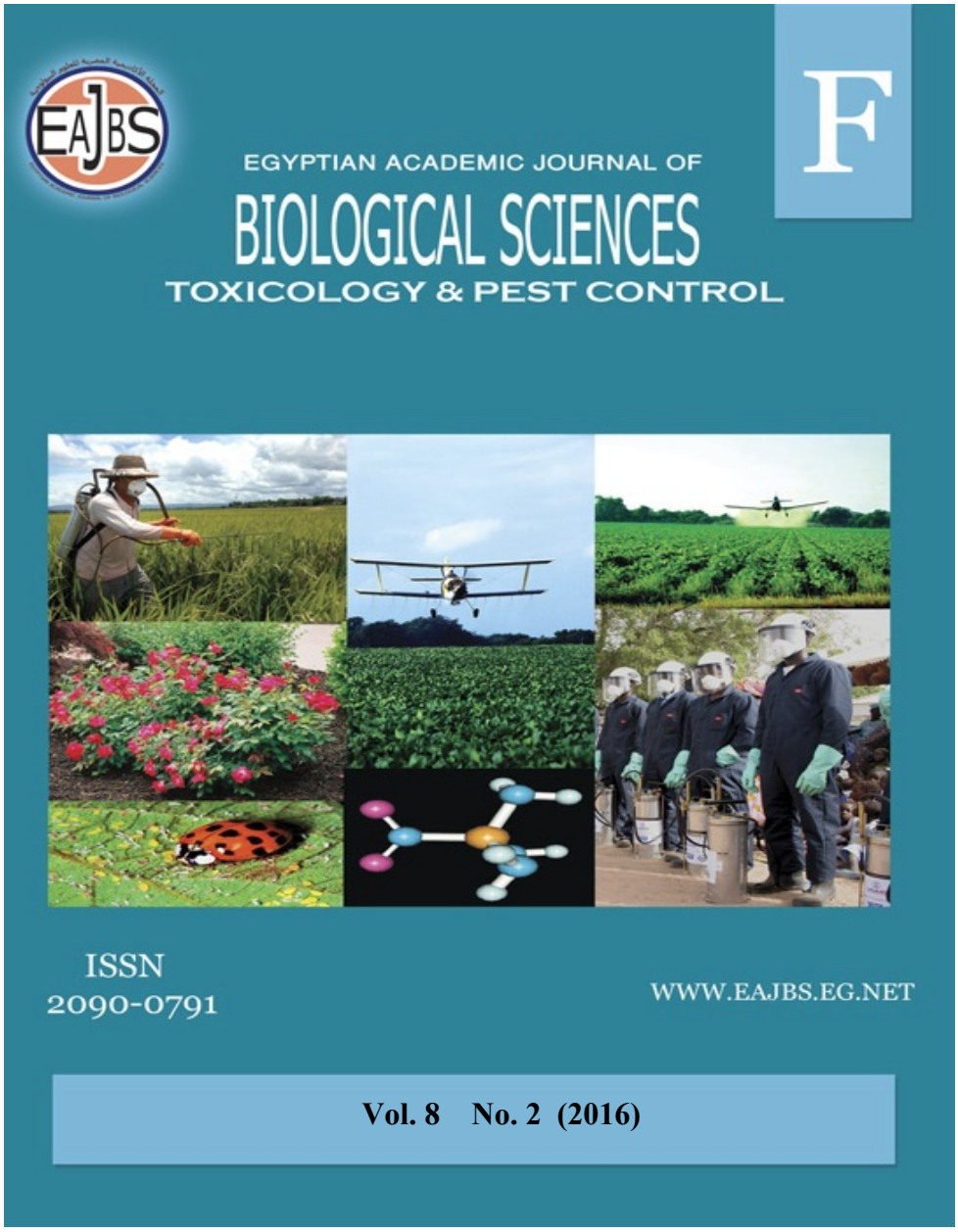

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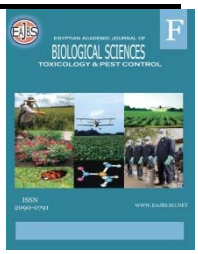
Egypt. Acad. J. Biolog. Sci., 8(1): 73 - 80 (2016)

Egyptian Academic Journal of Biological Sciences
F. Toxicology & Pest control
ISSN: 2090 - 0791
www.eajbs.eg.net



Efficacy of Some Biopesticides and Their Field Persistence on Cotton Plants Against *Spodoptera littoralis* (Boisd.)

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ARTICLE INFO
Article History
Received:20/7/2016
Accepted:25/8/2016

Key words:
Spodoptera littoralis
Cotton leafworm
Bioinsecticides
Field persistence
Residual activity
Latent effects
Spinetoram
Dipel 2X

ABSTRACT

Bioinsecticides considered a one of the safest method for pest control. A field study was conducted to compare the efficiency of the two types of bioinsecticides with two different mode of action against Egyptian cotton leaf worm *Spodoptera littoralis* (Boisd.). The recommended rate of these insecticides was sprayed on the foliage of cotton plants in the field and the reduction % were recorded after 2,4,6,8 days. Also, semi field studies were conducted to determine the latent effects of tested bioinsecticides on biological aspects. The results revealed that Spinetoram filed treatment recorded the highest reduction present 95.5% after 2 days and reduced gradually to 74.0% after 8 days with general mean 85.1%, while Dipel 2X, caused 24.8% reduction percent after 2 days and increased gradually up to 86.7 % after 8 days with general mean 55.9 %. Semi filed studied explained that; Spinetoram treatment was more effective on 2nd and 4th *S. littoralis* biological aspects than Dipel 2X treatment, specially; larval mortality, pupal mortality, adult emergence, malformed adult % fecundity and fertility. These results indicated that Spinetoram had the potentiality to be promising substitutes of conventional toxicants for *S. littoralis* control under field conditions.

INTRODUCTION

Cotton is one of major economic crops, the most important fiber in Egypt. It is cultivated mainly for production of fiber used in industry, for seed oil production and one of crop throughout spry by many pesticides on growth season. The cotton leafworm, *Spodoptera littoralis* (Boisd.) Considered as one of the most series pest for many different crops in Asia, Africa and Europe (Horowitz *et al*., 1994 and Smagghe and Degheele, 1997). These caterpillars are very polyphagous, causing important economic losses in both greenhouses and open field on a broad range of ornamental, industrial and vegetable crops (Alford, 2000). Although insecticides are still one of the most powerful weapons in our never ending battle against pests. The extensive use of these chemicals has given rise to problems such as residual toxicity, rapid resurgence of target species, outbreaks of secondary pests and harmful effects on beneficial insects, which are natural enemies of either target or non-target pest species, in order to avoid these hazards. Therefore, there is a great need to develop alternative or additional techniques, which would allow a rational use of pesticides and provides adequate crop protection for sustainable food, feed and fiber protection.

During the last two decades research has been made for new and non-traditional control agents effective against this pest since resistance has been recorded for most conventional insecticides (Rashwan *et al*., 1992). There is growing interest in the use of bio-insecticides such as compounds based on bacteria, fungi, insect growth regulators and botanical pesticides (Rao *et al.* 1990; Ahmad *et al.* 2008; Mourad *et al.* 2008). These groups have modes of action different from those of conventional products (Ascher 1993; Thompson and Hutchins 1999 and Thompson *et al.,* 1999, also, their properties may differ considerably from the conventional chemicals with which growers are familiar. Also the Spinosyn family insecticides is a new components of bio-insecticides for pest control and many authors studed their efficacy on large scale of pests, Hogsette, 1999; James, *et al.,* 2008; El Wahab *et al.,* 2009; Kirst, 2010; Hamdy *et al.,* 2014 and Rasheed *et al.,* 2015. This present experiments aimed to compare the effectiveness of two bio-insecticides against the cotton leafworm *S. Littoralis* to find the best on for controlling this economic pest in an integrated pest management program.

MATERIALS AND METHODS

Maintanence of *S. littoralis* culture

The original colony of the cotton leafworm *S. littoralis* was obtained from a well-established culture at the Department of cotton leafworm; Plant Protection Research Institute. The insects were maintained under laboratory conditions of 27 ± 2^0 C, 70 ±5% R.H. Larvae were reared on fresh castor bean oil leaves, *Ricinus communis,* supplied daily in sufficient amounts, maintenance of the different developmental stages were conducted according to method described by (Dahi, 1997).

Tested compound:

Common name: Spinetoram

This insecticide is a mixture of major and minor components:

Major component (3'-O-ethoxy-5,6-dihyro spinosyn J)

Minor component (3'-O-ethoxy spinosyn L)

- Common name: Spinetoram

- Trade name: Radiant.

- Formulation used: (12% SC.)

- IUPAC of Chemical name:

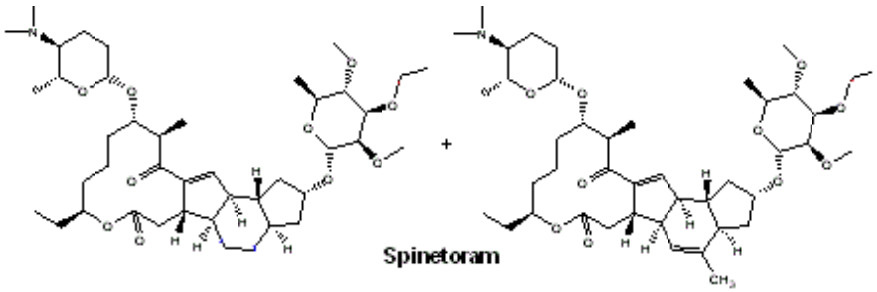
Major component: (3'ethoxy, 5,6-dihydro spinosyn J)

Minor component: (3'ethoxy spinosyn L)

Chemical Structure:

Minor component: (3'ethoxy spinosyn L)

Chemical Structure:



Rate of Application: 35ml/feddan

Common name: *Bacillus thuringiensis*

Trade name: Dipel 2X

Scientific name: *Bacillus thuringiensis* subsp. *Kurstaki*

Each mg contain 32000 international unit according to the analysis certificate.

Rate of Application: 200 gm/ feddan

Filed studies:-

The experiments were conducted at

Toukh district, Qalyobia Governorate to evaluate the field efficiency of Spinetoram and Dipel 2X against cotton leafworm, *S. littoralis*. The field area was cultivated with Giza 86 cotton variety on March 21, 2015 and the normal agricultural practices were applied. The experimental area was divided into plates of 1/16 feddan (262.5 m2). The treatment was arranged in randomized complete blocks design (RCBD) with four replicates each. Application of insecticide was on July 4. A motor sprayer was used. The volume of spray solution was 40 liters/feddan. The number of larvae were recorded on one meter lengthwise for five times (four at corners and the last one on plot center), before the spray and on 2,4,6 and 8 days after the spray. Reduction percent in the *S. littoralis* population was estimated using Henderson and Tilton (1955) as follows.

Semi-Filed studies

The purpose of this study was to evaluate the initial and residual effects of the tested filed pesticides Spinetoram and *Bacillus thuringiensis* (*Bt*) against the 2nd and 4th instars larvae of field strain of *S. littoralis*. From the same experiment area treated cotton leaves were collected after zero time, 1, 2, 3,4,5,6 and 7 days and transfer directly to the laboratory for feeding the 2nd and 4th larval instars of cotton leafworm to estimate the mortality percent. Ten larvae were placed in each jar (5 replicates) and allowed to feed on tested leaves during the first and second day of each interval and corrected mortalities and were calculated at end of each interval and corrected according to Abbott's formula (1925).

Latent effect of tested insecticides on *S. littoralis* biological aspects:

From the same experiment area treated cotton leaves were collected after 2 days and transfer directly to the laboratory for feeding the 2nd and 4th larval instars of cotton leafworm to estimate the mortality percent. Ten larvae were placed in each jar (10 replicates) and allowed to feed on tested leaves during the first and second day. The survived larvae were transmitted to new and clean 500 ml glass pots and were fed on untreated cotton leaves till pupation. Number of dead larvae and percentage of accumulated mortality were recorded. Larval duration, pupal duration, percentages of normal and deformed pupae, and percentages of normal and malformed adult emergence were recorded.

Statistical analysis

Obtained data were analyzed by using SAS package (SAS Institute 2003), significant differences were determined by analysis of variance (ANOVA) and based on the least significant differences using General Linear Model procedure (proc GLM). These tests followed by using Duncan's test at 0.05 probability level (Duncan 1955).

RESULTS AND DISCUSSION

The field recommended rates of Spinetoram and Dipel 2X were sprayed on cotton foliage under field conditions to study the filed efficacy of these insecticides and the persistence of their residues against 2nd and 4th instar larvae of *S. littoralis*. Efficiency of the tested insecticides and their latent effect (larval duration, pupation and adult emergence) on treated larvae were studied as well.

Filed studies:

Data in Table (1) showed the efficiency of recommended concentrations 35ml/feddan of radiant and 200gm/feddan of Dipel 2X against larvae of *S. littoralis* under field condition during 2015 cotton season. Spinetoram treatment exhibited high mortality (95.5%) after 2 days then reduced gradually to reach (74.0%) after 8 days of treatment. On the other hand; the obtained data after Dipel 2X treatment indicated that the larval mortality increased over time. The reduction percent elevated from 24.8 %

after 2 days to 86.7% after 8 days of application with general mean 55.9%. These results explained the differences between tested insecticides in there mode of action. Elbarky *et al.*, (2008) estimated that In the semi-field experiment, recommended doses of radiant (Spinetoram) exhibited high mortality 100 & 95.7 % after 0 and 1 days, respectively then decreased gradually to reach 58.1 % after 7 days. Also the field experiment showed high mortality 91.4% after 2 days then reduced gradually to reach 83.1% after 8 days. Osman and Mahmoud (2008).

Table 1: Field efficacy of Spinetoram and Dipel 2X on population reduction of *S. littoralis* after treatment by recommended rate during 2015 cotton season.

Insecticides	Rate of application	Reduction %				
		2 days	4 days	6 days	8 days	General mean
Spinetoram	**35ml/feddan**	95.5	86.7	84.2	74.0	85.1
Dipel 2X	**200gm/feddan**	24.8	43.9	68	86.7	55.9

Semi field studies:

Data in Tables (2&3) showed the efficiency of recommended concentrations of Spinetoram and Dipel 2X against 2nd and 4th larval instars of *S. littoralis* under semi field condition. As presented in Table 2 revealed that Spinetoram caused high mortality (100 % and 91.3%) after zero and 1 days respectively while it were (72.3% and 71.7 %) after treated with Dipel 2X then mortality % decreased gradually to reach (54.2% & 41.7) after 7days of treatment for Spinetoram and Dipel 2X, respectively.

Table 2: Accumulated corrected larval mortality % of 2nd instar *S. littoralis* larvae after treated with recommended rate of Spinetoram and Dipel 2X during 2015 cotton season.

Insecticides	Corrected larval mortality %								General mean
	Zero time	1 day	2 days	3 days	4 days	5 days	6 days	7 days	
Spinetoram	100	91.3	79.2	74.5	62.5	61.7	59.2	54.2	72.8
Dipel 2X	72.3	71.7	68.8	66.0	63.8	56.8	44.9	41.7	60.4

Table 3: Accumulated corrected larval mortality % of 4th instar *S. littoralis* larvae after treated with recommended concentrations of Spinetoram and Dipel 2X during 2015 cotton season.

Insecticides	Corrected larval mortality %								General mean
	Zero time	1 day	2 days	3 days	4 days	5 days	6 days	7 days	
Spinetoram	91.6	89.6	89.4	87.2	71.6	70.1	66.0	61.7	78.4
Dipel 2X	70.5	69.8	69.1	60.6	57.9	57.7	50.0	46.8	60.3

Data in Table (3) showed that feeding of *S. littoralis* larvae in their 4th instar on filed treated cotton leaves by Spinetoram and Dipel 2X caused mortalities that decreased as the exposure time to environmental factors was prolonged from Zero time to 7 days. The Accumulated Corrected larval mortality percentages after Spinetoram treatment was 91.6% (for zero time) reduced to 61.7% (after 7 days) while; it was 70.5% and 46.8% after zero time and 7 days of Dipel 2X treatment. It was clearly that 2nd instar *S. littoralis* larvae was more susceptible for tested insecticides treatment than the 4th instar.

Latent effects of tested insecticides filed persistence on the biological aspects of *S. littoralis*:

Most of previous studies about the efficiency of insecticides on lepidopteron pests had been conducted on larval stages and little has been published about their latent effects on pupae and adults. In this study, data in Tables (4 & 5) presented the latent effect of Spinetoram and Dipel 2X on the biological of 2nd and 4th instars *S. littoralis* larvae after feeding on treated cotton leaves with the recommended rates of the these insecticides after 2 days .

Table 4: Latent effect of Spinetoram and Dipel 2X recommended rats on *S. littoralis* biological aspects after treated as 2nd instar larvae.

Biological aspects		**Testes insecticides**			
		Spinetoram	**Dipel 2X**	**Untreated**	**LSD 1%**
Larval duration (days ± S.E)		15.77 ±0.26**a**	14.98 ±0.19**a**	14.62 ±0.24**a**	2.9968
Pupation %		36.20%	46.0%	95.0%	
Larval mortality %		63.80%	54.0%	5.0%	
Pupal weight (gm)		0.2964 ± 0.005**a**	0.3682 ±0.008 **a**	0.3417 ±0.02o **a**	
Pupal duration (days ± S.E)		9.55 ± 0.25**a**	11.12 ± 0.18**a**	10.74 ±0.14 **a**	2.6191
Pupal mortality %		16 %	4.42 %	8.55 %	
Emergence %	**Total emergence%**	84 %	95.58 %	91.45 %	
	Normal adult %	81.00%	90.00%	89.50%	
	Malformed adult %	19.00%	10.00%	10.50%	
No. of eggs /female		939 ± 21.4 **b**	1113 ±65.8 **ab**	1216 ±22.8 **a**	237.42
Hatchability %		91.00	94.30	98.00	0.0782
Incubation period (days ± S.E)		2.98 ±0.04**a**	3.18 ±0.06**a**	3.05 ±0.04**a**	0.7487
Longevity (days ±S.E)	♂	7.49 ±0.23 **a**	7.88 ±0.13 **a**	7.04 ±0.16 **a**	1.2284
	♀	7.76 ±0.28 **a**	8.40 ±0.19 **a**	8.62 ±0.27 **a**	1.4244

Table 5: Latent effect of Spinetoram and Dipel 2X recommended rats on *S. littoralis* biological aspects after treated as 4th instar larvae.

Biological aspects		**Testes insecticides**			
		Spinetoram	**Dipel 2X**	**Untreated**	**LSD 1%**
Larval duration (days ± S.E)		11.75 ±0.26a	11.37 ±0.44b	10.27 ±0.19b	1.135
Pupation %		38.4	54.0	100.0	
Larval mortality %		61.6	46.0	0.00	
Pupal weight (gm)		0.2677 ±0.006**a**	0.3689 ±0.015**b**	0.2993 ±0.012**a**	0.0656
Pupal duration (days ± S.E)		9.75 ±0.34a	10.76 ±0.21a	10.27 ±0.18a	1.448
Pupal mortality %		15.12	7.23	0.00	
Emergence%	**Total emergence%**	84.88	92.77	100.00	
	Normal adult %	95.00	84.16	97.50	
	Malformed adult %	5.0	15.84	2.50	
No. of eggs /female		1050 ±25.8b	1563 ±36.4a	1688 ±84.6a	311.35
Hatchability %		95.0	96.14	99.00	
Incubation period (days ± S.E)		3.11 ±0.16**a**	3.56 ± 0.17**a**	3.42 ±0.07**a**	1.2263
Longevity (days ±S.E)	♂	8.14 ±0.14**a**	8.38 ±0.18**a**	8.77±0.42**a**	1.5618
	♀	7.98 ±0.13**a**	8.09 ±0.35**a**	8.64 ±0.19**a**	1.3725

As shown in Table 4, a prolongation in the larval period (remaining period until pupation) occurred. This period lasted 15.77and 14.98 days for treated larvae with Spinetoram and Dipel 2X, respectively, opposed to14.62 days for the untreated larvae. As well as, in Table 5 the same result occurred after treated 4th instar *S. littoralis* larvae whereas; treatment with Spinetoram caused elevation in larval duration than treatment with Dipel 2X and untreated one. Abdel- Rahim *et al*. (2009); mentioned that Spinosad significantly prolonged *S. littoralis* larval duration field strain, comparing to untreated when this compound was applied at their LC_{50} values against 4th instar larvae.

Accumulated larval mortality percentages reached 63.8 and 54.0 % for the respective mentioned treatment of 2nd instar, while it was 5.0% in untreated one, on the other hand; treatment of 4th instar caused 61.6% and 46.0% for Spinetoram and Dipel 2X, respectively While, almost, all the feeding control larvae reached, successfully, the pupae stage (Table 5).

As criteria of latent effects, percentages of pupation, pupal duration, pupal weight, normal adults and malformed adults were studied and the obtained data are presented in Tables 4 and 5. It is noticed that, the negative effect of the tested insecticides on percentages of pupation and adult emergence was clearly accrued in 2nd instar more than 4th instar. The results revealed that, induced a slight reduction in pupae weight of pupae resulted from 2nd and 4th instar larvae fed on the leaves treated with recommended concentration of Spinetoram after 2days of spray was reduce than the other of untreated one. Meanwhile; the same treatment with Dipel 2X caused increasing in pupal weight in the both treated instars. El-Naggar (2013) reported that treatment with sub lethal concentrations of spinetoram reduced food consumption, larval growth rate, and efficiency of converting ingested and digested food into body tissue the tested insecticides in its weight compared to untreated larvae. Also, it was clear that, treatment with Spinetoram has more latent effect than with Dipel 2X in both treated instars on pupal mortality, normal adult and malformed adult. All treatments for the 2nd and 4th instar larvae caused significant reduction in fecundity (No. of eggs /female) and fertility (Hatchability %), whereas; spinetoram caused the most reduction effect i.e. (939 egg & 91%) and (1049 egg & 95.0%) followed be Dipel 2X i.e. (1113 egg & 94.3%) and (1497 egg & 96.14 %) in the mentioned biological aspects for the 2nd and 4th instar *S. littoralis* larvae, respectively. El-Barkey *et al.* (2009) reported that Spinetoram caused a significant reduction in the number of deposited eggs per *Pectinophora gossypiella* female.

CONCLUSION

The obtained results of this study revealed that Spinetoram is a bio-insecticide, has high persistent residues on cotton plants under field conditions. In addition, it demonstrated the superior effectiveness against the cotton leafworm, *S. littoralis,* for the longest periods post application causing high initial and latent effects comparing to the Dipel 2X (*Bt*). Moreover, many previous studies clarified that Spinetoram exhibited low toxicity to natural enemies and environment components. Thus, these novel bio-insecticides represent an important choice for use in Integrated Pest Management (IPM) programs as substitutes of conventional insecticides to control the cotton leaf worm with the recommended concentration under field conditions.

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ARABIC SUMMERY

كفاءة بعض المبيدات الحيوية وثباتها الحقلي على نباتات القطن ضد دودة ورق القطن

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١ معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقي – الجيزة

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تعتبر المبيدات الحيوية أحد أهم البدائل الآمنة لمكافحة اللآفات الحشرية الضارة بالمحاصيل المختلفة, وقد أجريت هذه الدراسة الحقلية لمقارنة كفاءة إثنين من المبيدات الحشرية الحيوية المختلفين فى طريقة الفعل على دودة ورق القطن المصرية على نباتات القطن . تمت المعاملة بالتركيزات الموصى بها من هذه المبيدات على أوراق نباتات القطن في الحقل وتقدير نسب الخفض فى تعداد اللآفة محل الدراسة بعد ٢ -٤ – ٦ – ٨ يوم ، كما اجريت دراسة حقلية معملية لتقدير الآثر الباقى للمركبات المستخدمة على الجوانب البيولوجية للآفة محل الدراسة. وأوضحت النتائج أن المعاملة الحقلية بمبيد الاسبينيتورام سجل أعلى نسبة خفض حيث كانت ٩٥.٥% بعد يومين ونخفضت تدريجيا إلى ٧٤.٠% بعد ٨ أيام بمتوسط عام للخفض بلغ ٨٥.١%، بينما المعاملة بالدبيل ٢ Xحقق ٢٤.٨% خفض يومين وزادت تدريجيا تصل إلى ٨٦.٧% في المائة بعد ٨ أيام بمتوسط عام للخفض بلغ ٥٥.٩ %. كما أظهرت نتائج التجارب الحقلية المعملية أن المعاملة بالاسبينيتورام كانت أكثر فعالية في التأثير على المظاهر البيولوجية لكلا من العمر الثانى والرابع لدودة ورق القطن المعاملة بالدابيل ٢ X ، وقد ظهر ذلك التأثير واضحا فى نسبة الموت فى اليرقات والعذارى ونسبة خروج الفراشات ونسبة التشوه فيها والكفائة التناسلية للحشرات الكاملة الناتجة من المعاملة مقارنة بالغير معاملة.