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Efficacy of the Entomopathogenic Nematode, Steinernema carpocapsae (Rhabditida: Steinernematidae), Against the Asian Corn Borer, Ostrinia furnacalis (Lepidoptera: Pyralidae)【Research report】

蟲生線蟲(Steinernema carpocapsae) (線蟲綱：Steinernematidae) 防治亞洲玉米螟(Ostrinia furnacalis) (鱗翅目：螟蛾科)之效力【研究報告】

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Abstract

The 3rd stage infective juvenile (IJ) of the entomopathogenic nematode, Steinernema carpocapsae, was found to be highly pathogenic to the Asian corn borer, Ostrinia furnacalis. Pathogenicity of nematodes to the 3rd, 4th, and 5th instar larvae of the corn borer was estimated by LC50 to be about 7.5, 8.7, and 16.3 IJs/ml, respectively. The LT50 value was determined to be 1.4, 2.4, and 4.9h for 3rd, 4th, and 5th instar larvae, respectively, when exposed to 200 IJs. At the same quantity of nematodes, the pupal mortality was 28.3%. However, it was only 6.7% when the quantity of nematodes was lowered from 200 IJs to 10 IJs. Corn borer mortality was not significantly different between treatment with nematodes and application of Bacillus thuringiensis perparations on the sweet corn field. Efficacy of nematodes against the corn borer when protected in the form of paste was found to be similar to that of chlorpyrifos. Comparison of different application times showed that application of nematodes after larval infestation resulted in fewer stem cavities and lower numbers of larvae surviving than with application before infestation. Therefore, it is suggested htat timing lf nematode application may practically affect its effectiveness against corn borer larvae.

摘要

蟲生線蟲(Steinernema carpocapsae)感染期的3齡幼蟲(I J)，對亞洲玉米螟(Ostrinia furnacalis)具有致病力，其半數致死濃度(LC50)對3、4及5齡幼蟲分別為7.5、8.7及16.3 IJs/ml。在25℃及相對濕度接近100%的環境中，以200IJs處理亞洲玉米螟3、4及5齡幼蟲，其半數致死時間(LT50)分別為1.4、2.4及4.9小時。並可造成28.3%蛹期死亡率，若蟲生線蟲數量由200 IJs降至10 IJs則蛹期死亡率降至6.7%多，此數值與對照組間已無顯著差異。將蟲生線蟲施用於玉米田，其殺蟲效力與蘇力菌相仿，若加入膏劑保護，則可達到與化學藥劑陶斯松相近的殺蟲效力。進行不同施用時機之試驗發現，先接昆蟲後施線蟲組的蛀孔數與蟲數較先施線蟲後接昆蟲組為少，由此結果可知選擇適當的施用時機可提高防治的效果。

Key words: Steinernema carpocapsae, Ostrinia furnacalis, pathogenicity, biological contrlo.
關鍵詞: 蟲生線蟲、亞洲玉,米螟、致病力、生物防治

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蟲生線蟲(*Steinernema carpocapsae*)(線蟲綱：Steinernematidae)防治亞洲玉米螟(*Ostrinia furnacalis*)(鱗翅目：螟蛾科)之效力

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摘 要

蟲生線蟲(*Steinernema carpocapsae*)感染期的3齡幼蟲(IJ)，對亞洲玉米螟(*Ostrinia furnacalis*)具有致病力，其半數致死濃度(LC_{50})對3、4及5齡幼蟲分別為7.5、8.7及16.3 IJs/ml。在25℃及相對濕度接近100%的環境中，以200 IJs處理亞洲玉米螟3、4及5齡幼蟲，其半數致死時間(LT_{50})分別為1.4、2.4及4.9小時。並可造成28.3%蛹期死亡率，若蟲生線蟲數量由200 IJs降至10 IJs則蛹期死亡率降至6.7%，此數值與對照組間已無顯著差異。將蟲生線蟲施用於玉米田，其殺蟲效力與蘇力菌相仿，若加入膏劑保護，則可達到與化學藥劑陶斯松相近的殺蟲效力。進行不同施用時機之試驗發現，先接昆蟲後施線蟲組的蛀孔數與蟲數較先施線蟲後接昆蟲組為少，由此結果可知選擇適當的施用時機可提高防治的效果。

關鍵詞：蟲生線蟲、亞洲玉米螟、致病力、生物防治

前 言

Dutky *et al.*(1964)指出鱗翅目、雙翅目、膜翅目、鞘翅目、直翅目、半翅目、同翅目及等翅目等昆蟲對蟲生線蟲均具感受性。Kaya and Hara (1980; 1981)亦報告蟲生線蟲對多種鱗翅目昆蟲殺蟲效力良好。Kaya (1987)更明確指出白蟻、蟑螂等地下害蟲，樹蜂、蠹蟲、螟蟲等鑽莖害蟲，甜菜夜蛾(*Spodoptera exigua*)、海灰翅夜蛾(*S. littoralis*)等食葉害蟲，及蚊類等水棲害蟲對蟲生線蟲均有相當高的感受性，故具開發應用的潛力。由於蟲生線蟲寄主範圍廣，並已可商品化之大量飼養，如今已應用於害蟲生物防治，可用淹沒式施用法防治數種害蟲(Georgis, 1992; Kaya and Gaugler, 1993)。本省有關蟲生線蟲方面的研究不多，過去在椿象(*Anasa tristis*) (Wu, 1988)及紋白蝶〔*Pieris* (=*Artogeia*) *rapae crucivora*〕(Wu and Chow, 1989)有這方面的報告發表，但尚無應用在亞洲玉米螟(*Ostrinia furnacalis*)防治上之研究。目前本省防治此螟蟲，主要以施用系統性或殘效性較長的化學殺蟲劑爲主(Tseng and Wu, 1990)。此類藥

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劑雖具備迅速殺死害蟲、效率高等優點，但不當的使用易造成農藥的殘留及環境的污染。有鑑於此，近年來研究趨勢大力發展生物防治法來防治此一害蟲。而蟲生線蟲又具有成爲生物製劑之基本條件。因此，本文即利用蟲生線蟲(*Steinernema carpocapsae*)爲材料，探討其應用於亞洲玉米螟防治之效力及可行性。本試驗在室內測試蟲生線蟲對亞洲玉米螟幼蟲之半數致死濃度、半數致死時間及對蛹之致死率。田間試驗則評估蟲生線蟲對亞洲玉米螟幼蟲之殺蟲效力，及適當的施用時機，以供發展生物防治。

材料與方法

一、供試昆蟲之飼育

自超甜玉米(*Zea mays* L.)(Honey 236)植株上採得亞洲玉米螟(*O. furnacalis*)之幼蟲，以Hung *et al.* (1988)之方法累代飼育，並且不定期自田間引進野生種蟲源與實驗室人工飼育之蟲源雜交。

二、供試之微生物製劑

(1)蟲生線蟲

本試驗所採用之蟲生線蟲(*S. carpocapsae* All trian)係由美國天普大學(Temple University)張芳男教授所提供，爲美國加州Biosys公司生產之成品(SAF-T-SHIELD®)，此產品係將蟲生線蟲具感染力之3齡幼蟲(infective juveniles, IJ)吸附在海綿中，儲存於4℃之冰箱供試。於每次實驗之前，再從冰箱取出製備成懸浮液或膏劑使用。

(a)線蟲懸浮液之製備

取SAF-T-SHIELD® 海綿塊泡蒸餾水，讓蟲生線蟲從海綿塊中游出，再依實驗內容調配所需的線蟲濃度。

(b)線蟲膏劑(paste)之製備

膏劑乃是利用大豆油或棉子油，經局部的脫氫作用(dehydrogenation)，內含甘油一酸酯(monoglycerides)和甘油二酸酯(diglycerides)的一種乳化製品。線蟲膏劑則以1份線蟲懸浮液，加1份W.R.P. (water retentive polymer)再加2份上述之膏劑所配製而成。配方及成品亦由美國天普大學張芳男教授及Mr. M. J. Gehret所提供。

(2)蘇力菌(*Bacillus thuringiensis*, Bt)：

分取三種不同蘇力菌水懸粉劑，於實驗之前加蒸餾水稀釋使用。

(a)由美國賓州Ecogen公司提供之Cutlass水懸粉劑，爲*B. t.* subsp. *kurstaki*(B.t.k)品系，內含10.0%的毒蛋白。

(b)由美國賓州Ecogen公司提供之EG2175水懸粉劑，爲*B. t.* subsp. *aizawai* (B.t.a)品系，內含10.0%的毒蛋白。

(c)由台灣安農公司提供之San415I水懸粉劑，爲*B. t. k.* serotype 3a、3b strain Sa-11品系，內含6.4%的毒蛋白。

(3)白殭菌(*Beauveria bassiana*)：爲中興大學昆蟲系昆蟲病理研究室所保存之菌種，係從殭病家蠶分離而來。本實驗所用者，乃經感染亞洲玉米螟後再分離所得，並以SMA+Y培養基，在25℃環境下培養15天後，置於4℃儲存，使用時配成懸浮液。

三、蟲生線蟲對亞洲玉米螟致病力之檢定

(1)蟲生線蟲對亞洲玉米螟幼蟲半數致死濃度之測定

配製含有2、5、10、15、25、50、100及200 IJs之蟲生線蟲懸浮液各1ml，滴在石膏培養皿的濾紙上，再各放入一隻亞洲玉米螟3、4或5齡幼蟲，先感染24小時後取出，移入單隻飼育杯內。經48小時後記錄其死亡率。每一處理濃度取3重複，每重複取20隻幼蟲。

(2)蟲生線蟲對亞洲玉米螟幼蟲半數致死

時間之測定

配製200 IJs/ml的線蟲懸浮液。取直徑6cm墊有濾紙之石膏培養皿，滴入線蟲懸浮液1ml後，再各放入一隻亞洲玉米螟3、4或5齡幼蟲。經過1、2、4、6、8、12及24小時後，將螟蟲取出，移入單隻飼育杯內，48小時後記錄其死亡率。每一處理時間取3重複，每重複取20隻幼蟲。

(3)蟲生線蟲對亞洲玉米螟蛹致病力之測定

配製含有10、50、100及200隻線蟲之線蟲懸浮液各1ml，滴在石膏培養皿的濾紙上，另以滴入等量的蒸餾水爲對照組。每一培養皿放入一隻亞洲玉米螟的蛹，經感染24小時後取出，移入直徑9cm高9cm之緞帶盒內。7天記錄蛹之死亡率。每一處理濃度取3重複，每重複取20隻幼蟲。

四、田間測試蟲生線蟲對亞洲玉米螟之感染力

在嘉義縣新港鄉安和村，選取0.1公頃之玉米田進行試驗。分別取(3～3.5)×10^3 IJs/L的線蟲懸浮液，兩種蘇力菌水懸粉劑Cutlass (1,000x)與San415I (3,000x)，及線蟲與Cutlass (1,000x)、線蟲與San415I (3,000x)混合之懸浮液。以噴霧器施用於田間，並以0.1g (10^3 IJs/g)膏劑及陶斯松(0.3～0.5g/株)施用於心葉處。施用方法、時間及調查項目如下：從玉米植株的輪生中期開始施藥，每隔7天施藥一次，至雄花抽穗後停止。蟲生線蟲膏劑共施用3次，陶斯松依據植物保護手冊見議方式施用2次。以3×10 m^2 的面積爲一個試驗小區，每小區間隔爲3m。至玉米穗成熟後，每一小區取20株，每一處理3重複，共取60株玉米進行調查莖內的玉米螟蟲數及蛀孔數、穗內的玉米螟蟲數及蛀孔數、及可上市果穗率(穗長在15cm以上，切去穗端3cm後無蟲害者爲可上市果穗，秤取所有可上市果穗的重量與所有玉米穗總重量之比值，即爲可上市果穗率)。

五、施用時機對蟲生線蟲感染亞洲玉米螟效力之影響

在嘉義縣新港鄉安和村，選取0.1公頃之玉米田分爲A及B兩區進行試驗，A區先於每株玉米植株接入2隻玉米螟2齡幼蟲，經過10天後(爲配合玉米株生長勢及欲在玉米輪生中期至雄花抽穗期之間施藥3次，故以10天爲施藥間隔)再施用製劑。B區先用製劑10天後，再於每株玉米植株接入2隻玉米螟2齡幼蟲。施製劑區域分隔成面積3×10m^2 的不同小區施用不同製劑處理，其施用種類及方式如下：線蟲膏劑0.1g(10IJs/g)塗抹於心葉處，線蟲懸浮液3×10^3 IJs/ml，兩種蘇力菌製劑Cutlass (2,000x)與EG2175 (2,000x)，及白殭菌：10^7conidia/ml，平均噴施於玉米株之莖部及心葉處。陶斯松(chlorpyrifos) 5%粒劑，每株施用0.3～0.5 g。施用方法及時間如上項田間試驗所述，調查項目爲玉米莖及穗內之玉米螟蟲數及蛀孔數。

結　果

一、蟲生線蟲對亞洲玉米螟致病力之室內檢定

蟲生線蟲對亞洲玉米螟3齡、4齡及5齡幼蟲的半數致死濃度(LC_{50})分別爲：7.5、8.7及16.3 IJs/ml(表一)。當亞洲玉米螟暴露在含200 IJs/ml濃度的濾紙上，其3、4及5齡幼蟲的半數致死時間(LT_{50})分別爲：1.4、2.4及4.9小時(表二)，但接種後8小時後各齡期幼蟲之死亡率均可達到90%以上。對蛹的致病力，以10～200 IJs/ml的線蟲濃度測試，當200 IJs/ml隻線蟲存在時，蛹之死亡率爲28.3%。若在10 IJs/ml的濃度時，蛹死亡率降至6.7%，與對照組間無顯著差異(圖一)。

表一　蟲生線蟲對亞洲玉米螟幼蟲之半數致死濃度

Table 1. LC_{50} of *O. furnacalis* larvae caused by *S. carpocapsae*

Instar	LC_{50}* (95% confidence limits)(IJs/ml)	Concentration-mortality regression line (Y=a+bx)**	SE of b	*R*
3rd	7.5(6.1−8.9)	Y=3.13+2.13x	0.40	0.966
4th	8.7(6.8−10.9)	Y=3.37+1.73x	0.28	0.974
5th	16.3(14.7−18.1)	Y=0.69+3.55x	0.50	0.981

* Recorded on the 2nd day after exposure to *S. carpocapsae*.

** Y: mortality in probits, x: log concentration (IJs/ml).

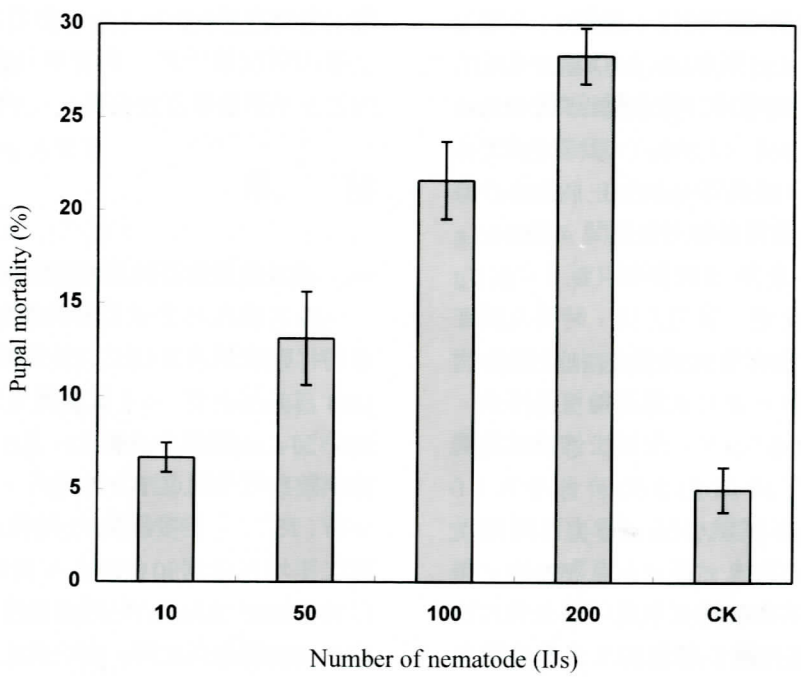
表二　亞洲玉米螟在200隻線蟲下幼蟲之半數致死時間

Table 2. LT_{50} of *O. furnacalis* larvae after exposure to IJs of *S. carpocapsae*

Instar	LT_{50}* (95% confidence limits)(h)	Time-mortality regression line (Y=a+bx)**	SE of b	*R*
3rd	1.4(0.7−1.9)	Y=4.85+1.09x	0.31	0.925
4th	2.4(1.8−3.6)	Y=4.56+1.16x	0.31	0.933
5th	4.9(3.9−7.1)	Y=3.88+1.61x	0.40	0.942

* Recorded after exposure for different durations.

** Y: mortality in probits, x: log time (h).



圖一　亞洲玉米螟在不同線蟲數目下蛹之死亡率

Fig. 1. Pupal mortality of *O. furnacalis* with different inoculated numbers of *S. carpocapsae*.

二、蟲生線蟲對亞洲玉米螟田間殺蟲效力之評估

在田間使用蟲生線蟲膏劑、蘇力菌與化學藥劑陶斯松相比較。結果顯示蛀入莖內玉米螟的蟲數以陶斯松最少，其次爲線蟲膏劑、線蟲與蘇力菌Cutlass混合組及線蟲與蘇力菌San415I混合組。而線蟲懸浮液、蘇力菌Cutlass及蘇力菌San415I等3組蟲數較多，但均較對照組爲少。蛀入穗內的蟲數以陶斯松、線蟲膏劑、線蟲懸浮液、線蟲與蘇力菌Cutlass混合組及線蟲與蘇力菌San415I混合組等5組較少。而蘇力菌Cutlass及蘇力菌San415I，兩組蟲數較多，但均較未做任何藥劑處理之對照組爲少。在可上市果穗率方面，以線蟲膏劑、陶斯松及蘇力菌Cutlass懸浮液等3組較高，另以線蟲懸浮液、蘇力菌San415I、線蟲與蘇力菌Cutlass混合組及線蟲與蘇力菌San415I混合組等4組較少。噴施自來水的對照組，因幼蟲在莖中蛀蝕，不僅造成玉米植株倒伏及折斷影響採收，且果穗不飽滿，蛀孔又多商業價值偏低，可上市果穗率僅約33%(表三)。將蟲生線蟲與目前廣爲使用之蘇力菌製劑相比較，在莖及穗中的蟲數相仿，可上市果穗率亦相近，均在50%～60%之間若再添加適當的保護膏劑更能彰顯其防治成效，可上市果穗率增加至72%，已達陶斯松處理組66%的水準，而且無農藥殘毒的危險。蘇力菌製劑對侵入期之蟲生線蟲無毒殺效果，但兩者混合使用時並無加成效果。

三、施用時機對蟲生線蟲感染亞洲玉米螟成效之影響

在田間試驗結果顯示，A區先接入幼蟲後施用製劑的處理，以線蟲膏劑的效果最好，玉米植株中玉米螟的蟲數最少。而陶斯松、

表三　蟲生線蟲及蘇力菌製劑施用於田間對亞洲玉米螟防治效果之比較

Table 3. Comparison of effectiveness of *S. carpocapsae* and Bt for control of *O. furnacalis* on a sweet corn field

Treatment	No. of cavities and insects/plant				Marketable ears/ yield
	Stem		Tassel		
	Cavity	Survivor	Cavity	Survivor	
Nematode Paste	2.00 bc	1.05 bc	0.55 b	0.37 ab	71.54 a*
	(0.96)	(0.46)	(0.30)	(0.20)	(3.64)
Nematode Suspension	3.42 ab	2.05 ab	0.70 b	0.37 ab	51.48 b
	(0.45)	(0.23)	(0.25)	(0.16)	(3.13)
Bt Cutlass Suspension	2.90 ab	1.97 ab	0.82 ab	0.57 ab	59.48 ab
	(0.09)	(0.13)	(0.20)	(0.18)	(2.39)
Bt San415 Suspension	3.17 ab	2.20 ab	0.98 ab	0.55 ab	49.93 b
	(0.81)	(0.76)	(0.03)	(0.05)	(15.83)
Bt Cutlass Suspension	2.07 bc	1.13 bc	0.67 b	0.30 b	49.08 b
+Nematode	(0.29)	(0.33)	(0.18)	(0.10)	(15.64)
Bt San415 Suspension	2.42 abc	1.53 bc	0.82 ab	0.45 ab	52.83 b
+Nematode	(0.68)	(0.46)	(0.23)	(0.05)	(1.27)
Chlorpyrifos Granule	1.25 c	0.72 c	0.57 b	0.28 b	65.53 ab
	(0.53)	(0.28)	(0.08)	(0.08)	(7.46)
Ck —	3.73 a	3.00 a	1.85 a	1.00 a	32.89 c
	(0.79)	(0.87)	(1.03)	(0.73)	(3.77)

* Within a column, means (S.D.) followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

線蟲懸浮液、蘇力菌Cutlass及白殭菌的效果次之，4者間無顯著差異。蘇力菌EG2175效果最差，蛀入玉米植株內玉米螟的蟲數最多。B區先施用製劑後接玉米螟幼蟲的處理結果相似。線蟲膏劑與陶斯松效果較好，線蟲懸浮液、蘇力菌EG2175、蘇力菌Cutlass及白殭菌等處理組，蛀入玉米植株內的蟲數較多，4者間無顯著之差異(表四)。由結果可知線蟲施用於田間，對亞洲玉米螟的殺蟲效力與蘇力菌相似，若加入膏劑保護可得更佳之效果。比較A區與B區的防治效果，在植株上發現的蛀孔數與蟲數，除陶斯松及蘇力菌EG2175之外，A區大部分處理組均較B區爲少。因陶斯松屬長效性藥劑，在蟲害未發生前先施用，藥劑成分會留在植株中，玉米螟幼蟲侵入植株較易與藥劑接觸而達到殺蟲目的，故其效果較好。而其他之微生物製劑，對環境之抗性較弱，在蟲害發生之前施用，雖有預防之作用，但微生物本身亦需對環境進行適應並存活，時間延長後較易降低在田間族群的數量。若於蟲害發生之初即刻施用，則易與蟲隻接觸，入侵繁殖進而立足，而達到更好的效果。由此可知施用時機的選擇甚爲重要。

討　論

Yang *et al.* (1991)報告3齡亞洲玉米螟體內只要有1隻蟲生線蟲(*S. carpocapsae* Beijing strain)侵入，在48小時內可達90%之死亡率。在125隻蟲生線蟲之環境下，1小時後玉米螟幼蟲之死亡率可達50.7%。此與本試驗結果相近。Glazer (1992)測得*S. carpocapsae*對30～50 mg之海灰翅夜蛾幼蟲(*S. littoralis*)，其LT_{50}爲2.1小時，LC_{50}爲25IJs/ml，與重量相近之3齡及4齡亞洲玉米螟相比較

表四　田間施用不同微生物製劑防治亞洲玉米螟效果之比較

Table 4. Comparison of effectiveness of different microbial agents for control of *O. furnacalis* on a sweet corn field

Treatment	No. of cavities and insects/stem and tassel			
	Cavities**		Survivors**	
	A	B	A	B
Nematode Paste	1.50 g	1.90 fg	0.67 f	1.25 de*
	(0.15)	(0.13)	(0.13)	(0.00)
Nematode Suspension	2.82 de	3.53 b	1.88 c	2.18 bc
	(0.12)	(0.33)	(0.03)	(0.15)
Bt Cutlass Suspension	2.98 cd	3.27 bcd	1.72 cd	2.13 bc
	(0.14)	(0.21)	(0.33)	(0.40)
Bt EG2175 Suspension	3.60 b	3.20 bcd	2.40 b	1.98 bc
	(0.35)	(0.05)	(0.30)	(0.16)
Beauveria Suspension	3.20 bcd	3.45 bc	1.90 c	2.18 b
bassiana	(0.30)	(0.43)	(0.35)	(0.18)
Chlorpyrifos Granule	2.27 ef	1.60 g	1.68 cd	1.00 ef
	(0.33)	(0.25)	(0.49)	(0.25)
Ck　　—	5.13 a	5.10 a	3.97 a	3.87 a
	(0.45)	(0.13)	(0.08)	(0.14)

* Within the same treatment (cavities or survivors), means (S.D.) followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

** A: application of nematodes after larval infestation. B: application of nematodes before larval infestation.

，LC_{50}以亞洲玉米螟較低，亞洲玉米螟似較具感受性。Glazer and Navon (1990)以番茄夜蛾(*Heliothis armigera*)之幼蟲爲試驗材料，其死亡率會隨線蟲數目的增加而上升。在含200隻以上線蟲的處理組，番茄夜蛾的幼蟲暴露48小時即有100％之死亡率，其增加趨勢與本試驗結果相似，若以不同重量之幼蟲進行試驗，幼蟲死亡率隨重量之增加而遞減。本試驗結果顯示亞洲玉米螟幼蟲死亡率，隨齡期之增加而遞減，亦有相似的結果。Kaya and Hara (1981)報告指出6種螟蛾科昆蟲，因蟲生線蟲感染之蛹死亡率介於18.6％～100％之間。亞洲玉米螟之蛹，其死亡率爲28.3％，屬於較不具感受性之種類。

Morris (1985)發現*S. carpocapsae*可殺死27種農業害蟲，包括鱗翅目7科、雙翅目3科和鞘翅目3科的昆蟲。而*S. carpocapsae*對鱗翅目的害蟲，如甜菜夜蛾(*S. exigua*)的幼蟲(Kaya and Nelsen, 1985)、前蛹及蛹(Kaya and Grieve, 1982)，大臘蛾(*Galleria mellonella*)的幼蟲(Poinar and Himsworth, 1967)及蛹(Kaya and Grieve, 1982)，家蠶(*Bombyx mori*)的幼蟲(Moyle and Kaya, 1981)，洋薊羽蛾(*Platyptilia carduidactyla*)的幼蟲(Kaya and Hara, 1981)，甘薯蟻象(*Cylas formicarius elegantulus*)的蛹(Jansson *et al.*, 1993)等，在實驗室內進行檢測均有很強之致病力。本試驗結果顯示亞洲玉米螟亦具感受性。

將此種線蟲施用於田間，根據國外諸多研究報告，對蘋果蠹蛾(*Cydia pomonella*) (Kaya *et al.*, 1984)、玉米穗蟲(*Heliothis zea*) (Bong, 1986)、洋薊羽蛾(*P. carduidactyla*) (Eidt and Dunphy, 1991)等鱗翅目的害蟲，及鞘翅目的歐洲金龜子(*Rhizotrogus majalis*)及日本甲蟲(*Popillia japonica*)的幼蟲，均有相當程度的防治效果(Kard *et al.*, 1988; Villani and Wright, 1988；Wright *et al.*, 1988; Forschler and Gardner, 1991; Selvan *et al.*, 1994)。田間試驗證實蟲生線蟲可減輕甘薯蟻象的爲害 (Jansson *et al.*, 1993)，並對粉介殼蟲(*Dysmicoccus vaccinii*)亦具殺蟲效果(Stuart *et al.*, 1997)。由本試驗結果可知，蟲生線蟲施用於田間，對亞洲玉米螟具有防治效果，但線蟲膏劑與蘇力菌混合使用時並無協力作用，此結果與Bari and Kaya (1984)及Kaya and Barlando (1989)所得結果相似。

綜合以上結果，可知蟲生線蟲對亞洲玉米螟具感染力，若加添適當的保護製劑，以減緩蟲生線蟲周圍環境相對溼渡降低的速率，施用於田間可得到與化學殺蟲劑相仿的效果，其田間實際施用之策略，仍待進一步探討。

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Efficacy of the Entomopathogenic Nematode, *Steinernema carpocapsae* (Rhabditida: Steinernematidae), Against the Asian Corn Borer, *Ostrinia furnacalis (Lepidoptera: Pyralidae)*

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ABSTRACT

The 3rd stage infective juvenile (IJ) of the entomopathogenic nematode, *Steinernema carpocapsae*, was found to be highly pathogenic to the Asian corn borer, *Ostrinia furnacalis*. Pathogenicity of nematodes to the 3rd, 4th, and 5th instar larvae of the corn borer was estimated by LC_{50} to be about 7.5, 8.7, and 16.3 IJs/ml, respectively. The LT_{50} value was determined to be 1.4, 2.4, and 4.9 h for 3rd, 4th, and 5th instar larvae , respectively, when exposed to 200 IJs. At the same quantity of nematodes, the pupal mortality was 28.3%. However, it was only 6.7% when the quantity of nematodes was lowered from 200 IJs to 10 IJs. Corn borer mortality was not significantly different between treatment with nematodes and application of *Bacillus thuringiensis* preparations on the sweet corn field. Efficacy of nematodes against the corn borer when protected in the form of paste was found to be similar to that of chlorpyrifos. Comparison of different application times showed that application of nematodes after larval infestation resulted in fewer stem cavities and lower numbers of larvae surviving than with application before infestation. Therefore, it is suggested that timing of nematode application may practically affect its effectiveness against corn borer larvae.

Key words: *Steinernema carpocapsae, Ostrinia furnacalis*, pathogenicity, biological control.

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