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RELATIVE TOXICITY OF SOME BIO-RATIONAL INSECTICIDES TO SECOND INSTAR LARVAE AND ADULTS OF ONION THRIPS (*THRIPS TABACI* LIND.) AND THEIR PREDATOR *ORIUS ALBIDIPENNIS* UNDER LABORATORY AND FIELD CONDITIONS

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Abstract: Studies on the relative toxicity of different bio-rational insecticides against second instar larvae and adults of onion thrips, *Thrips tabaci* were carried out on Experimental Farm and in the laboratory, Faculty of Agriculture, University of Suez Canal. Eight insecticides Dipel 2x, BioFly, Agrin, BioGuard, Spinosad, Neemix, Mectin and Match were all evaluated for their relative toxicity towards *T. tabaci* with recommended dose, half of recommended dose and quarter of recommended dose in the laboratory and only recommended dose under field conditions. Spinosad was the most toxic among the tested insecticides followed by Mectin, Match and Agrin when used against thrips adults. The respective values of LC_{50} of those insecticides were 0.048 cm/l, 0.070 cm/l, 0.079 cm/l and 0.137 g/l. Also, Spinosad was the most effective insecticide against second instar larvae followed descendingly by: Agrin, Match and Dipel 2x. Toxicity index values at LC_{50} level show such superior efficiency of Spinosad (100%) when applied against adults and second instar larvae of onion thrips under laboratory conditions. All insecticides under field conditions caused reduction of infestations of thrips. For the residual effect post application, all insecticides gave significant reductions in thrips numbers at the 21 day post treatment except for: Agrin and Match. Spinosad, Mectin, Neemix and BioFly gave the best control and continued to suppress thrips populations till 21 days after treatment. Spinosad was non harmful and Dipel 2x, Agrin were slightly harmful, BioGuard was significantly harmful whereas BioFly, Match and Mectin were very harmful to *Orius albidipennis*.

Key words: bio-rational insecticides, onion thrips, *Thrips tabaci*, natural enemies, *Orius albidipennis*, dose-mortality, residual effect

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INTRODUCTION

The onion thrips, *Thrips tabaci* Lindeman is an important pest of field and greenhouse crops around the world (Tommasini and Maini 1995). In field cultures of onion (*Allium cepa* L.) it is a serious pest as populations may be high particularly during hot, dry weather (Kahrer 1990; Schade 1997).

Feeding by thrips can cause direct and indirect damage. Indirect damage arises from feeding on parenchyma of leaves and subsequent reduction in photosynthetic ability of the plant. Damaged areas become desiccated causing a silvery flecked appearance (Straub and Emmett 1992). Disease transmission is another form of indirect damage. Feeding wounds caused by thrips enhance entry and development of diseases by providing alternative penetration sites (McKenzie *et al.* 1993). Fungi can either invade the damaged tissue or grow on the outer surface nourished by thrips faecal deposits. Onion thrips are known vectors of viral and bacterial diseases (Lewis 1973). Heavy infestation leads to decreased quality as well as quantitative losses in onion (Kendall and Capinera 1987; Vierbergen and Ester 2000).

Adults are the preferred target when using insecticides because they are easier to hit than larvae with the mist sprayers and are also generally more sensitive to the products. Chemicals as a sole approach to thrips control is becoming either less effective or less acceptable environmentally or by the public (Lewis 1997). In an IPM programme, the use of pesticides remains necessary for two reasons. First, there are a number of pests and diseases that cannot yet be controlled by their natural enemies. Second, selective pesticides supplement biological control in case the predators or parasites are temporarily unable to control the pest (van der Staay 1991).

The effect of chemical pesticides on natural enemies also depends on the type of pesticide used. Broad spectrum insecticides adversely affect more natural enemies than selective ones. The overall objective of this study was to evaluate some bio-rational insecticides against onion thrips and their natural enemy under laboratory and field onion production conditions.

MATERIALS AND METHODS

Insect collection

Adults, second instar larvae of onion thrips, *T. tabaci* and its natural enemy *Orius albidipennis* were collected using fine aspirators from an untreated onion field in Experimental Farm, Faculty of Agriculture, University of Suez Canal. In each aspirator 10 adults or larvae was collected into 5 cm long transparent glass tubes and transported to the laboratory.

Insecticides tested

Commercial formulations of the following insecticides were tested against second instar larvae and adults of onion thrips, *T. tabaci* and adults of *O. albidipennis* : Dipel 2x (*Bacillus thuringensis* var. *kurstaki* 22000 IU/mg), BioFly (*Beauvaria bessiana* 100%, 30×10^6 cell), Agrin (*Bacillus thuringensis* (Bt) 32000 IU/mg), BioGuard (*B. thuringensis* bacteria 30 million IU/g), Spinosad (spinosyns A and D, *Saccharopolyspora spinosa*, 0.24% SL), Neemix (4.5% azadirachtin), Match (50% EC lufenuron), Mectin (*Streptomyces avermitilis*, 80% avermectin B1a and 20% avermectin B1b).

Table 1. Name and concentration of tested pesticides

Name	Concentration dose		
	full	half	quarter
Dipel 2x	0.5 g/l	0.25 g/l	0.125 g/l
Agrin	0.75 g/l	0.375 g/l	0.187 g/l
BioGuard	5 g/l	2.5 g/l	1.25 g/l
BioFly	1.5 cm/l	0.75 cm/l	0.375 cm/l
Match	0.4 cm/l	0.2 cm/l	0.1 cm/l
Mectin	0.4 cm/l	0.2 cm/l	0.1 cm/l
Neemix	1.25 cm/l	0.625 cm/l	0.312 cm/l
Spinosad	0.5 cm/l	0.25 cm/l	0.125 cm/l

Laboratory bioassay

Leek leaves disks (2 cm diam.) were cut and dipped into the test solutions for 5 seconds with gentle agitation. They were allowed to surface-dry on a paper towel and then placed into plastic Petri-dishes (5 cm diam.) containing moistened filter papers to avoid desiccation of leaves. Formulations of test compounds were prepared in distilled water at a recommended dose, half of recommended dose and a quarter of recommended dose. Match and mectin were tested at concentrations of 0.4, 0.2 and 0.1 cm/l. Dipel 2 x was tested at concentrations of 0.5, 0.25 and 0.125 g/l. Agrin was tested at concentrations of 0.75, 0.375 and 0.187 g/l. BioGuard was tested at concentrations of 5, 2.5 and 1.25 g/l. BioFly was tested at concentrations of 1.5, 0.75 and 0.375 cm/l. Neemix was tested at concentrations of 1.25, 0.625 and 0.312 cm/l and spinosad was tested at concentrations of 0.5, 0.25 and 0.125 cm/l for adults or second instar larvae of onion thrips, but we used only the recommended dose of previous insecticides against the adults of *O. albidipennis*. Approximately 10 live adults or second instar larvae were transferred with a camel hair brush into each dish. The lid of each dish was ventilated by a hole (1.5 cm in diam.) covered with a fine metal gauze. Five dishes were used for each treatment. Number of dead adults and larvae in each dish was recorded after 24 h of treatment (Hassan 1977).

Field bioassay

In the field study, onion plants grown on the Experimental Farm of Faculty of Agriculture were utilized. The experiment was carried out as a randomized complete block design consisting of four replicates. Each replicate contained 10 rows of onion plants (15 × 10 m square). The insecticide treatments included Dipel 2 x at 0.5 g/l, Agrin at 0.75 g/l, BioGuard at 5 g/l, BioFly at 1.5 cm/l, Match at 0.4 cm/l, Mectin at 0.4 cm/l, Neemix at 1.25 cm/l and Spinosad at 0.5 cm/l. Insecticides were sprayed on the 24 April 2007. The total number of insects (adults and larvae) was recorded after 1, 3, 5, 7, 9, 12, 15, 17, 19 and 21 days after application on five selected plants of each replicate.

Statistical analysis

Mortality rates in each insecticide concentrate were analyzed through ANOVA (SAS Institute, 1999). If there were significant differences ($p \leq 0.05$), differences were compared using FLSD test. A standard probit analysis was used to calculate LC_{20}, LC_{50}, LC_{90} and slope of insects under test (SAS/STAT Institute 1999).

Methodology used in the evaluation of tested insecticides was mainly based on Hassan's (1977) publication on standardized techniques for testing field-effects of chemicals on arthropods.

RESULTS AND DISCUSSION

The value of LC_{20}'s, LC_{50}'s and LC_{90}'s were tabulated in Table 2 and 3 with the corresponding slope and toxicity index for each insecticides tested against adults and seconed instar larvae of the onion thrips. The results of adults in Table 2 showed that Spinosad was the most toxic among the tested insecticides followed by Mectin, Match and Agrin. The respective values of LC_{50} of those insecticides were 0.048 cm/l, 0.070 cm/l, 0.079 cm/l and 0.137 g/l, respectively. At the LC_{90}, the descending order of toxicity was similar, Spinosad (0.259 cm/l), Mectin (0.284 cm/l), Match (0.196 cm/l) and Agrin (2.187 g/l). The toxicity index values show such superior efficiency of Spinosad at LC_{50} (100%) followed by Mectin (68.5%), Match (60.7%) and Agrin (35.0%). As for slope values, Agrin had the steepest toxicity line, whereas Match had the flattest one. Seal *et al.* (2006) stated that the insecticide Chlorfenapyr was the most effective in reducing the densities of *S. dorsalis* adults and larvae followed by Spinosad and Imidacloprid.

Table 2. The toxic effect of the bio-rational insecticides against adults of *T. tabaci*

Insecticides	Slope	LC_{20} [95% CI]*	LC_{50} [95% CI]	LC_{90} [95% CI]	TI [%]**
Dipel 2x [a]	3.92	0.043 (0.015–0.123)	0.136 (0.086–0.214)	0.790 (0.354–1.762)	35.2
Agrin [a]	8.55	0.022 (0.002–0.299)	0.137 (0.050–0.381)	2.187 (0.383–12.297)	35.0
BioGuard [a]	5.78	0.243 (0.042–1.404)	1.077 (0.524–2.213)	10.342 (3.152–33.933)	3.71
BioFly [b]	5.91	0.142 (0.040–0.505)	0.639 (0.419–0.975)	6.313 (1.250–31.88)	7.51
Match [b]	2.02	0.043 (0.023–0.081)	0.079 (0.055–0.113)	0.196 (0.148–0.259)	60.7
Mectin [b]	2.95	0.028 (0.010–0.082)	0.070 (0.040–0.125)	0.284 (0.182–0.442)	68.5
Neemix [b]	3.87	0.045 (0.001–0.224)	0.142 (0.052–0.390)	0.813 (0.492–1.345)	33.8
Spinosad [b]	2.97	0.025 (0.006–0.104)	0.048 (0.018–0.130)	0.259 (0.175–0.376)	100

* confidence interval, ** toxicity index at LC_{50}
[a] g/l
[b] cm/l

Table 3. The toxic effect of the bio-rational insecticides against nymphs of *T. tabaci*

Insecticides	Slope	LC_{20} [95% CI]*	LC_{50} [95% CI]	LC_{90} [95% CI]	TI [%]**
Dipel 2x [a]	3.26	0.020 (0.004–0.111)	0.054 (0.020–0.149)	0.251 (0.167–0.376)	16.6
Agrin [a]	16.79	0.002 (0.000–1.999)	0.025 (0.001–0.917)	0.951 (0.201–4.497)	36.0
BioGuard [a]	2.53	0.388 (0.152–0.992)	0.855 (0.505–1.448)	2.840 (1.995–4.043)	1.05
BioFly [b]	6.28	0.057 (0.007–0.446)	0.271 (0.113–0.653)	2.899 (0.851–9.880)	3.32
Match [b]	2.58	0.021 (0.005–0.084)	0.048 (0.021–0.109)	0.163 (0.117–0.226)	18.75
Mectin [b]	2.27	0.042 (0.021–0.082)	0.084 (0.058–0.122)	0.244 (0.175–0.339)	10.71
Neemix [b]	8.28	0.015 (0.000–0.583)	0.092 (0.014–0.611)	1.399 (0.484–4.043)	9.78
Spinosad [b]	7.46	0.002 (0.000–1.414)	0.009 (0.000–0.739)	0.124 (0.044–0.354)	100

*confidence interval, ** toxicity index at LC_{50}
[a] g/l
[b] cm/l

Data presented in Table 3 show that Spinosad (at LC_{20}, LC_{50} and LC_{90}) was the most effective insecticide against second instar larvae followed descendingly by Agrin, Match and Dipel 2x. Toxicity index values at LC_{50} level show such superior efficiency of Spinosad (100%) followed by Agrin (36.0%), Match (18.75%) and Dipel 2x (16.6%). The slope values show that Agrin had the highest slope value (16.79) whereas Mectin had the lowest slope value (2.26). Results indicated that the larval stage of onion thrips was more susceptible to the tested bio-rational insecticides than the adult one. Our data has been supported by Abbas and Eldakrowry (1988); Ali and Young (1996) who observed that the susceptibility of *Helicoverpa* to both conventional and biological insecticides tends to decline with increasing age and size.

Data presented in Figure 1 indicated that all insecticides under field conditions caused reduction of infestations of thrips. The highest reduction was 100% in Biofly after 3, 5 and 7 days, Mectin after 12, 15 and 17 days and Spinosad after 3, 5, 7 and 9 days after treatment. On the other hand, the lack of reduction of infestation was hoted for Agrin and Match at 21st day after application.

At 1, 3, 5, 7, 9, 12, 15, 17 and 19 days post treatment, all insecticides significantly reduced thrips numbers below the untreated check (Table 4). (df = 4.32; F = 76.29; p = 0.0000 after 1 day, df = 4.32; F = 19.93; p = 0.0000 after 3 days, df = 4.32; F = 105.10; p = 0.0000 after 5 days, df = 4.32; F = 125.34; p = 0.0000 after 7days, df = 4.32; F = 78.66; p = 0.0000 after 9 days, df = 4.32; F = 49.34; p = 0.0000 after 12 days, df = 4.32; F = 60.22; p = 0.0000 after 15 days, df = 4.32; F = 32.38; p = 0.0000 after 17 days, df = 4.32; F = 24.91; p = 0.0000 after 19 days, df = 4.32; F = 31.17; p = 0.0000 after 21 days of treatment.

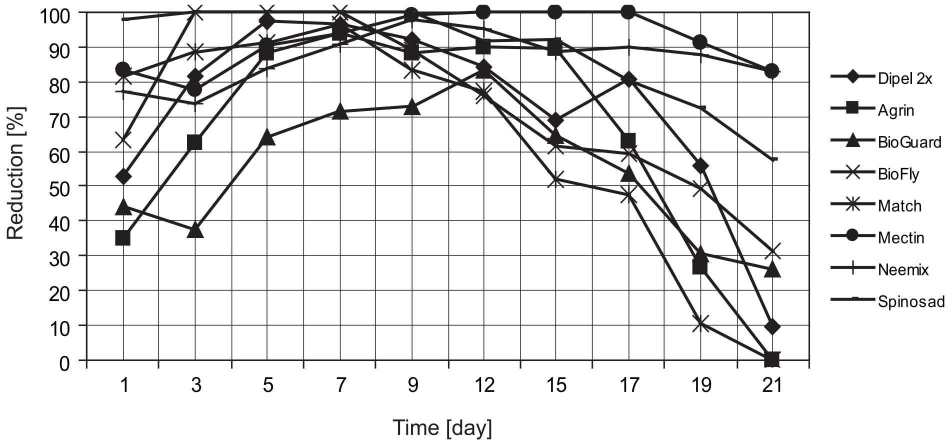

Fig. 1. Effect of bio-rational insecticides on reduction of infestation of *T. tabaci* under field condition

Table 4. Effect of insecticides on thrips population in terminal leaves

Treatments	Mean total thrips/leaf									
	1	3	5	7	9	12	15	17	19	21*
Dipel 2x [0.5 g/l]	15.6 c	4.6 c	0.8 de	0.8 c	1.6 cde	3.8 bc	7.8 c	5 de	9.2 cd	17.2 b
Agrin [0.75 g/l]	21.4 b	9.4 c	3.6 cd	1.4 c	2.4 cd	2.6 bcd	2.6 d	9.6 cd	15.4 bc	22.4 a
BioGuard [5g/l]	18.4 bc	15.6 b	10.8 b	6.8 b	5.4 b	4.0 bc	8.8 b	12 bc	14.6 cd	14 b
BioFly [1.5 cm/l]	1.2 e	0 e	0 e	0 c	2.2 cde	5 bc	9.6 bc	10.6 bc	10.6 d	13 c
Match [0.4 cm/l]	6 d	2.8 de	2.6 cde	0.8 c	3.4 bc	5.4 b	12 b	13.6 b	18.8 ab	21.4 ab
Mectin [0.4 cm/l]	5.4 d	5.6 cd	2.8 cde	1.4 c	0.2 de	0 d	0 d	0 f	1.8 e	3.2 e
Neemix [1.25 cm/l]	7.4 d	6.6 cd	4.8 c	2.2 c	0.4 de	1.2 cd	2.8 d	2.6 ef	2.6 e	3.2 e
Spinosad [0.5 cm/l]	0.6 e	0 e	0 e	0 c	0 e	2 bc	2 d	5.2 de	5.8 e	8 d
Untreated	33.1 a	25.0 a	30.0 a	24.2 a	20 a	24.4 a	25 a	26.7 a	21.3 a	19.1 ab

Means within columns, followed by the same letter are not significantly different (ANOVA; LSD = 0.05)
* days after treatments

All insecticidal treatments gave significant reductions in thrips numbers at 21 days post treatment except for Agrin and Match. As well as, data indicated that Spinosad, Mectin, Neemix and Biofly gave the best control and continued to give significant reduction in thrips populations till 21 days of treatment compared to the remain insecticides and untreated check. Martin (2005) stated that if a threshold of 0.1 thrips /plant from a 50 or 100 plant sample was exceeded then an application a cluster of insecticide sprays should be used. Also the action threshold of 0.1 thrips/plant is much lower than thresholds used overseas, e.g. three thrips/ onion leaf (Shelton *et al*. 1987), one thrip/leaf (Edelson *et al*. 1989) and 4–15 thrips/plant depending on onion plant growth stage (Bird *et al*. 2004).

Table 5. Differential toxicity of bio-rational insecticides in a laboratory bioassay to *O. albidipennis*

Treatments	Rate	% Mortality	Toxicity category*
Dipel 2x	0.5 g/l	39	slightly harmful
Agrin	0.75 g/l	41	slightly harmful
BioGuard	5 g/l	66	significantly harmful
BioFly	1.5 cm/l	82	very harmful
Match	0.4 cm/l	100	very harmful
Mectin	0.4 cm/l	75	very harmful
Neemix	1.25 cm/l	14	non harmful
Spinosad	0.5 cm/l	11	non harmful
Control		0	

*toxicity categories are based on those proposed by Hassan (1977)

Table 6. Mean numbers of *O. albidipennis* on onion before and after treatment with some bio-rational insecticides

Treatments	Rate	Mean number of *O. albidipennis*/leaf		
		before spraying	after spraying	
		Alive	Alive	Dead
Dipel 2x	0.5 g/l	0.75	0.25 bc	0.25 ab
Agrin	0.75 g/l	1.00	0.50 abc	0.50 ab
BioGuard	5 g/l	0.50	0.50 abc	0.25 ab
BioFly	1.5 cm/l	0.25	0.00 c	0.75 ab
Match	0.4 cm/l	0.50	0.00 c	0.75 a
Mectin	0.4 cm/l	1.00	0.50 abc	0.25 ab
Neemix	1.25 cm/l	0.75	1.00 ab	0.25 ab
Spinosad	0.5 cm/l	1.00	1.00 ab	0.00 b
Control		1.00	1.25 a	0.00 b

Means within columns, followed by the same letter are not significantly different (ANOVA; LSD = 0.05)

Data presented in Table 5 show that Match, BioFly and Mectin caused higher mortality of *O. albidipennis* adults equal to 100%, 82%, 75%, respectively and the toxicity category was very harmful. Agrin was significantly harmful and caused 66% mortality, Dipel and Agrin could be classified as slightly harmful and caused 39% and 41% mortality, respectively. Whereas, Spinosad and Neemix were non harmful and caused 11% and 14% mortality, respectively.

McCord *et al*. (2002) stated that the management system needs to be developed for chilli thrips, *Scirtothrips dorsalis* that will take of advantage of natural enemies and retard the development of insecticide resistance by rotational use of those insecticides with different modes of action.

Data presented in Table 6 indicate that the bio-rational insecticide Spinosad had the lowest negative effect on *O. albidipennis* (df = 4,32; F= 3.317; p= 0.0090 for live insects and df = 4,32; F= 1.777; p= 0.1258 for dead insects). Seal *et al*. (2006) studied the comparative effectiveness of chemical insecticides against the chilli thrips, *S. dorsalis* on pepper and their compatibility with natural enemies and they found that the imidacloprid and cyhalothrin caused 100% mortality of Cryptolaemus adults, but abamectin spared 33%, chlorfenapyr 50% and spinosad 67% of population.

CONCLUSIONS

The results of our study indicate that the effects of the bio-rational insecticides we evaluated differed considerably in their age specific toxicity. The differences can be attributed to different modes of action of the products and also to the developmental stage of onion thrips, *T. tabaci.*

The best overall results were obtained with Spinosad, Mectin, Neemix and Biofly provided excellent control through 21 day period at the recommended dose of 0.5 cm/l, 0.4 cm/l, 1.25 cm/l and 1.5 cm/l, respectively. The bio-rational insecticides look promising and could be alternative insecticides in the future for controlling onion thrips and be safe at the same time for natural enemies.

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POLISH SUMMARY

WZGLĘDNA TOKSYCZNOŚĆ NIEKTÓRYCH BIORACJONALNYCH INSEKTYCYDÓW W STOSUNKU DO DRUGIEGO STADIUM LARWALNEGO I DOROSŁYCH OWADÓW WCIORNASTKA TYTONIOWCA (*THRIPS TABACI* LIND.) I JEGO NATURALNEGO WROGA *ORIUS ALBIDIPENNIS* W WAUNKACH LABORATORYJNYCH I POLOWYCH

Na farmie doświadczalnej oraz w laboratorium Wydziału Rolnictwa University of Suez Canal przeprowadzono badania względnej toksyczności niektórych bioracjonalnych insektycydów w stosunku do drugiego stadium larwalnego i dorosłych owadów wciornastka tytoniowca (*Thrips tabaci* Lind.). Oceniono pod tym względem osiem insektycydów: Dipel 2x, BioFly, Agrin, BioGuard, Spinosad, Neemix, Mectin i Match w dawkach zalecanych, zmniejszonych o połowę i zredukowanych do ¼ w warunkach laboratoryjnych, natomiast w polowych tylko w dawkach zalecanych. Spino-

sad okazał się najbardziej toksyczny w stosunku do dorosłych owadów wciornastka spośród testowanych insektycydów przed Mectin, Match i Agrin. Wartości LC_{50} dla tych insektycydów wynosiły odpowiednio 0,048 cm/l, 0,070 cm/l, 0,079 cm/l i 0,137 g/l. Również i dla drugiego stadium larwalnego Spinosad okazał się najbardziej skuteczny wyprzedzając w kolejności Agrin, Match i Dipel 2x. Wartości indeksów toksyczności na poziomie LC_{50} wykazały stuprocentową skuteczność Spinosad przeciwko owadom dorosłym wciornastka tytoniowca i jego larwom w drugim stadium po zastosowaniu w laboratorium. W warunkach polowych wszystkie insektycydy powodowały zmniejszenie zasiedlenia cebuli przez owady. Oprócz Agrin i Match wszystkie insektycydy wykazały znaczną redukcję liczby wciornastka 21. dnia po aplikacji. Spinosad, Mectin, Neemix i BioFly powodowały największe ograniczenia populacji owada do 21 dni po zabiegu. Spinosad nie był szkodliwy a Dipel 2x i Agrin niezbyt szkodliwe dla *Orius albidipennis*. BioGuard wykazywał w stosunku do niego znaczną szkodliwość, podczas gdy BioFly, Match i Mectin okazały się bardzo szkodliwe.