutella xylostella. This plague is mainly controlled with chemical products, applying the products 8 to 15 times. Rogelio Trabanino (1998), mentions some factors that have made difficult its control, and sometimes even impossible in some areas: Its high level of proliferation, short generations, adaptation to environmental conditions (10 to 15 ^{o}C), Their feeding in hidden places, and waxy leaves, which make fumigation less efficient, capacity to develop pesticide resistance, and migratory capacity.

Since 1994 there has been a tendency towards economical growth of Nicaragua. The investments and exportation are increasing as a result of the security inspired by macro economical environment to national and foreign investors REDCAHOR (2000).

Now a day Nicaragua shows the lowest agricultural yield in Central America; As a result of a delayed and obsolete technology that production systems face.

On the other hand, Nicaragua has excellent conditions for the development of horticulture, but this potential has hot been optimally used, because since 1990 to 1998 no projects for the improvement of vegetable products, which are an important source of food, have been implemented.

1997-1998 preliminary researches about natural enemies of cabbage plagues were started. The main parasitoid that was found, in a proportion of 40%, was Diadegma Insulare, which is not very efficient in the control of cabbage moth, since then many efforts to establish a breeding of this parasite, in farms of producers, were started. These actions are known as biological control of plagues.

The objective of this research is to introduce and verify options of ecological control of insect plagues in cabbage, cauliflower and broccoli, with vegetable producers in the communities La Almaciguera, La Tejera, and La

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

Laguna –Estelí- in order to obtain products free of chemical wastes.

Methodology

Massive breeding of P. Xylostella

A breeding sample of P.Xylostella was established for the parasitoid breeding, and it reproduces. An egg laying chamber where adult P. Xylostella will lay eggs in aluminum sheets impregnated of cabbage juice.

Construction of egg laying chambers: an egg laying chamber is a plastic recipient with 2-3 liters capacity, with plastic lids; this lid has three fissures, nets for ventilation are placed in two of the fissures and in the central one, a cross shaped rubber piece is placed.

Preparation of egg laying sheets:

- Cut cabbage leaves in the green house.
- Weigh 65 grams of leaves.
- Blend the leaves in 500 milliliters of waters during 2 minutes.
- Transfer the juice in a 2000 milliliter recipient.
- Introduce it in autoclave at 12^{o}c, 1.05 kg/cm^{2} during 2 minutes.
- Then filter the juice and soak 15 * 12 cm aluminum stripes.
- Dry them at normal temperatures.
- Store them in refrigeration at 0^{o}c. Now they are ready to be used.

Preparation or food for adult plutella: Natural solution: it is made out of honey, the honey must be 100% pure, it is dissolved in distilled water until getting a 10% solution, and it must be a homogeneous solution. The use of honey is better, because it is a more complete diet, since it has a 60 to 80% of glucose and fructose, 20% of water, 0.5 % minerals above all potassium and phosphorus; amino acid chains, vitamins A,B and C, estrogenic hormones, inhibiters, insulin and cholinergic substance that provide a complete diet for the insects.

Reproduction of P. Xylostella: Larvae and nymphs of P. Xylostella are collected in cabbage fields trying not to take material infected by fungus or any pesticide substance that can pollute the laboratory. When there are approximately 200 nymphs of P. Xylostella they are introduced in the egg laying chamber.

In the egg laying chamber, a 50 milliliter capacity recipient with honey solution is introduced; an absorbent stripe, through which insects will take the food, is added to the recipient. Then the egg laying sheets are placed and the recipient is closed. The egg laying chamber should be placed in a dark place or covered with a dark cloth.

After 24 hours, the egg laying sheets with plutella eggs are removed to be used in the inoculation of cabbage plants for production of p. xylostella or for the production of parasitoids.

Establishment of tests with producers and releasing of the parasites D. insulare

The tests were made as producers traditionally do in dry season (January through March 2003).

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

Nº RUC: 041295-9574
Nº Perpetuo: 616
Telefax: 0-7133550
Aptdo. 60 – Estelí

a) Preparation of the seed bed
b) Preparation of the permanent field
c) Transplantation, fertilization and control
d) sanitary control

Releasing of parasites and evaluation of the incidence in the field

For the control of the moth P.Xylostella the micro biological commercial pesticide dipel 6.4 WG© (*Bacillus thuringiensis* var. *Kurstaki*) was used, taking into account the levels of economical damage of 0.2 larvae per plant during the sowing season in Estelí according to (Días et al, 1999). Five patches were taken at random for the sampling in the field, in every patch ten plants were checked, counting the number of larvae in the plant totalizing them at the end of the recounting.

Chambers for releasing of parasitoids consisting of a plastic cup with a lid, tied to a wooden stake about 75 cm above the ground were placed inside the cultivation.

Inside the cup there is a glued recipient of Styrofoam; containing nymphs of D. insulare. These releasing chambers were located in representative places in the field in order to have uniformity in the distribution of the parasitoid.

It is also necessary to isolate the chamber from the insects on the ground; spiders and ants that could feed on nymphs; it is done by applying an oily film around the stake. The incidence of D. Insulare was evaluated through the percentage of parasitism registered in the larvae of p. xylostella. This percentage is calculated out of the recollection of larvae that are present in the cultivation; it is advisable to gather the biggest possible number of larvae to avoid statistic mistakes.

The number of nymphs of p. xylostella and D. insulare in the sample are recorded, dividing later the number of D. insulare by the total of nymphs of the three species that were found.

At the moment of gathering and recount, the data of possible predators that could have a significant importance for the plague control and that could be used in the biological control are taken.

Variables recorded at the moment of harvest

- Number of larvae and nymphs of P. xylostella
- Number of larvae of P. xylostella with parasites
- Number of predator insects and parasitoids
- Number of commercial items formed / hectare.
- Number of formed non commercial items (sick) formed / hectare.
- Percentage of foliage damage
- Level of economical damage

Results

Establishing of the breeding of Diadegma insulare

Laboratory results

In box 1, the reproduction of Diadegma insulare is shown. In laboratory conditions it was possible to obtain

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

satisfactory results, since a total production of 22136 larvae of plutella was obtained, out of which 18622 were parasites resulting an average of parasitism of 79.36%.

Box1. Reproduction of* Diadegma insulare *in its host place; November 2002 through April 2003,* Plutella xylostella *in the laboratory of breeding located in the farm Tisey, community La Almaciguera, Estelí.

Month	*week*	*Production*	*Larvae with parasites*	*Nº of larvae with no parasites*	*% of born larvae*	*Parasitism %*
Nov.	*3*	*506*	*435*	*71*	*87*	*85.96*
	4	*666*	*601*	*65*	*86*	*90.24*
December	*1*	*1140*	*1017*	*123*	*76*	*89.21*
	2	*465*	*395*	*70*	*98*	*85*
	3	*398*	*206*	*192*	*96*	*21.76*
	4	*751*	*659*	*92*	*85*	*87.74*
January	*1*	*1278*	*980*	*298*	*92*	*76.68*
	2	*254*	*232*	*22*	*90*	*91.33*
	3	*168*	*132*	*36*	*93*	*78.57*
	4	*698*	*503*	*195*	*86*	*72.06*
February	*1*	*1256*	*1096*	*160*	*98*	*87.26*
	2	*1698*	*1412*	*286*	*91*	*83.60*
	3	*1972*	*1796*	*176*	*93*	*91.07*
	4	*2014*	*1987*	*27*	*86*	*98.21*
March	*1*	*2952*	*2697*	*255*	*87*	*91.36*
	2	*1098*	*968*	*130*	*79*	*88.16*
	3	*248*	*169*	*79*	*88*	*68.14*
	4	*659*	*469*	*190*	*94*	*71.18*
April	*1*	*1065*	*769*	*296*	*95*	*72.20*
	2	*987*	*659*	*328*	*98*	*66.77*
	3	*798*	*454*	*344*	*97*	*56.90*
	4	*1065*	*986*	*79*	*49*	*92.58*
Total		***22136***	***18622***	***3514***	***88.36***	***79.36***

Results are good when compared to others recorded in other breeding in artificial conditions, (Brenes, J. 2000). These results are successful for a breeding with percentage of parasitism that reaches up to 85%. This has been a breeding controlled by producers who have been trained through technical advisory by specialists in biological control. This experiment in the field should have an average fewer than 85%, but in 22 recorded generations 12 generations above 85% of parasitism were found. More over, 88.36% of

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

emergency, that guaranties the quality of its production, resulted.

Limiting factors and physical environments

The presence and success of an organism or groups of organisms depend on a series of conditions. Any condition that approaches or exceeds the limits of tolerance is called condition or limiting factor. In stable conditions the available basic material in the nearest amounts to the minimum requirement tends to be the limit; this concept has been spread as the Law of Leibig.

Organisms are not only able to adapt in the physical environment by tolerating it, but also to use the natural periodicity of it in order to synchronize their actions and to program their history of life in a way they can get benefits out of favorable conditions.

The ranks of temperature that were observed in January and February 2003 were 13 to 26°c in January, and the variation of temperature is only 1°c, from 14 up to 27°c during February.

The temperature in March varied from14 to 29°c, this tendency is very similar to the temperatures recorded during January and February.

It is considered that the optimal ranks for the development of D. Insulare parasitoid from high areas varies from 700 to 1400 millimeters above sea level in Nicaragua. This parasitoid develops efficiently according to (Talekar, N.S. and Lim, 1998). In ranks of temperature that vary from 15 to 25°c and it does not controls efficiently the cabbage moth when temperatures are more than 27°c during two consecutive weeks.

Then temperature was not a limiting factor during the production of parasitoids.

Efficiency of use of parasitoids in experimental parcels with producers

The results obtained in the parcel were taken by the producers. They recorded data of agronomical control of the most important pests in natural enemies. These recordings were made in notebooks of control that were designed together with the producers, in order to record the most important actions in the parcels, see notebooks in appendix.

Box2. Releasing of parasitoid *D. insulare* in producers' farm.

Producer's name	Date of releasing	Nº releasing/dates				Total
		1	2	3	4	

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

Nº RUC: 041295-9574
Nº Perpetuo: 616
Telefax: 0-7133550
Aptdo. 60 – Estelí

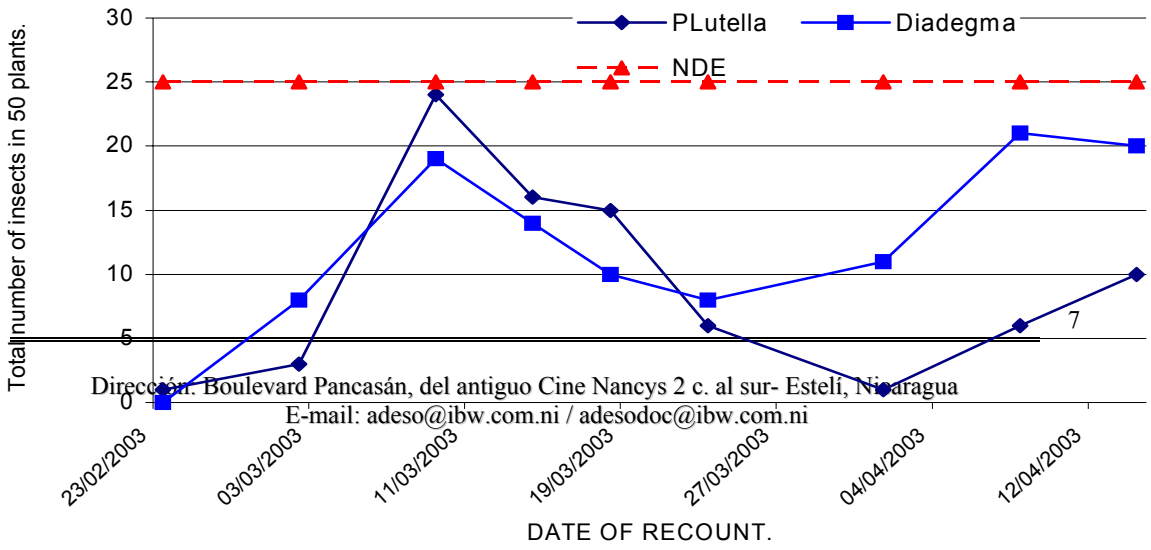
Gustavo Cerrato	03/02/03	20/02/03 390	05/03/03 250	23/03/03 250	01/04/03 1000	**1890**
Heriberto Cerrato	03/02/03	20/02/03 390	05/03/03 250	23/03/03 250	01/04/03 1000	**1890**
Lesther Navarro	06/02/03	26/02/03 400	02/03/03 365	25/03/03 1051	08/04/03 700	**2516**
Eladio Navarro	21/02/03	11/03/03 400	29/03/03 400	06/04/03 1000	14/04/03 700	**2500**
Grand total						**8796**

It should be taken into account that there was capacity of production of parasitoids to comply compromises of releasing in experimental parcels fulfilling with the foreseen calendars and goals (see chart 2). The capacity of production is linked to the capacity of person in charge of the laboratory who has achieved an opportune adaptation of the technique of breeding of parasitoids that had been raised in laboratory conditions only and managed by experienced technicians. It is considered a big achievement because this laboratory is managed by producers that were trained and they did it efficiently. The amounts of parasitoids to be released are part of the process of test, since steady amounts have not been possible to be established.

The appropriation of a complete cycle of technological transference is very important; here producers establish a test, they manage it, take decisions and judge obtained results.

All this is considered an achievement due to the fact that the production of parasitoids in this laboratory of field was managed by producers who were trained, resulting in a technology of high quality and acceptance.

Incidence of Plutella and Diadegma in Gustavo Cerrato's parcel, compared to NDE.



Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

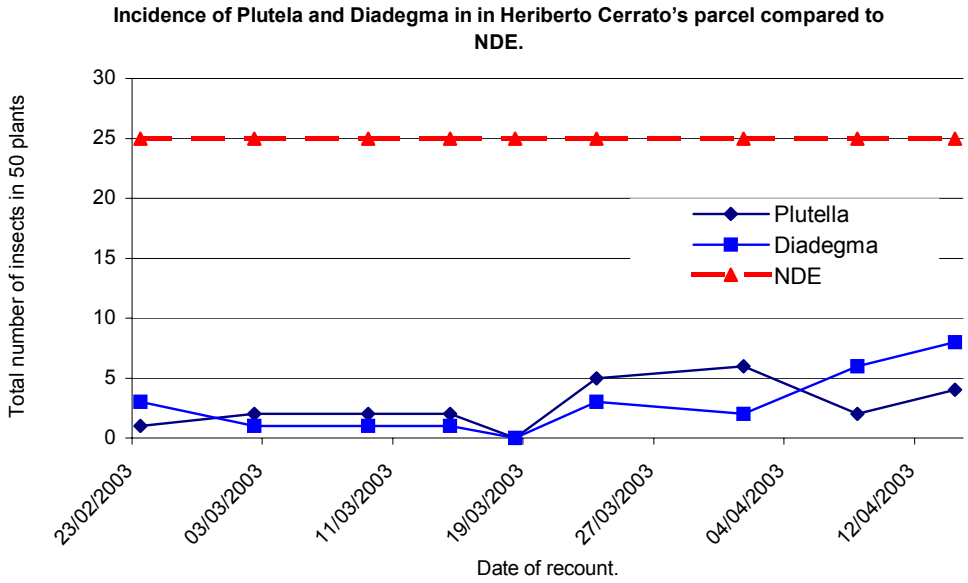
Picture1. Incidence of Plutella xylostella (larvae) and Diadegma Insulare (adults), according the recollections during the irrigation season. The data represent the number of insects in 50 plants in parcels of broccoli and cabbage.

A good control of cabbage moth was obtained, keeping it under the level of economical damage, where B.t. on this date (03/11/03) was applied, as it can be seen in picture $N^0$1, there is an ascendant overlapping between the pest and the parasite in the first dates of the recounting, and in the last stage, the number of parasitoids Diadegma insulare is higher than that of their hosts, this result is a product of the releasing that assured the increase of their population in the fields.

In this parcel, the population of moth, was reduced under N.D.E. (picture 2), during all the cycle of production it can be seen that there was a synchrony between the pest and its host, and at the end the incidence of the parasitoid was above the pest. That means that the biological control was efficient when the producer did not use chemical pesticides.

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

Nº RUC: 041295-9574
Nº Perpetuo: 616
Telefax: 0-7133550
Aptdo. 60 – Estelí



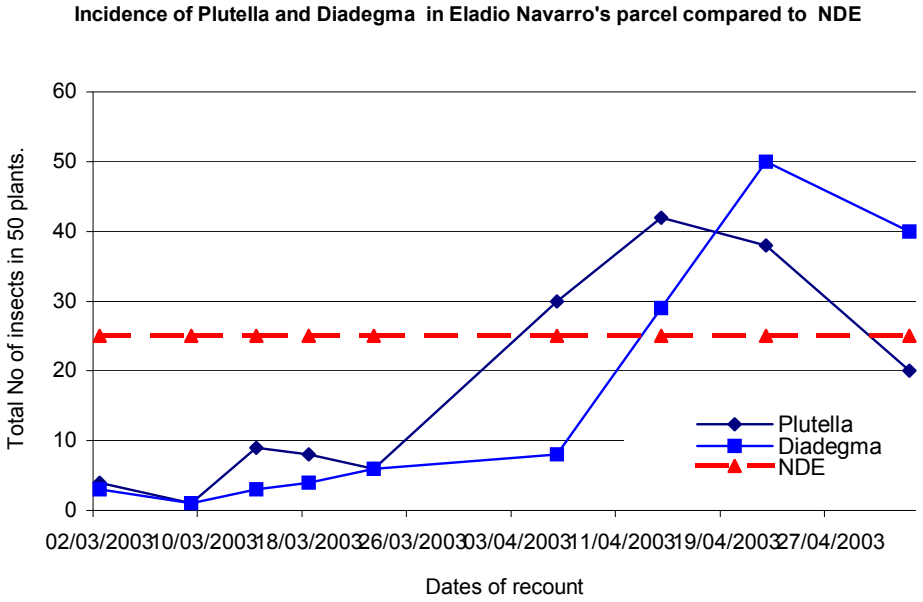
Picture2. Incidence of Plutella xylostella (larvae) and Diadegma insulare (adults), according the recollections during irrigation season. The data present the number of insects in 50 plants in parcels of cabbage.

A good control of the cabbage moth was obtained; keeping it under the level of economical damage, where B.t. on this date (03/11/03) was applied. As it can be seen in picture 1, during the first dates of recount there is a descending overlapping between the pest and the parasite, and in the last stage, the number of parasitoids Diadegma insulare is above the number of its host, this result is a product of the releasing that assured the increase of its population in the field.

In this parcel the population of cabbage moth was reduced under the NDE (picture 2), during all the cycle of production, it can be seen that there was a synchrony between the pest and its host, ending above the pest the incidence of the parasitoid. This means that the biological control was efficient when the producer did not used chemical pesticides.

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

Nº RUC: 041295-9574
Nº Perpetuo: 616
Telefax: 0-7133550
Aptdo. 60 – Estelí



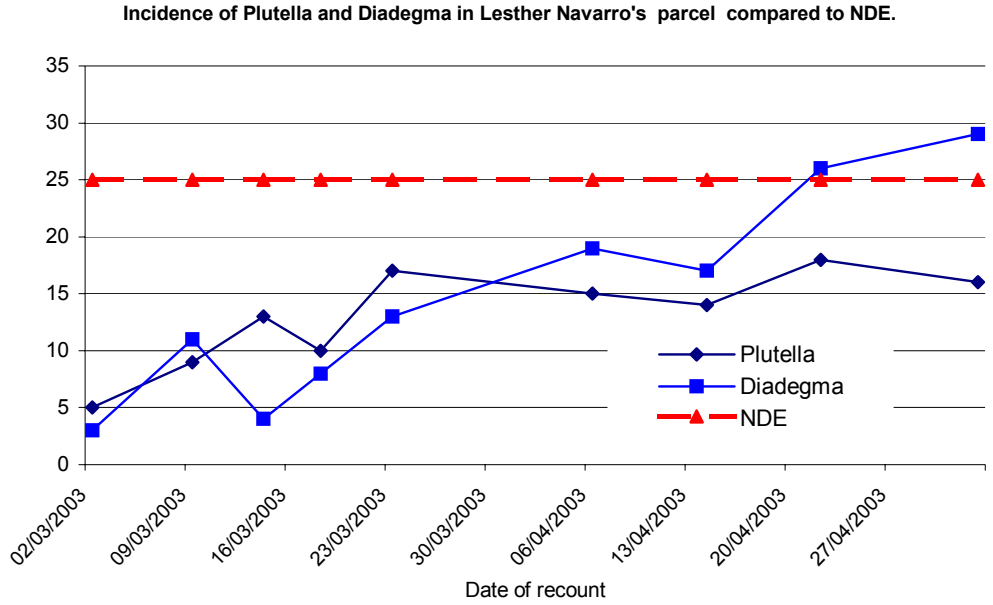
Picture 3. Incidence of Plutella xylostella (larvae) and Diadegma insulare (adults), according the recollections during the irrigation season. The data present the number of insects in 50 plants in the parcel of broccoli and cabbage.

In picture 3, the incidence of the pest and its parasitoid keeps the same overlapping tendency during the first 4 dates of recount, later we can see an increase of both populations. And at the end, the number of parasitoid is above its host, Plutella Xylostella; above the level of economical damage.

This behavior of the population of pest is due to the fact that in this parcel the B.t was applied on April the first, which reduces its population and do not affects the population of parasitoids. The use of B.t is compatible with the releasing of parasitoids, because they are not affected. In researches about the effects of various pesticides against natural enemies (Idris and Grafius, 1993), it has been concluded that B.t does not affect them due to its way of action. Similar results were reported by Talekar and Shelton 1993. Shelton et al (1993) who recommends a more rational use of B.t for it is one of the few pesticides against which high and generalized resistance has not been presented.

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

Nº RUC: 041295-9574
Nº Perpetuo: 616
Telefax: 0-7133550
Aptdo. 60 – Estelí



Picture4. Incidence of Plutella xylostella (larvae) and Diadegma insulare (adults), according the recollections during irrigation season. The data present the number of insects in 50 plants in parcels of broccoli and cabbage.

In this parcel of reproduction we can see that the reduction of the incidence of the pest is under the NDE (picture 4), during the cycle of cultivation presents the same tendency as the incidence of parasites starting in the fourth date it is above the pest, which confirms the success of the releasing in the field.

On the other hand, it can be seen that the pest population prefers cabbage, and this behavior was similar in the parcels where there was broccoli and cabbage.

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

Results of the recollections in experimental parcels

Box 3. Results of the parasitoid in 4 parcels established with producers in the community La Almaciguera in 2 farms.

Producer	Dates of recollection	Nº of collected larvae	Nº larvae with parasite	Percentage of parasitism
Gustavo Cerrato	23/03/03	15	3	16
	06/04/03	22	11	*50*
	14/04/03	40	25	*62*
	03/05/03	44	32	*73*
Heriberto Cerrato	23/03/03	26	5	19
	06/04/03	30	10	33
	14/04/03	30	15	*50*
	03/05/03	40	25	*63*
Lesther Navarro	23/03/03	30	10	33
	06/04/03	22	9	41
	14/04/03	25	12	*48*
	03/05/03	60	50	*83*
Eladio Navarro	22/03/03	20	5	25
	05/04/03	30	12	40
	19/04/03	50	25	*50*
	03/05/03	73	42	*58*

These results confirm that the releasing in each of the parcels increased the percentage of parasitism passing from 16% up to 73% in Gustavo Cerrato's parcel and 19 up to 63% in Heriberto Cerrato's parcel. (See box 3) where Lester Navarro passes the parasitism from 33 up to 83, here it was bigger because in this parcel grew up weed that blooms early and provides food for the parasitoids, guarantying this way its establishment and conservation. This results are similar to those found out in other researches such as Araya, R. et al (1993), who reports levels of parasitism of D. insulare in different places in Costa Rica; levels that vary from 7.6% up to 16%. In rainy season they grow up to 36%, in dry season on the other hand, it decreases down to 7.0%. Alam, M. M. (1992), reports the percentage of parasitism in three places of Jamaica (Douglas Castle, Castle Kelly y Blue Montain), during the period 1988-1990 with ranks of 6.1%-75.8%, 0%-45.5% -1.1% and 57.4%. Mueckenfus, A. E. *et al* (1992) reports that in the southern coast of Carolina the percentages of parasitism reach up to 90% with averages of 41%; In México, Mccully y Araiza, M. D. (1992), mentions the percentage of parasitism of *D. insulare* in broccoli and cauliflower gardens in the years 1988, 1989 and 1990 with averages of

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

62.5%, 36.0%, 30.2%; 56.7%, 30.9% and 32.3% In each year for each cultivation, respectively.

In Nicaragua, Pérez, H. (1999), reports the percentage of parasitism from 58% up to 76%. Miranda, F., Zamora. M. (1997), in parcels treated with Dipel record 63% up to 37% percentage of parasitism of *D. insulare*. (Delgado, O. 2001), records a rank of 0% up to 61.9% percentage of parasitism in a parcel treated with Dipel, with an average of 31.52% for the last period of sowing of 1998. The reports of parasitism belong to the cultivation of cabbage in the same locality.

Box 4. Results that the parcels subject to research yielded

PRODUCER: Eladio Navarro. (CABBAGE)						
No. of plants per hectare.	% of commercial plants	Unit price	Foliage damage	Cost per hectare$	Gross income C$	Net income C$
35,200	77	2	0	12,200	70,400	58,400
PRODUCER: Lester Navarro (Broccoli)						
	80	3,330			110,998,89	98,998,89
Cabbage						
33,333	80	2	2%	12,000	66,666	54,666
Gustavo Cerrato (Cabbage)						
33,333	92%	2	5%	12,000	66,666	154,666,66
Broccoli						
33,333	92%	5		12,000	166,665	154,665
Heriberto Cerrato (Cabbage)						
33,333	77%	2	7,5%	12,000	66,666	54,666

Box 4 shows the yielded results. The parameter of foliar damage did not overrate 7.5% as average, which indicates that the control of the pest was efficient getting this way a good quality and profitable production for each of the producers, this is due to the cultivations were sown in dry season and commercialized by the end of April and beginning of May 2003, which guaranty that the garden vegetables commercialized in this time reach the best prices in the national market.

Other insects were present, among them there were predators found in the fields of the parcels subject to research, being the bedbugs the most important predators of P. larvae and the striped worm that attack cabbage and broccoli plants leptofobia aripa. According to data obtained in this research they were not significant, there fore they had no incidence in the population of cabbage moth. According to interviews to producers these predators' bedbugs were released in 1998 by a professor of Escuela Agricola Zamorano. This confirms that they have established and contribute to the natural control of pests.

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

Nº RUC: 041295-9574
Nº Perpetuo: 616
Telefax: 0-7133550
Aptdo. 60 – Estelí

Conclusions

1. The used methodology for this massive breeding of the parasite Diadegma insulare assures enough amounts to make releasing in parcels and to supply the program of MIP (Integrated Management of Pests), to control the plutela xylostella.

2. The environmental temperature conditions with a rank of (13-27^{0}c) and the relative humidity of (32-80%) prevailing in Tisey area are suitable for the development of breeding of parasitoids.
3. The parasitism in the laboratory reached an average of 79% and a maximum of 98%. On the other hand, the establishments of percentages of parasitism, in the parcels subject to research, was recorded, this assures a 16% up to 83% increase due to releasing in the parcels.

4. The use of parasitoid D. insulare kept the incidence of the pest under the level of economical damage, hence the utilization of parasitoids in dry season is profitable to small producers, this justifies that producers accept the use of parasitoids as a biological alternative, since it assures a production of broccoli and cabbage without chemical products.

5. The utilization of Bacillus thuringiensis is compatible with the use of parasitoids when the population of pest reaches the economical damage level.

6. Training workshops improve the knowledge on the use of parasitoids for the producers of the association.

7. The predator bedbug podisus sp and the killer bedbug were, according to the producers, the ones that eat leptofobia aripa, but the biggest populations appears during the last period of sowing (August - December).

8. The maintenance of the breeding sample of parasitoid D. insulare assured in a 100%, the foreseen releasing in the parcels subjects to research.

Recommendations

1. To research about the cycle of life of the parasitoid in the laboratory and in the field.
2. To validate the use of parasitoids in other communities emphasizing :

    a) Quantify the approximate amount of parasites that should be released per hectare.
    b) To evaluate the profitability of the use of parasitoids within a program of integrated control of pests.

3. To breed predator insects to evaluate their feasibility of use.
4. To carry out a training process about bio ecological topic in associations of small agricultural producers in order to continue the breeding with small

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

producers to assure a process of sustainable agriculture.

Bibliography

ALAM, M. M. 1992. Diamondbck moth and natural enemies in Jamaica and some other caribbean islands. In: Diamondbck Moth and other crucifer pests. Proceding of the second international workshop. N: S: talekar, Editor. Asian vetajetable research and development center. Tainan, Taiwan (10-14 December 1990). p. 233-243. Plubication No. 92-368.

ANDREWS, K.L; SANCHEZ, R. J. And CAVE, R.D. 1992. Management of diamondback moth in central America. In: Diamondback moth and other crucifer pests. Proceding of the second international workshop. N. S. Talekar, Editor. Asian vegetable Research and Development Center. Tainan, Taiwan (10-14 December 1990). p. 489-450.

ARAYA, M. M.; MONGE, L. A.; CARAZO, R, E Y CARTIN, L.V.M. 1999. Diagnóstico del uso de insecticidas para el combate de Plutella xylostella en Costa Rica. Manejo integrado de plagas. (Costa Rica) No. 52.p 49-61.

BRENES, J. 2000.Cría masiva y liberación de parasitoide, de *Plutella xylostella* L, y su manejo a través *Bacillus thuringiensis* en el cultivo de repollo *Brassica oleracea* L, en tres épocas de siembra. Tesis Ingeniero Agrónomo. Universidad Nacional Agraria. Managua, Nicaragua.

BRENES, J. Y MIRANDA, F. 1998.Cría y biología del parasitoide *Diadegma insulare* (Cresson), de *Plutella xylostella*, bajo condiciones de laboratorio. En: VII Congreso Internacional de Manejo Integrado de Plagas, VII Latinoamericano de Moca Blanca y geminivirus XXXVIII Reunión anual de la sociedad Americana de fitopatología división del caribe (APS-CD), (26 al 30 de octubre de 1998). Managua, Nicaragua. (Memoria). p.96.

CAVE, R. 1995 (a). Manual para la enseñanza del control biológico en América Latina. Escuela Agrícola Panamericana. El Zamorano. Honduras. p 187.

DELGADO, O. 2001. Manejo de la palomilla del repollo *Plutella xylostella* (L), en el cultivo de repollo, (*Brassica oleracea* L), a través del uso de insecticidas NIM 20, Dipel (*Bacillus thuringiensis*) y Evisect (Thiociclam). Tesis Ingeniero Agrónomo. Universidad Nacional Agraria Managua, Nicaragua.

DIAZ, B.J. et al (1999). Manejo Integrado de Plagas en el Cultivos de repollo. CATIE. Managua, Nicaragua, p. 105

HASSANEI, M. H. 1958. Biological studies on the Diamondback moth, *Plutella maculipensis* (Curt). (Lepidoptera: Plutellidae) In: Talekar, N.S; Lee, S.F; Chen, B.S y Sun, L.Y (compilers) 1985. Annoted Biblography of diamondback moth. Asian Vegetable Research and Development Center (AVDRC). Schanhuan. Taiwan. p 86 publication 85-229.

IDRIS. A. B.; GRAFIUS,S.E. 1993. Fiel studies on the effect of pesticide on the diamondback moth (Lepidoptera: Plutellidae) and parasitism by *Diadegma Insulare* (hyminoptera:Ichneuminidae).J. Econ. Entomol.86☹4) 1196-1202).

MCCULLY, J. E. and SALAS, M. D. 1992. Seasonal variation in populations of the principal insect causing contamination in processing brocculi and cauliflower in central Mexico. In: Diamondback Moth and other crucifer pests. Proceding of the second International workshop. N. S. Talekar, Editor. Asian Vegetable Research and Development Center. Tainan, Taiwan (10-14 December 1990). p 51 - 56. Plublication N° 92-368.

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni

MIRANDA, F. y ZAMORA, M. 1997. Evaluación de los enemigos naturales de la palomilla del repollo (*Plutella xylostella* L.) y sus plantas hospederas en Tisey Estelí. Universidad Nacional Agraria. Managua Nicaragua.

MIRANDA, F.; BRENES, J. Y PEREZ, H. 1998. Reproducción de parasitoides cortesía de plutellae y *Microplitis plutellae* de la palomilla del dorso del diamante (*Plutella xylostella*), durante la etapa de cuarentena. Universidad Nacional Agraria Managua, Nicaragua.

MIRANDA, F; BRENES, J; PÉREZ, H. 1999. Crianza y estudio de parasitoide para el control biológico de la palomilla del repollo (*Plutella xylostella* l.), Universidad Nacional Agraria. Managua, Nicaragua.

MUCKENFUS, A. E.; SHEPARD, B. M. AND FERRER, E. R. 1992. Natural Mortality of diamondback moth in coastal south Carolina. In: Diamondback Moth and other crucifer pests. Proceding of the second International workshop. N. S. Talekar, Editor. Asian Vegetable Research and Development Center. Tainan, Taiwan (10-14 December 1990). p 27. Plublication N° 92-368.

PEREZ, H. (1999). Cría y Liberación de Parasitoide *Diadegma insulare* (Cresson) de la Palomilla del repollo (*Plutella xylostella* L.) dentro de un contexto de MIP. Universidad Nacional Agraria. Managua, Nicaragua. p. 42

QUEZADA, J. R. 1989. Utilización del control biológico clásico. En: Manejo integrado de plagas insectiles en la agricultura. Estado actual y futuro. Keith Andrews, José Quezada (Edits). Escuela Agrícola Panamericana. El Zamorano Honduras. p. 187.

SCHELTON, A.M.; ROBERTSON, J.L.; TANG, J.D.; PEREZ, C.; EIGENBRODE, S.D.; PREISLER, H.K.; COOLEY, R.J. 1993. Resistanse of diamondback moth (Lepidoptora: Plutellidae) to *Bacillus thuriengiensis* subespecies in the field. J. Econ. Entomol. 86 (3) 697-705.

REDCAHOR 2000. Impact of REDCAHOR acction on the vegetable subsector in the region/ ed. By collaborative Vegetable Research and development Network for Central America, Panama and the Dominecan Republicand Inter –American Institute for Cooperation on agriculture- San Jose CR: IICA.

TALEKAR, N. S. y MEI-YING LIN. 1998. Training manual on IPM of Diamondback moth. Asian Vegetable Research and Development Center (AVDRC). Shanhua, Tainan, Taiwan. publication Nº 98-472 p 66.

TALEKAR, N.S. & LIM, S. 1998. Mass rearing of parasitoids in crucifer. Asian Vegetable Research and Development Center (AVDRC) Chanhua, Taiwan, Taiwan.

TRABANINO, R. 1998. Guía para el manejo integrado de plagas invertebradas en Honduras. Escuela agrícola panamericana. El Zamorano, Honduras 85-86.

Dirección: Boulevard Pancasán, del antiguo Cine Nancys 2 c. al sur- Estelí, Nicaragua
E-mail: adeso@ibw.com.ni / adesodoc@ibw.com.ni