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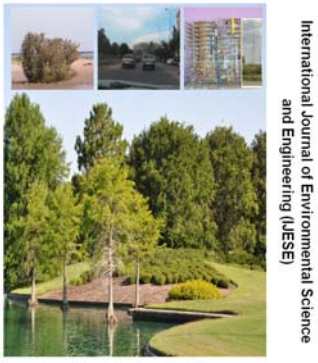

Biology and control of the broad mite *Polyphagotarsonemus latus* (Banks, 1904) (Acari: Tarsonemidae)

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ABSTRACT

The effect of feeding on two host plant species pepper, *Capsicum annum* L. (Solanaceae) and cucumber, *Cucumis sativus* L. (Cucurbitaceae) was studied on some biological aspects of *Polyphagotarsonemus latus* (Banks) in the laboratory at 24 ± 2°C, 70 ± 5% RH and 16L: 8D photoperiod. The study revealed that pepper plant is a more suitable diet than cucumber for *P. latus* as revealed by lower duration periods of developmental stages and greater number of eggs which are essential for mite survival and population build up.

Control studies included the evaluation of field efficacies of seven pesticides against different stages of *P. latus* infesting pepper. The study revealed that Abamectin was the most effective followed by Liquid sulfur (Calcium polysulfide), Canola oil (2% Erucic Acid Rapeseed oil), Orange oil (D-Limonene), *Beauveria bassiana*, Azadirachtin and 4.5% Matrine.

1. INTRODUCTION

Family Tarsonemidae includes more than 500 world widely distributed mite species. The greater part of which are pests of agricultural crops particularly those grow in greenhouses. Others are fungivores, algivores, predators of other mites, parasites of insects and possibly symbionts of insects (Zhang, 2003). *Polyphagotarsonemus latus* (Banks) is a minute herbivorous mite that attacks numerous plant crops from diverse families including Solanaceae, Cucurbitaceae and Malvaceae causing severe symptoms and yield losses. Its attack is confined mostly to new growths resulting in curling of leaf margins, firmness of infested leaves, necrosis of growing points, aborted buds, malformed fruits and growth inhibition (Grinberg *et al*., 2005). Recently, several studies were concerned with the biology (Namvar and Arbabi, 2007; Al-Ani and Al-Jboory, 2008; Matos *et al*., 2009) or control of *P. latus* (Pereira *et al*., 2007; Sarkar *et al*., 2007; Venzon *et al*., 2008; Van Maanen *et al*., 2010). However, the majority of these studies did not address the possible effect of host plant on these parameters.

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Effect of host plant on biological aspects of mites was recently studied in *Amphitetranychus viennensis* infesting black cherry (*Prunus serotina*), cherry (*Prunus avium*) and apple (*Malus domestica*) (Kafil *et al*., 2007) and *Tetranychus kanzawai* on *Orixa japonica* (Rutaceae) and *Phaseolus vulgaris* (Fabaceae) (Ito, 2010).

The host plants; pepper, *Capsicum annum* L. and cucumber, *Cucumis sativus* L. belonging to families Solanaceae and Cucurbitaceae, respectively are important commercial vegetables in Egypt. Pepper is a good source of vitamin C and A, while cucumber contains mineral salts and enzymes for protein and lipid digestion. In Egypt, both crops are attacked by a number of insect and mite pests, out of them; *P. latus* is considered as one of the major pests under plastic house conditions. Considering the drastic economic importance of *P. latus* and rare availability of basic information on its biology or control particularly in Egypt or the North African region, we studied the duration of developmental stages and some biological parameters of *P. latus* following feeding on the above two host plants in addition to the efficiency of some pesticides against different stages of the mite.

2. MATERIALS AND METHODS

2.1. Biological studies:

P. latus was reared at 24 ± 2°C, 70 ± 5% RH and 16L: 8D photoperiod on two host plants namely pepper, *C. annum* (Godyon cultivar) and cucumber, *Cu. sativus* (164 D.D. cultivar) using the leaf arena method (Abou-Setta and Childers, 1987). The method includes putting a plant leaf of pepper or cucumber on filter paper placed over thin layer of sponge which in turn is placed over a layer of cotton saturated with water in a foam dish. The leaf stalk was directed downward to reach the saturated cotton. One cm apart around the plant leaf, ribbons of filter paper immersed with Tangle oil were placed to prevent escaping of mites from the leaf. The water was added when needed to keep humidity at constant limit.

A pure culture of mite individuals was maintained in the laboratory where mated females were transferred to a replicate of arena leaf of the two host plants. Laid eggs by such females were observed until hatching. The resulted larvae were placed singly on new fresh arena leaves and examined twice daily to determine the duration of each developmental stage, longevity of males and females, sex ratio and oviposition periods.

2.2. Efficiency of pesticides:

Efficacy of seven pesticides against *P. latus* infesting pepper plant was carried out in a plastic house at the farm of Agricultural Research Center, Giza governorate, Egypt. The plastic house was 30m × 9m × 3m divided into 24 plots, each about 11.25 m^2. Each plot was replicated three times in a randomized complete block design. Pepper seedlings var. Godyon was planted using drip irrigation system in August 2008. All experimental plots received the normal agricultural practices as usual.

Treatments included the use of Abamectin (Vertemic 1.8% EC) (40 cm/100 L water), Liquid sulfur (Calcium polysulfide) (500 cm/100 L water), Botany gard (derived from the fungus *Beauveria bassiana*) (250 cm/100 L water), Canola oil (2% Erucic Acid Rapeseed oil) (300 cm/100 L water), Bioca (4.5% Matrine) (200 cm/100 L water), Orange oil (D-Limonene) (500 cm/100 L water) and Neemix (Azadirachtin) (75 cm/100 L water). To estimate acaricidal efficacy of tested pesticides against *P. latus,* random samples of 10 young leaves per replicate for each plot were collected after 1, 3, 5, 7, 10, 17 and 24 days of pesticide application. Each sample was placed in a tightly closed paper bag and transferred to the laboratory in the same day for inspection under stereobinocular microscope. Pre-counts were made for all replicates to determine the initial distribution and density of mites. Reduction percentage was calculated according to Henderson and Tililon (1955) through the following formula:

Reduction % = [(Ta x Cb / Tb x Ca) - 1] x 100

Ta = Treatment after spray, Tb = Treatment before spray, Ca = Control before spray,

Cb = Control after spray.

Statistical analysis (ANOVA and simple correlation) of the present data were carried out by using SAS program.

3. RESULTS

3.1. Biological studies:

Copulation occurs immediately after the female has emerged from the quiescent nymph skin. Mated females produce both males and females, while unmated females produce only males. The life cycle of *P. latus* pass through

egg, larva, quiescent nymph and adult stages (Table 1).

3.1.1. Duration of developmental stages:

Duration of *P. latus* stages, viz egg, larva, nymph and adults was almost higher in case of feeding on cucumber than on pepper plants with significant increase in the duration of eggs producing females, larvae producing males and both adults (Table 1). However, the duration of larvae and nymphs producing females were significantly higher in case of pepper than in cucumber plants. In case of stages producing males, the duration of egg, larva and nymph ranged between 2.67-2.71, 2.42-3.0 and 2.75- 3.0 days, respectively in both plants. In case of those producing females, the durations were 2.5-2.55, 1.89-2.2 and 2.74-3.13 days, respectively. Male and female longevity ranged between 7.17-7.67 and 10.17-10.74, respectively in both plants (Table 1).

Table 1: Duration of different stages of *Polyphagotarsonemus latus* fed on pepper or cucumber plants.

Stage	Duration of developmental stages (Days)				F value		L.S.D.	
	Pepper		Cucumber					
	Male	Female	Male	Female	Male	Female	Male	Female
Egg	2.67 ± 0.00 [a*] (2.67−2.67)	2.50 ± 0.11 [b] (2.00−3.00)	2.71 ± 0.03 [a] (2.65 −2.79)	2.55 ± 0.09 [a] (2.00−2.71)	0.76	71.19	0.11	0.01
Larva	2.42 ± 0.32 [b] (2.00−3.33)	2.20 ± 0.24 [a] (1.33−3.33)	3.00 ± 0.11 [a] (2.70−3.20)	1.89 ± 0.22 [b] (1.00−3.00)	28.6	24.19	0.27	0.16
Nymph (quiescent)	2.75 ± 0.37 [a] (2.00−3.67)	3.13 ± 0.04 [a] (3.07−3.24)	3.00± 0.07 [a] (2.85 −3.20)	2.74 ± 0.05 [b] (2.62−2.85)	0.44	41.7	0.92	0.15
Adult	7.17± 0.55 [b] (5.67−8.00)	10.17 ± 0.57 [b] (7.00−13.00)	7.67± 0.054 [a] (7.58−7.82)	10.74 ± 0.46 [a] (8.67−13.33)	68.6	46.71	0.15	0.07

* Mean ± S.E. (Minimum-Maximum). Similar letters have insignificant difference in each row.

3.1.2. Reproductive parameters:

Oviposition period and total number of eggs were significantly higher in case of feeding on pepper (9.25 and 31.58, respectively) than on cucumber plant (7.75 and 26.42, respectively) (Table 2). The pre-oviposition period, mean generation time, male and female life cycle longevity and daily rate of eggs were almost higher in case of pepper than on cucumber but without significant differences. The recorded data for these parameters were 0.68-0.72, 7.9-8.52, 7.83-8.71, 7.18-7.84 and 3.41-3.43, respectively between both plants. Sex ratio was in favor of females (76%) in both plants (Table 2).

Accordingly, pepper plant may be considered as one of the suitable diets for *P. latus* where it showed lower duration periods of developmental stages and greater number of eggs which are essential for mite survival and population build up.

3.2. Efficiency of some pesticides against *P. latus:*

3.2.1. Effect on adults:

Results showed that using of Abamectin and Liquid sulfur gave the best reduction percentage as 93.81% and 87.40%, respectively, while the lowest reduction percentage was obtained by Azadirachtin was 28.31% (Table 3). There were significant differences between them.

3.2.2. Effect on immature stages:

The highest average reduction percentage was 96.71%, 83.06% and 74.57% when using Abamectin, Liquid sulfur and Canola oil, respectively followed by decrease in Orange oil, *Beauveria bassiana*, Azadirachtin and Matrine with significant difference between tested compounds (Table 4). No significant difference between *Beauveria bassiana*, Azadirachtin and Matrine was recorded.

Table 2: Biological parameters of *Polyphagotarsonemus latus* reared on pepper or cucumber plants.

Biological Parameter		Pepper	Cucumber	F value	LSD value
Pre-oviposition period (Days) (Period from female molting until depositing of first egg)		0.68 ± 0.10 [a] * (0.37−1.00)	0.72 ±0.02 [a] (0.66−0.80)	0.1	0.324
Oviposition period (Days) (Period of depositing eggs)		9.25 ± 0.51 [a] (6.00 −12.00)	7.75 ± 0.22 [b] (7.00−9.00)	7.33	1.149
Total eggs (Mean number of eggs/female)		31.58 ± 2.04 [a] (18.00−46.00)	26.42 ± 1.03 [b] (21.00−32.00)	5.11	4.741
Daily rate of eggs (Mean no. of eggs/female/day)		3.43 ± 0.15 [a] (2.57−4.17)	3.41 ± 0.09 [a] (3.00−3.88)	0.02	0.362
Mean generation time (Days) (Period from egg to egg)		8.52 ± 0.32 [a] (7.01−9.70)	7.90 ± 0.22 [a] (6.76−9.43)	2.57	0.806
Life cycle (Period from egg to adult)	Males	7.83 ± 0.50 [a] (7.00−9.00)	8.71 ± 0.01 [a] (8.69−8.71)	3.06	1.224
	Females	7.84 ± 0.35 [a] (6.33−9.33)	7.18 ± 0.22 [a] (6.04−8.71)	2.6	0.857
Sex ratio (Males : Females)		24:76	24:76		

* Mean ± S.E. (Minimum-Maximum). Similar letters have insignificant difference in each row.

Table 3: Mean number of *Polyphagotarsonemus latus* adults/leaf (apical leaves) of pepper plant before and after application of seven pesticides and their corresponding reduction percentages under plastic house conditions.

Inspection date / Treatments		Count before treatment	Days after treatment							Average reduction percentage
			1st day	3rd day	5th day	7th day	10th day	17th day	24th day	
Control (Mean no./Apical leaf)		9.35	19.00	31.67	44.00	31.90	17.67	32.67	33.35	
Abamectin	Mean	14.67	0.00	0.00	0.00	0.00	0.67	4.99	16.33	
	R %		100.0 [a]	100.0 [a]	100.0 [a]	100.0 [a]	97.60 [a]	90.26 [a]	68.80 [a]	93.81 [a]
Beauveria bassiana	Mean	11.70	8.26	8.88	6.73	16.01	12.76	45.14	42.83	
	R %		65.26 [d]	77.60 [c]	87.78 [b]	59.89 [b]	42.30 [c]	0.00 [f]	0.00 [d]	47.55 [b]
Matrine	Mean	9.80	3.26	5.58	6.41	20.17	15.57	35.69	40.10	
	R %		83.63 [b]	83.20 [b]	86.11 [b]	39.68 [c]	15.93 [f]	0.00 [f]	0.00 [d]	44.08 [bc]
Azadirachtin	Mean	10.73	17.89	13.95	24.52	27.57	15.35	30.71	45.14	
	R %		17.97 [e]	61.62 [d]	51.43 [c]	24.70 [d]	24.33 [e]	18.10 [d]	0.00 [d]	28.31 [c]
Orange oil	Mean	13.33	5.32	1.01	1.39	17.90	16.50	44.13	46.90	
	R %		80.35 [c]	97.76 [a]	97.78 [a]	60.65 [b]	34.50 [d]	5.25 [e]	1.35 [d]	53.95 [b]
Canola oil	Mean	18.67	0.33	0.76	1.74	1.03	7.99	39.61	45.41	
	R %		99.12 [a]	98.80 [a]	98.02 [a]	98.39 [a]	77.36 [b]	39.29 [c]	31.81 [c]	77.54 [a]
Liquid sulfur	Mean	16	0.33	0.00	0.17	0.34	0.33	21.96	26.20	
	R %		98.98 [a]	100.0 [a]	99.77 [a]	99.37 [a]	98.90 [a]	60.71 [b]	54.09 [b]	87.40 [a]
F. value			110.71	23.34	29.88	132.13	74.25	115.13	110.53	15.33
L.S.D			2.68	2.95	3.05	2.58	3.88	3.10	2.68	17.56

Mean=mean number of adults, R% = mean reduction percentage. Similar letters have insignificant difference in each column.

3.2.3. Effect on eggs:

Efficacies of seven assayed compounds against *P. latus* eggs arranged in a descending series as follows; Abamectin, Liquid sulfur, Canola oil, Orange oil, *Beauveria bassiana*, Azadirachtin and Matrine being 86.12%, 67.58%, 59.25%, 22.6%, 18.28%, 11.89% and 1.18% reduction percentages, respectively (Table 5). There were significant differences between them.

It could be recommended that the use of Abamectin, Liquid sulfur and Canola oil in controlling *P. latus* stages will give better results.

Table 4: Mean number of *Polyphagotarsonemus latus* immatures/leaf (apical leaves) of pepper plant before and after application of seven pesticides and their corresponding reduction percentages under plastic house conditions.

Inspection date / Treatments		Count before treatment	Days after treatment							Average reduction percentage
			1st day	3rd day	5th day	7th day	10th day	17th day	24th day	
Control (Mean no./Apical leaf)		21.47	25.20	29.73	19.07	23.00	30.67	29.53	37.07	
Abamectin	Mean	17.73	0.33	0.11	0.32	0.25	0.10	1.00	4.03	
	R %		98.41 a	99.56 a	97.95 ab	98.69 a	99.62 a	95.88 a	86.83 a	96.71 a
Beauveria bassiana	Mean	20.00	8.83	14.94	13.42	19.84	42.54	29.63	40.29	
	R %		62.39 c	46.08 d	24.44 d	7.04 d	0.00 d	0.00 d	0.00 d	19.99 d
Matrine	Mean	15.07	14.53	14.45	11.52	30.14	33.73	31.90	33.47	
	R %		17.89 e	30.77 f	13.94 e	0.00 e	0.00 d	0.00 d	0.00 d	8.94 d
Azadirachtin	Mean	17.73	13.22	14.80	14.21	21.16	27.75	27.53	37.54	
	R %		36.50 d	39.73 e	9.77 f	0.00 e	0.00 d	0.00 d	0.00 d	12.29 d
Orange oil	Mean	24.57	1.36	5.27	1.77	15.79	31.17	42.56	43.16	
	R %		95.30 b	84.51 c	91.91 c	40.00 c	11.20 c	0.00 d	0.00 d	46.13 c
Canola oil	Mean	23.30	0.22	2.00	0.96	0.48	4.11	20.71	35.22	
	R %		99.19 a	93.80 b	95.38 b	98.10 a	87.66 b	35.38 c	12.46 c	74.57 b
Liquid sulfur	Mean	20.33	0.38	1.25	0.25	1.58	0.45	10.56	22.68	
	R %		98.39 a	95.57 b	98.61 a	92.76 b	98.46 a	62.23 b	35.38 b	83.06 ab
F. value			86.22	49.66	94.55	210.95	264.86	169.78	118.65	43.55
L.S.D			2.49	2.87	3.00	2.21	2.07	2.01	2.03	15.37

Mean=mean number of immatures, R%=mean reduction percentage. Similar letters have insignificant difference in each column.

Table 5: Mean number of *Polyphagotarsonemus latus* eggs/leaf (apical leaves) of pepper plant before and after application of seven pesticides and their corresponding reduction percentages under plastic house conditions.

Inspection date / Treatments		Count before treatment	Days after treatment							Average reduction percentage
			1st day	3rd day	5th day	7th day	10th day	17th day	24th day	
Control (Mean no./Apical leaf)		16.40	25.27	27.07	49.80	50.53	38.93	63.67	75.20	
Abamectin	Mean	33.73	5.96	7.54	6.58	0.96	1.30	17.17	77.37	
	R %		88.53 b	86.45 b	93.58 b	99.08 a	98.37 a	86.89 a	49.97 a	86.12 a
Beauveria bassiana	Mean	24.60	25.68	7.02	64.96	90.66	95.80	96.32	112.83	
	R %		32.20 d	82.70 c	13.05 f	0.00 c	0.00 d	0.00 c	0.00 b	18.28 cd
Matrine	Mean	18.54	31.40	28.07	77.40	72.81	63.88	82.14	95.66	
	R %		0.00 f	8.27 f	0..00 g	0.00 c	0.00 d	0.00 c	0.00 b	1.18 d
Azadirachtin	Mean	15.07	18.33	19.89	26.45	73.55	44.11	95.91	91.88	
	R %		21.02 e	20.02 e	42.19 d	0.00 c	0.00 d	0.00 c	0.00 b	11.89 cd
Orange oil	Mean	19.27	4.77	13.92	47.95	87.49	73.68	75.18	88.36	
	R %		83.94 c	56.22 d	18.04 e	0.00 c	0.00 d	0.00 c	0.00 b	22.60 c
Canola oil	Mean	22.88	1.28	6.10	14.97	0.69	23.32	99.85	105.37	
	R %		96.36 a	83.85 bc	78.45 c	99.02 a	57.07 c	0.00 c	0.00 b	59.25 b
Liquid sulfur	Mean	23.2	5.02	3.73	2.02	2.83	6.27	76.51	106.38	
	R %		85.95 bc	90.27 a	97.14 a	96.05 b	88.62 b	15.05 b	0.00 b	67.58 b
F. value			66.55	46.25	59.57	161.70	281.99	108.81	46.21	27.57
L.S.D			2.67	2.78	2.91	0.72	1.49	1.72	1.54	17.26

Mean=mean number of eggs, R% = mean reduction percentage. Similar letters have insignificant difference in each column.

4. DISCUSSION

The life cycle of *P. latus* in the current study passed through egg, larva, quiescent nymph and adult stages. This resembled findings obtained by Vieira and Chiavegato (1998), Srinivasulu *et al*. (2002), Dhooria (2005) and Al- Ani and Al-

Jboory (2008). The present study showed that pepper was rather more suitable than cucumber plant for *P. latus* survival and population build up as noticed from roughly lower duration periods of developmental stages and greater number of eggs. This may be attributed to differences in phytochemical structure between leaves of pepper or cucumber plants. This suggestion needs further physiochemical studies on their leaves.

The present study showed that the longevity period of egg, larva and nymph ranged between 2.67-2.71, 2.42-3.0 and 2.75- 3.0 days, respectively in males and 2.5-2.55, 1.89-2.2 and 2.74-3.13 days, respectively in females among plant species. Male and female longevity ranged between 7.17-7.67 and 10.17-10.74, respectively.

These results are in almost agreement with those of Almaguel *et al*. (1984), Karmakar (1997), Dhooria (2005) and Al-Ani and Al-Jboory (2008) in case of eggs, Vieira and Chiavegato (1999), Vieira (2001) and Al-Ani and Al-Jboory (2008) in case of larvae and nymphs and Vieira and Chiavegato (1998) and Namvar and Arbabi (2007) in adults. However, extended values for larval longevity (4.4 days) (Almaguel *et al*., 1984) and male and female longevity (11.4 and 15.3 days, respectively) (Ho, 1991) were recorded on pepper. On the other hand, Srinivasulu *et al*. (2002) noticed that the incubation period of egg, larva and nymph were 1.51, 0.825 and 0.71 days, respectively for males and 1.62, 0.9 and 0.8 days, respectively for females on chilli. On potato, these periods were 1.32, 1.1 and 1.12 days, respectively in both sexes (Namvar and Arbabi, 2007). Adult longevity on chilli (Srinivasulu *et al*., 2002), green gram (Dhooria, 2005) and potato (Al-Ani and Al-Jboory, 2008) was also lower than that in the present study. These differences may be due to planting under different environmental conditions and host varieties.

The preoviposition (0.68-0.72 days) and oviposition periods (7.75-9.25 days) of *P. latus* in the present study were much similar to those observed by Vieira and Chiavegato (1999) and Al-Ani and Al-Jboory (2008) in the preoviposition period and Karmakar *et al*. (1996) in oviposition period. However, Namvar and Arbabi (2007) and Al-Ani and Al-Jboory (2008) recorded longer preoviposition (1.3 days) and shorter oviposition (3.15 days) periods, respectively when fed on potato. Total number of *P. latus* eggs (26.42-31.58) and its daily rate of egg laying (3.41-3.43) in the present study were in agreement with those mentioned by Karmakar *et al*. (1996) and Namvar and Arbabi (2007) in number of eggs and Al-Ani and Al-Jboory (2008) in daily rate. However, the latter parameter was higher (5.6) when fed on *Citrus limon* leaves (Vieira and Chiavegato, 1999) and fruits (Vieira, 2001). Number of eggs was lower (10.0) in potato (Al-Ani and Al-Jboory, 2008). These differences are probably due to different host plants.

Longevity of male (7.83-8.71days) and female (7.18-7.84 days) life cycles in *P. latus* were almost similar to those obtained by Silva *et al*. (1998), Dhooria (2005), Kavitha *et al*. (2007) and Al-Ani and Al-Jboory (2008). On the other hand, Das and Singh (1998), Vieira and Castro (1999) and Chauhan *et al*. (2002) found that the life cycle of *P. latus* was 5, 3.02 and 4.17 days on citrus, jute, cotton and mulberry, respectively which may be due to different host diets. Generation time (7.9-8.52 days) in the present study was much similar with that obtained by Vieira and Chiavegato (1998) and Al-Ani and Al-Jboory (2008). Sex ratio in favor of females was recorded in most of the previous and present studies.

Results showed that Abamectin, Liquid sulfur and Canola oil proved to be effective insecticides against adult *P. latus*. Orange oil, *Beauveria bassiana* and Matrine showed moderate efficiency and finally Azadirachtin caused slight effect. These results are in great accordance with those obtained by Karmakar *et al*. (1996), Herron *et al*. (1996), Leonel *et al*. (1999), Dos Santos *et al*. (1999), Raj (2001), Rai and Solanki (2002), Srinivasulu *et al*. (2002), Misra (2003), Hath and Chakraborty (2004), Reddy and Kumar (2006), Pereira *et al*. (2007) and Venzon *et al*. (2008) who stated that Abamectin, Liquid sulfur and Canola oil were the most effective in reducing population density of *P. latus*, followed by Azadirachtin extracts. However, Rajasri *et al*. (1991) and Pena *et al*. (1996) showed that *Beuvaria bassiana* treated plants had greater percentage of *P. latus* mortality. Also, Lascar and Ghosh (2005) and Reddy *et al*. (2007) found that the use of Azadirachtin preparations for controlling *P. latus* gave moderate impact.

Concerning the effect of the tested compounds on immature stages and eggs, results revealed that Abamectin followed by Liquid sulfur and Canola oil showed high efficiency. Orange oil had moderate efficacy, while *Beauveria bassiana*, Matrine and Azadirachtin

caused slight effect. These results are in great accordance with those obtained by Herron *et al*. (1996), Srinivasulu *et al*. (2002), Misra (2003), Reddy and Kumar (2006), Pereira *et al*. (2007) and Venzon *et al*. (2008). However, Pena *et al*. (1996) noticed that *Beauveria bassiana* had stronger effect on the above stages and Reddy *et al*. (2007) found that Azadirachtin gave moderate effect. Highest efficiency of Abamectin over other pesticides against *P. latus* is probably attributed to the binding effect of avermectins to the glutamate-gated chloride channels expressed on neurons and muscle cells (Wolstenholme and Rogers, 2005). The latter authors reported that the activated channels open very slowly but essentially irreversibly, leading to a very long-lasting hyperpolarization or depolarization of the above cells and therefore blocking further function. However, the use of any chemical as a pesticide selected for agricultural use depends on its environmental fate. Abamectin neither persists nor accumulates in the environment rapidly degrades in water and its strong binding to soil limits its bioavailability.

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