BIOLOGICAL CONTROL OF CABBAGE WEBWORM, *HELLULA UNDALIS* AND CABBAGE WORM, *ARTOGIA RAPAE* USING ENTOMOPATHOGENIC NEMATODES ON CABBAGE SEEDLINGS.

AZAZY, A.M. AND GEHAD,M. MOUSA

Plant Protection Res. Institute, ARC, Giza -Egypt

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Abstract

Efficacy of three entomopathognic nematode strains, viz., *Steinernema carpocapsae* (Scall); *S. riobrave* (Sr.) and *Heterorhabditis* sp. (Hbs1)) in reducing population of *Hellula undalis* F. and *Artogia rapae* L. (Lepidoptera: Pyralidae) on cabbage seedlings under field and greenhouse conditions was evaluated. The result showed that the treatments were more effective under greenhouse conditions than under field conditions in case of *H. undalis*. The reduction was 96.2, 94.3 and 79.4% for Sr., Hbs1 and Sc., respectively. Whereas in the field the results were 81.5, 78.3 and 73.8 % for Sc., Sr. and Hbs1, respectively. On the other hand no significant differences were found between field and greenhouse results in case of *A. rapae*. *H. undalis* was more susceptible to the three tested nematode strains, than *A. rapae*.

Key Words: Biological control, ntomopathogenic nematodes, cabbage seedlings.

INTRODUCTION

Cabbage, *Brassica oleraceae* L. is subject to attack by several insect pests. The cabbage webworm (CWW), *Hellula undalis* F. and the cabbage worm, *Artogia* (*Pieris*) *rapae* (L). (Lepidoptera: Pyralidae) infest cabbage heads heavily. *H. undalis* is a serous pest on crucifer crops in the tropic and subtropical regions. It was detected for the first time in 1990 (Rejesus and Javier, 1997). In the Philippines it is seen nowadays as one of the most severe pests on crucifers. Major damage occurs on young plants but caterpillars also feed on older plants. Severe injury occurs when they tunnel into the main stem. Damage at this stage of plant growth results in stunting, and sometimes death of young plants. More often, however, damage to the growing point results in deformed plants and the formation of multiple growing points or heads. On older plants the larvae feed on leaves and by tunneling into leaf petioles. Positive identification can only be made if the insect is found, but if webbing with dirty frass is found on tunnel. Yield losses can reach up to 100% within 3 weeks had been documented in untreated crucifer fields in the Philippines during the dry season (Mewis *et al.*, 2001b). Chemical control of *H. undalis* is not very effective because the larvae are shielded in a loose web in the growing point (shoot) and have probably acquired resistance to insecticides. Several larval and egg parasitoids (e.g. *Apanteles* sp., *Bracon gelechiae* Ashm., *Microchelonus blackburni* Cam., and *Trichogramma minutum* Riley), and pathogens (*Bacillus thuringiensis* Berliner, granulovirus, and nucleopolyhedrovirus) were reported from *H. undalis* in Africa and other regions of Asia (AVRDC,1987; Waterhouse and Norris, 1989; Sivapragasam and Aziz, 1990; Battu,1991; Sivapragasam and Chua,1997b). Mewis *et al.*, (2003) observed infection in the pest species *H. undalis* and shows potential for microbiological pest management. Laboratory experiments were conducted at 20, 25and 35°C to assess the potential of *Steinernema carpocapsae* (all strain) as a biological control agent of cabbage pyralids (Hsiao, 1997).

A. rapae causes large damage to the quantity and quality of cabbage plants. *A. rapae* was found in the most Egyptian governorates where cabbage plants are cultivated.

Entomopathogenic nematodes showed high efficiency in controlling *A. rapae* in the laboratory and under field conditions (Saleh, 1995; Bader El-Sabah and Azazy, 2004).There for the objective of this experiment was to test the efficacy of three entomopathogenic nematode strains against *A. rapae* and *H. undalis* under field and greenhouse conditions.

MATERIALS AND METHODS

Three entomopathogenic nematode strains were used in the present study (i.e. *Steinernema carpocapsae* (Sc. all) *S. riobrave* (Sr.) (imported from USA) and *Heterorhabditis* sp. (Hbs1) (isolated from Egypt)). The nematodes were produced in vivo on larvae of *Galleria mellonella* L. (Lepidoptera: Pyralidae) and maintained in the laboratory using the methods of Woodring and Keya (1988). Experiments were carried out on cabbage seedlings (variety Ganzory) in Giza governorate. The field evaluation was carried out during two seasons (2003 and 2004) in area of quarter of feddan (1050m^2). The greenhouses evaluation was carried out during 2004 only in area of 20 m^2.

Seedlings were sprayed by the entomopathogenic nematode strains after natural infestation by the two insects. Twenty five cabbage seedlings of one month old (5 replicates X 5 seedlings) were sprayed with 1.5 l of nematode suspension (2000 IJs/ml) using portable sprayer (two liters capacity) for every nematode strain. Another 25 cabbage plants were left as a control. *A. rapae* and *H. undalis* pre-counts were taken for every treatment. Control was treated with water only. Both alive and dead larvae of the two tested insect species were counted after one week of treatment. In case of *H. undalis* the infested seedlings were gathered in paper bags for inspection by dissecting in laboratory. The percentage of reduction in *A. rapae* and *H. undalis* population counts were calculated according to Henderson and Tiliton equation (1955).

Statistical analysis of data was carried out using a computer software package "Costat ", a product of Cohort Software Inc., Berkeley, California, USA. Duncan's multiple range test (Duncan's, 1955) was used to differentiate between means.

RESULTS AND DISCUSSION

Under greenhouse conditions, data indicated that the reduction of *H. undalis* was 96.2, 94.5 and 79.5% for Sr., Hbs1 and Sc., respectively (Table, 1). While, reducing of *A. rapae* was 79.4, 72.2 and 57.1% for Hbs1, Sr. and Sc., respectively (Table,1). The data also revealed that there tested were no significant differences between the effects of the three entomopathogenic nematode strains on *H. undalis* ($F= 1.79$, $P= 0.187$) and *A. rapae* ($F=1.15$, $P=0.332$).

Under field conditions, in season 2003, the data showed that the entomopathogenic nematode strain (Sc.) was more effective than the two other nematode strains. (Sr. and Hbs1) achieved reduction 81.5, 76.1 and 73.8%, respectively on *H. undalis* (Fig.1). While, in season 2004, the result revealed that the two entomopathogenic nematode strains achieved mortality (100%) for Sc. and Sr. but Hbs1 resulted 66.7%. Statistical analysis showed that there were significant differences between the three entomopathogenic nematode strains in the two seasons on *H. undalis* (F=2.792, P= 0.035). In case of *A. rapae* in season 2003, the data showed that the reduction was 91.7, 82.9 and 63.5% for Sc., Sr. and Hbs1, respectively (Fig.2). While in the season 2004, the data revealed that the three entomopathogenic nematode strains achieved reduction 87.5, 75 and 50% for Sc., Sr. and Hbs1, respectively. The two entomopathogenic strains (Sc. and Sr.) gave percent reduction of *H. undalis* and *A. rapae* ranged between (76.1- 100%) followed by Hbs1, under field conditions. Statistical analysis revealed that there were high significant differences between the entomopathogenic nematode strains on *A. rapae* in two seasons (F=5.5, P=0.0004).

Generally, the entomopathogenic nematode strains were effective against *H. undalis* and *A. rapae* under greenhouse and field conditions. The three nematode strains were able to kill larvae of *A. rapae* before developing into pupae. This finding is in full accordance with Saleh, 1995; Badr El-Sabah and Azazy, 2004. The strains of steinernematid tended to give better control in temperature range of (5-25°C) than at highest temperatures (15-35°C) Kung *et al.*, (1991). On the other hand, the *Heterorhabditid* activity against *G. mellonella* larvae was inhabited below 10°C and significantly decreased at 30°C (Zervos *et al.*, 1991 and Azazy, 2001).Kahounova and Mracek 1991, mentioned that it is difficult to explain why the mortality increased or did not increase in the seasons. Probably the lower infectivity or some inconvenient a biotic factors may influence the survival of nematodes on trees.

The obtained data shown in (Fig.3) revealed that spraying of nematode suspensions strains caused reduction of *H. undalis* (80.2, 85.2 and 91.2 %) while, in case of *A. rapae* the reduction was (65.77, 76.4 and 78.89%) for Sc., Sr. and Hbs1, respectively. The data also revealed that there were significant difference between the two insects (P<0.05).On the other hand Sc. caused higher reduction rates better than Sr. and Hbs1 on *H. undalis* and *A. rapae*. The life of *H. undalis* differs significantly from that of *A. rapae* in that there is generally only one larva per gallery. Whereas, the *A. rapae* was found on the leaves of plants. Plant –boring lepidopterous insects, in particular carpenterworms and Sesiid occurring in moist galleries have been controlled effectively with steinernematids and heterorhabditids (Kaya and Brown 1986). The moist galleries are ideal for the survival and searching of the entomopathogenic nematode strains were more effective against *Zeuzera pyrina* than *Synanthedon myopaeformis* (Azazy1996 and 2001).The infective juveniles (IJs) success has been achieved against soil-dwelling pests and those in cryptic habitats (Begley, 1990; Klein, 1990). The effectiveness of nematodes is enhanced by the favorable microclimate inside the galleries, where air humidity is high enough to prevent their desiccation. The effectiveness of treatment depends on both suitable timing of application and method of treatment. Deborah *et al.*, (1996) said that the concealed habitat of the banded ash clearing borer larvae protects it from conventional insecticide applications, entomopathogenic nematodes offer a safe, potentially economically, and relatively effective means of reducing BACB larval populations after trees have been attacked, decreasing the need for protective chemical sprays. In our experiment, spraying cabbage seedlings by Sc., Sr. and Hbs1 significantly reduced the numbers of *H. undalis* as compared with control. The applied nematode strains on head plants that exposed to direct sunlight could be affected and their efficacy may be reduced. *A. rapae* larvae generally confine their feeding on foliage. Nematode strains applied on the galleries were expected to surv.ve longer than those on the plant surface. However, the major reason for lack of success of nematode application in the field is the intolerance of IJs to extremes of desiccation temperature and UV (Baur *et al.*, 1995; Mason and Wright, 1997).

In summary, the present results encourage further studies to evaluate the possible use and the potential of entomopathogenic nematode strains in a control program against *H. undalis* and *A. rapae* in the field and greenhouse conditions.

REFERENCES

1. Avrdc.1987. Screening cabbage accessions for resistance to cabbage webworm. Progress Report.1985.Asian Vegetable Research and Development Center. Shanhua. Taiwan. pp. 19-23.
2. Azazy, A.M.1996. Biological control of insects with insect parasitic nematodes. M.Sc. Thesis, Fac. Agric. Moshtohor Zagazig Univ.Benha Branch, 82pp.
3. Azazy, A.M. 2001.Comparative studies between insect pathogenic nematodes and other methods in controlling some soil insects and fruit tree borers. Ph.D. Thesis, Fac. Agric. Moshtohor Zagazig Unvi. Benha Branch, 126pp.
4. Badr El-Sabah, A.F. and Azazy, A.M. 2004. Integration of Three Biocontrol Agents for the Control of the Cabbage Worm, *Artogia* (*Pieris*) *rapae*(L.).Egyptian. J. Biolo.Cont.14 (1):225-230.
5. Baur, M.E., Kaya, H.K. and Thurston, G.S. 1995. Factors affecting entomopathogenic nematode infection of *Plutella xylostella* on a leaf surface.Entomol.Exp. Appl.77:234-250.
6. Battu, G.S. 1991. Yield levels of the occlusion bodies obtained from the baculovirus-infested *Hellula undalis.* Indian. J. Entomol.53: 530.522.
7. Begley, J.W.1990. Efficacy against insects in habitats other than soil. *In* :"Entomopathogenic nematodes in Biological Control"(R. Gaugler and H. K. Kaya, Eds.), pp. 215-231.CRC Press, Boca Raton, FL.
8. Deborah, C.; Smith, F.; Stanton, A.G. and Robert,G.W.1996. Evaluation of entomopathogenic nematodes as biological control against the Banded Ash clearing borer. J. Environ. Horticulture. 14 (2): 67-71.
9. Duncan, D.B. 1955. Multiple range and multiple F-tests. Biometrics, 11: 1-45.

10. Henderson, C.F. and Tiliton, W.A. 1955. Test with acaricides against the wheat mites. J. of .Econ.Entomol.49:157-161.

11. Hsiao, W.F.1997.Pathogenicty of entomopathogenic nematode, *Steinernema carpoacpsae* to cabbage webworm and cabbage pyralid. Plant Protection Bulletin (Taipei), 39(4): 305-312.

12. Kahounova, L and Mracek, Z.1991. Larval mortality of *Synanthedon myopaeformis* (Lepidoptera: Sesiidae) in apple trees sprayed with *Steinernema* sp. strain hylobius (Nematoda: Steinernematidae).Acta Etomol. Bohemoslov. 88:202-210.

13. Kaya, H.K.; and Brown, L.R. 1986. Field application of entomogenous nematodes for biological control of clearing moth borers in alder and sycamore trees. J. Arbori.12 (6): 150-154.

14. Klein, M. G.1990. Efficacy against soil-inhabiting insect pests. In systems. *In* "Entomopathogenic nematodes in Biological Control"(R. Gaugler and Kaya, H.K. Eds.), pp.195-214.CRC Press, Boca Raton, FL.

15. Kung, S. P.; Gaugler, R and Kaya, H. K.1991. Effects of soil temperature, moisture and relative humidity on entomopathogenic nematode persistence. J. Invert. Pathol., 57 : 242-249.

16. Mason, M. and Wright, D. J. 1997.Potential for the control of *Plutella xylostella* larvae with entomopathogenic nematodes. J.Invertebr.Pathol.70: 234-242.

17. Mewis, I., Ulrichs, Ch. and Schnitzler, W.H.2001b. Oviposition preference of the cabbage webworm *Hellula undalis* (Fabricius) (Lepidoptera: Pyralidae).Mitt.Dtsch.Ges.all.angew.Entomol.13: 535-538.

18. Mewis, I., Regina,G.K., Ulrichs, Ch. and Schnitzler, W.H.2003.First detection of a microsporidium in the crucifer pest *Hellula undalis* (Lepidoptera: Pyralidae)-a possible control agent. Biological control. 26:202-208.

19. Rejesus, B.M. and Javier, P.A. 1997. Assessment of the occurrence and abundance of *Hellula undalis* in the Philippine. AVNET-II Final Workshop Proceedings (AVRDC), pp.314-320.

20. Saleh, M. M. E. 1995. Efficiency of the Egyptian entomopathogenic nematode *Heterorhabditis tayserii* (Nematoda: Heterorhabditidae) in controlling the cabbage worm, *Pieris rapae* (L.) (Lepidoptera: Pieridae). Egypt. J. Biological Pest Control, 5(2): 103-105.

21. Sivapragasam,A and Aziz, A.M.A. 1990. Cabbage webworm on crucifers in Malaysia. In: Talekar, N.S. (Ed), Diamondback Moth and Other Crucifers Pests. Asian Vegetable Research and Development Center, pp.75-80. (Chapter 8).

22. Sivapragasam,A and Chua, T.H.1997b.Natural enemies for the cabbage webworm, *Hellula undalis* (Fabr.) (Lepidoptera: Pyralidae).In Malaysia. Res. Popul.Ecol.39: 3-10.

23. Thompson, H.S. and Killy, W.S. 1957.Vegetable crops Edited by Thompson Washington and London (Arabic translated, ed. Modern. Egypt. Press, Cairo, Cyprus).

24. Waterhouse, D.F. and Norris, K.R.1989. Biological Control Pacific Prospects Supplement Australian Central for International Agriculture Research, Canberra, pp.77-81.

25. Woodring, J.L. and Kaya, H.K. 1988. *Steinernematid* and *Heterorabditid* Nematodes: A Handbook of biology and techniques. Southern Cooperation Series Bull. 331:30pp.

26. Zervos, S.; Johnson, S.C.Y and Webster, J. M. (1991). Effect of temperature and inoculum size on reproduction and development of *Heterorhabditis heliothidis* and *Steinernema glaseri* (Nematoda:Rhabditoidea) in *Galleria mellonella*. Canadian, J. Zool. (69), 5: 1261-1269.

Table (1): Efficacy of the entomopathogenic nematode strains against *H. undalis* and *A. rapae* under greenhouse conditions.

Nematode strains	% Reduction ± SE	
	H. undalis	*A. rapae*
Steinernema carpocapsae (Sc.all)	94.5±7.2 a	57.1±20.5 a
S. riobrave (Sr.)	96.2±5.4 a	72.2±22.9 a
Heterorhabditis sp (Hbs1)	79.5±19.6 a	79.5±21.1 a

Values in each column followed by the same letters are not significantly different (P>0.05 Duncan multiply range test).

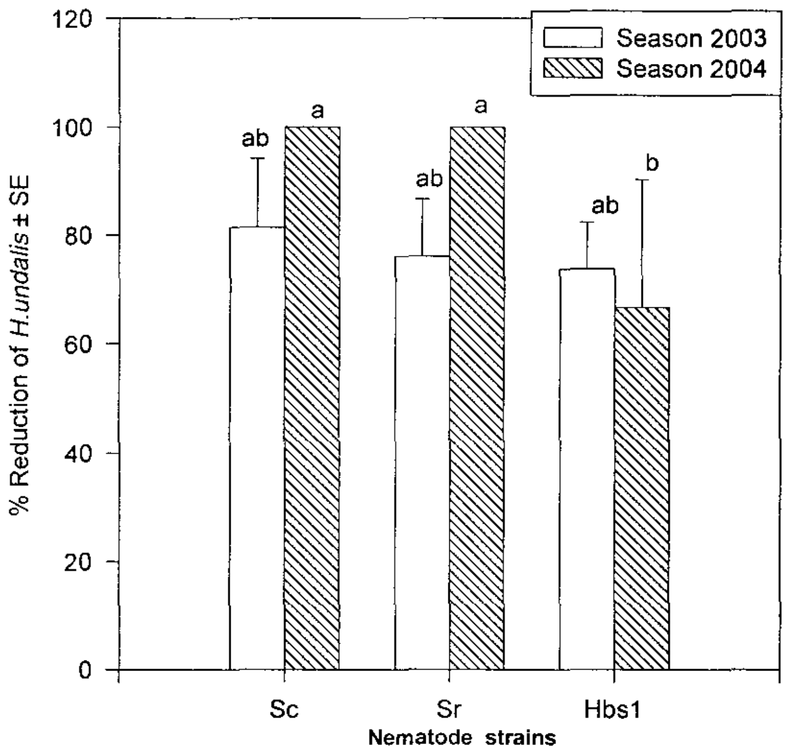

Fig.1.Percent mortality of larvae in cabbage seedlings within two seasons after treatment with three entomopathogenic nematode strains. Values with the same letter are not significantly different (P>0.05,Duncan,s multiply range test).

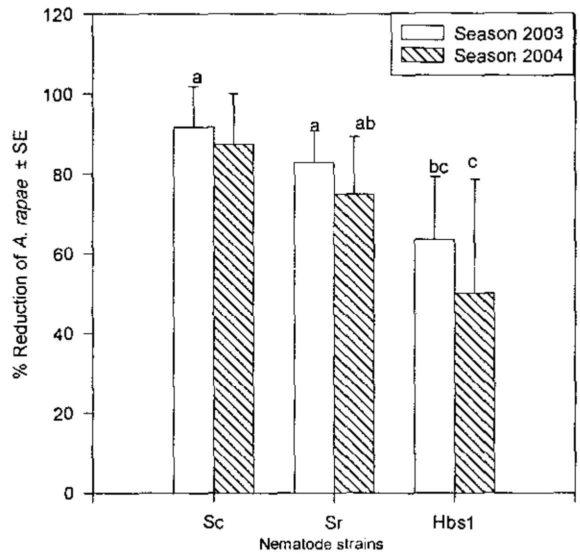

Fig.2.Percent mortality of larvae in cabbage seedlings within two seasons after treatment with three entomopathogenic nematode strains. Values with the same letter are not significantly different (P>0.05,Duncan,s multiply range test).

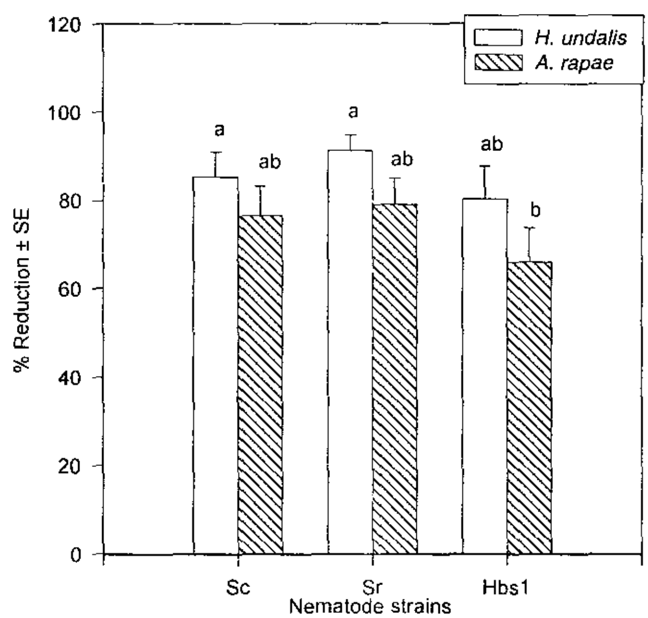

Fig.3.Efficacy of various entomogenous nematodes against *H. undalis* and *A. rapae*.Values with the same letter are not significantly different (P>0.05, Duncan,s multiply range test).

المكافحة الحيوية لحفار ساق الكرنب و دودة ورق الكرنب باستخدام النيماتودا الممرضة للحشرات على شتلات الكرنب.

أحمد محمد عزازى – جهاد محمد موسى

معهد بحوث وقاية النباتات– مركز البحوث الزراعية – الدقى –جيزة

تم تقدير كفاءة ثلاثة أنواع من النيماتودا الممرضة للحشرات (شتينرنيما كاربوكبسى ، شتينرنيما ريبورفى المستوردة من الولايات المتحدة الأمريكية) ، (هيتيروربديتس المعزولة من البيئة المصرية) فى خفض تعداد كلا من حفار ساق الكرنب و دودة ورق الكرنب على نباتات الكرنب فى الحقل و الصوب .و قد أظهرت النتائج أن معاملة حفار ساق الكرنب فى الصوب أفضل من المعاملة فى الحقل حيث كانت النتائج للأنواع النيماتودا الثلاثة، شتينرنيما ريبورفى، هيتيروربديتس، شتينرنيما كاربوكبسى ٩٦,٢% ، ٩٤,٣%، ٧٩٤% على التوالى بينما بلغت نسبة الموت فى الحقل ٨١,٥%، ٧٨,٣%، ٧٣,٨%، نتيجة أصابة بنيماتودا شتينرنيما كاربوكبسى، شتينرنيما ريبورافى، هيتيروربديتس على التوالى ومن ناحية أخرى لم يكن هناك فرق معنوى عند معاملة دودة ورق الكرنب فى الحقل و الصوب ٠ و بدراسة مدى حساسية كلا من الحشرتين للإصابة بالأنواع الثلاثة من النيماتودا الممرضة للحشرات تبين أن حفار ساق الكرنب كان أكثر حساسية من دودة ورق الكرنب.ويتضح من هذه الدراسة أنه يمكن استخدام النيماتودا الممرضة للحشرات ضمن برامج المكافحة المتكاملة للآفات تحت ظروف الحقل و الصوبة.