Resistant Pest Management Newsletter

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Letter from the Editors

Online Registration

The Arthropod Pesticide Resistance Database (APRD) (http://www.pesticideresistance.org/) is a gateway search engine for arthropod resistance detailing thousands of resistance cases since the 1914. This database is the only comprehensive and arthropod resistance resource in the world. In 2006, the web site received over 540,000 visits lasting 10 minutes or longer. The Database contains extensive resistance information and is recognized as the world's largest repository for data including:

1. Resistance case date, location and author(s),
2. Resistant arthropod classification,
3. Pesticide(s) involved in the resistance case,
4. Mode of action,
5. Bioassay methods and life stage(s),
6. LD50s, fiducial limits, discriminating doses, resistance levels, impact of the resistance, and cross resistance information,
7. References (laboratory data, peer review journal article, unpublished manuscript, etc.), and
8. Statistical summary information.

Parts of the database have been available online since 1992, but until now it has not provided interactive features or online submissions and better search features. You can search this database by:

- Order
- Family
- Genus
- Active ingredient
- Mode of action
- Location
- Year
- Reference

The Database editors and staff are also **ANNOUNCING A NEW FEATURE in 2007:** The **ONLINE SUBMISSION OF RESISTANCE CASES**. This feature will **ALLOW RESISTANCE WORKERS TO PUBLISH** their work through a web-based peer review process.

The submission process is simple and peer review decisions usually take less than two weeks. To make a submission, simply go online and register by filling out a request for an access password. One of the Chief Editors will contact you with a password and you can submit your resistance case(s) directly to the Editorial Board composed of respected resistance scientist from around the world. Following submission of the new resistance case, a confirmation email will be sent stating that the submitter's case has been received and sent out for review. Before submitting any resistance case, please, make sure that it is not already cited in the resistance database.

Following successful peer review, new resistance cases will be published in the database and the author's name and affiliation duly acknowledged and PUBLISHED BOTH IN THE DATABASE AND IN THE **Resistant Pest Management Newsletter**.

To register online, connect to http://www.pesticideresistance.org/signup/ click on "**apply online**", go to and fill out the registration request form. The fields in the form marked with a red "*" must be completed before the submission request will be accepted; all other fields are optional. Once the form is submitted a verification email will be sent to the email address that you entered into the form. Click on the link or paste the address into your browser to verify the registration request. In about 24 hours, a confirmation email will be sent to your account stating that you are now registered with the database. You chose your own Login ID and password during the registration process. There is no recovery feature for this information, so please record this information when registering.

Anyone can access the database and search through its tables and view multiple searches. However, only registered members (password gated) can submit a new case for publication to the database.

Resistance Management from Around the Globe

Assessment of Acute Toxicity of Insecticides for Monitoring Insecticide Resistance in Rice Leaffolder,*Cnaphalocrocis Medinalis* (Guenee) in Tamil Nadu, India

KEY WORDS: Insecticide resistance, *Cnaphalocrocis medinalis*, Discriminating dose.

The leaffolder complex composing of *Cnaphalocrosis medinalis* (Guenee), *Marasmia* (= Susumia) *exigua* Butler), *M. bilinealis* (Hampson), *M. patnalis* (Bradley), *M. ruralis* (Walker), *M.suspicalis* (Walker) and *M. trapezalis* (Guenee) causes significant damage to rice in Tamil Nadu. In the complex, *C. medinalis* is the predominant (>80%) species (Gunathilagaraj and Gopalan, 1986; Rajendran and Gopalan, 1987; Subramanian 1990) in Tamil Nadu.

The frequent use of certain insecticides leading to the development of insecticide resistance is not uncommon (Endo et. al. 1987; 1993, Endo and Kozano,1988; Xiao et. al ,1994). The rice leaffolder *C. medinalis* resistance to insecticides has been used for many years against this pest.

For effective implementation of resistant management practices, it is essential to have some estimate of changes of resistance levels throughout the area where a particular chemical is applied (Taylor, 1983). These estimates rely on initial baseline levels of susceptibility and variability in populations so that future comparisons can be made (Georghiou and Mellon, 1983; Hopkins et. al., 1984).

In Tamil Nadu, the commonly used insecticides are monocrotophos, phosphamidon, quinalphos and chlorpyriphos. The present study was undertaken to create base-line data for a few widely used insecticides in the control of rice leaf folder, *C.medinalis*.

MATERIALS AND METHODS Uniform and continuous culture of the leaffolder *C. medinalis*, without exposure to insecticides was maintained on TN-1 potted rice plants, a highly susceptible variety to rice leaffolder in Paddy Breeding Station (PBS), Tamil Nadu Agricultural University, Coimbatore.

Four commonly used insecticides, *viz.* monocrotophos (70%, Hindustan Ciba-Geigy Ltd., Mumbai), quinalphos (69%, Sandoz (India) Ltd., Mumbai), chlorpyriphos (97.5%, Cynamid (India) Ltd., Mumbai) and phosphamidon (94.7%, Hindustan Ciba-Geigy Ltd., Mumbai) used in rice were chosen for this study.

Fourth instar larvae weighing 20-30 mg selected for assay were placed in a glass vial (9 cm long and 2 cm dia) and anesthetized by CO_2. The topical application was made with a calibrated 1 µl single needle guided plunger syringe as 0.5 µl unit of acetone containing a predetermined concentration of technical insecticide. Application was made to the dorsal prothorax of the insect. The control insects were treated with analytical reagent acetone alone. The treated larvae were transferred to clear plastic cups (8.5 cm dia at base) lined with moistened filter paper @ 10 larvae/cup and provided with cut leaves. The moisture from filter paper maintained the turgidity of leaves. The cups were covered with snugly fitted lids and were held inside an environmental chamber with a constant temperature range of 25 ± 2°C, 70 ± 5 per cent relative humidity and 12 h light. Mortality was recorded 24 and 48 h after treatment (HAT). Larvae were considered dead if they did not move when probed or if they could not right themselves within 14 seconds when placed off their ventors.

This test was conducted on larvae for first generation and then from each generation starting from fifth generation in greenhouse cultured population without exposure to any insecticide. In the field collected populations, larvae from first generation were used and LD_{50} and LD_{95} were estimated for population collected from each location. The corrected percentage mortality was worked out using the Abbot's formula (Abbott, 1925). Log-dose-probit mortality lines were computed by probit analysis (Regupathy and Dhamu, 2001).

Larval populations were collected from different predominant rice growing areas in Tamil Nadu, *viz.* Coimbatore, Thanjavur, Bhavani and Killikulam to assess the relative level of resistance/susceptibility to these insecticides using the discriminating doses arrived at. Collections were made where the insects were reasonably abundant.

RESULTS AND DISCUSSION The toxicity of insecticides was in the order of monocrotophos, quinalphos, chlorpyriphos and phosphamidon irrespective of generations studied by topical method.

The insect became more susceptible through eight generations of insecticide exposure-free culturing. The susceptibility of *C. medinalis* population by cutting exposure to insecticide increased. The extent varied with chemical used. The susceptibility index at LD_{50} was 1.518, 1.511, 1.185, 1.415 for monocrotophos, quinalphos, chlorpyriphos

and phosphamidon, respectively; the index at LD_{95} was 1.483, 1.154, 1.055 and 1.262, respectively.

The slope functions of log-dose-mortality for the F_1 Coimbatore population were 1.710, 1.783, 2.403 and 2.511 for monocrotophos, quinalphos, chlorpyriphos and phosphamidon respectively. For the F_8 Coimbatore population, the respective figures were 1.604, 1.568, 2.330 and 2.333. The steepness of slope did not differ significantly as far as susceptibility of the pest to different insecticides was concerned. The decrease of slope was 6.2 per cent for monocrotophos, 17.6 for quinalphos, 7.2 per cent for chlorpyriphos and 7.08 for phosphamidon.

The susceptible level gradually increased with the succeeding generations which is evident from decline in LD_{50} and LD_{95} values to all the insecticides barring chlorpyriphos (Table 1) and susceptibility index. Such reversion during relaxation of selection pressure has been demonstrated in other insects like *Aedes aegyptii* (Linnaeus) (Abedi and Brown ,1960), *Plutella xylostella* (Linnaeus) (Chandrasekaran and Regupathy. 1996) and *Nilaparvata lugens* (Stal) (Sujatha, and Regupathy ,1997).

The susceptibility base-line-data (LD_{50}) of monocrotophos for *C. medinalis* generated through the network for Asian rice growing countries by topical assay method is 0.003 µg/individual. Such base-line data are not available for other insecticides taken for this study. Based on the slope function and increased susceptibility, the following discriminating dose screen for testing the *C. medinalis* populations was arrived at: monocrotophos 0.35 µg, quinalphos 0.50 µg, chlorpyriphos 1.0 µg and phosphamidon 5.5 µg.

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Table 1. Acute toxicity of certain insecticides to fourth instar *C. medinalis* of TNAU culture by topical application

Generation	Monocrotophos			Quinalphos			Chlorpyriphos			Phosphamidon		
	b	LD_{50}	LD_{95}	b	LD_{50}	LD_{95}	b	LD_{50}	LD_{95}	b	LD_{50}	LD_{95}
1	1.7106	0.0546	0.5005	1.7837	0.0712	0.5985	2.4032	0.2534	1.3586	2.5111	1.5074	6.8112
5	1.7852	0.0487	0.4069	1.6628	0.0575	0.5612	2.1431	0.2296	1.3420	2.3396	1.3447	6.7860
6	1.7173	0.0452	0.3681	1.6960	0.0573	0.5391	2.3180	0.2287	1.1670	2.3512	1.3028	6.5205
7	1.7392	0.0388	0.3433	1.5973	0.0484	0.5186	2.4970	0.2281	1.0396	2.4285	1.2248	5.8260
8	1.6047	0.0360	0.3375	1.5688	0.0471	0.5112	2.3306	0.2245	1.1405	2.3331	1.0651	5.3979

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Whitefly-*Bemisia tabaci* Biotype Survey of Urban and Urban-Field Interfaces in South and Central Arizona

The Q biotype (Guirao et al., 1997), which is native to Spain, with its closest relatives in the Mediterranean region, (Brown, 2000; Brown et al., 1995), was discovered for the first time in the U.S.A. in commercial poinsettia plants in Tucson, Arizona, during the winter of 2004-05 (Brown et al., 2005; Dennehy et al., 2005). The Q biotype has become a major pest and/or virus vector in vegetable and ornamental crops in portions of the Mediterranean region, including the Canary Islands, Israel, and Spain, and in European greenhouses (Brown, 2007; Guirao et al., 1997). Most recently its presumed introduction on ornamental plants has been reported in China, Japan, and Mexico (Chu et al., 2006; Martinez-Carillo and Brown, 2007; Ueda et al., 2006). Early detections have been consistently associated with poinsettias. Populations of the Q biotype have been reported to express resistance to a number of insecicides that are otherwise effective against the now widely distributed exotic B biotype (Dennehy et al., 2006), of African-Middle Eastern origin (Brown, 2000; Brown et al., 1995; Costa and Brown, 1991). Determing the distribution of the Q biotype and developing contingency plans for its management are urgently needed to protect cotton, vegetable, and greenhouse crops in Arizona, and the U.S.A. in general.

The objective of this study was to collect, identify, and determine the biotypes of *Bemisia tabaci* that are present in southern Arizona. Sampling was done at several urban-agricultural interfaces to determine if the Q biotype could be found on ornamental hosts and if they had established in urban centers and/or adjacent fields. The sampling period was Jan.–Dec. 2006 and locations were concentrated near Phoenix and Tucson. The unusual, wet spring experienced in Arizona precluded sampling during the spring as planned. Populations did not build to significant levels in fields until the fall season, and thus most samples were collected in the fall. Several samples were collected from or near commercial or university greenhouse facilities.

Biotypes (Bedford et al., 1994; Brown, 2007; Brown et al., 1995; Costa et al., 1991, 1993) were identified using the established mitochondria cytochrome oxidase I (mtCOI) sequence as a molecular (DNA) marker (Brown, 2000; Frohlich et al., 1999; Viscarret et al., 2003). Individuals were collected live into 95% ethanol. Adults were ground in 5µl lysis buffer on a strip of parafilm using a plastic pestle. Thirty-five µl lysis buffer was added and the mixture was incubated at 65°C for 15 min. and then at 95°C for 10 min. Tubes with lysis were stored on ice while PCR reactions were prepared. A pair of mtCOI primers was used to amplify the target sequence (~820 bp) and initially were obtained from the UBC Insect Mitochondrial DNA Primer Oligonucleotide Set, compiled by B. J. Crespi and C. Simon (Simon et al., 1994). PCR primer sequences are: C1-J-2195 MTD-10 TTG ATT TTT TGG TCA TCC AGA AGT and L2-N-3014 MTD-12 TCC AAT GCA CTA ATC TGC CAT ATT A. These primers have been optimized and extensively validated for biotype differentiation using hundreds of samples collected from representative locations worldwide (Brown, 2000). PCR products were analyzed by agarose (1%) gel electrophoresis and visualized by staining with ethidium bromide. PCR products of the expected size (850 bp) were obtained for all samples shown in Table 1. PCR products were cleaned, quantified, and the DNA sequence was determined. Sequences were edited and subjected to comparative analysis by alignment with a suite of references sequences for a large number of haplotypes and biotypes available in the Arizona laboratory (Brown, 2007; 2000; Costa and Brown, 1991; 1993).

All 2006 samples analyzed were the B biotype of *B. tabaci*. Thus, in this survey the Q biotype was not detected in crops, weeds, vegetable gardens, or poinsettias in Arizona during 2006 (Table 1). This is positive news, and suggests that the Q biotype has not established outside of greenhouse environments in Arizona. However, monitoring of the Q biotype since 2005 by the Whitefly Biotype Q Task Force indicates that the Q biotype is found in greenhouses in 22 states (http://mrec.ifas.ufl.edu/LSO/bemesia/positive_states.htm). It is still too early to predict the eventual distribution of the Q biotype. The time required for the Q biotype to adapt to different hosts and field conditions is likely to vary depending on host suitability, competition with B biotype, fecundity, insecticide use on the host, and other factors. Effective management with appropriate insecticides, importation of whitefly-free plant materials, and diligent monitoring are still needed to ensure successful control and prevent establishment in fields of yet another potentially damaging variant of *B. tabaci*.

Table 1. Biotype identification of *Bemisia tabaci* collected from different host plants in south and central Arizona during 2006

Host	Date Collected	I.D./Tested	Biotype	Location
Lantana	7/19/2006	3 of 3	B	Phoenix
Weeds	7/19/2006	3 of 3	B	Phoenix
Watermelon	7/19/2006	10 of 10	B	Phoenix
Ornamentals	7/20/2006	8 of 8	B	Phoenix
Cotton	7/20/2006	10 of 10	B	Phoenix
Cotton	7/20/2006	10 of 10	B	Phoenix
Ornamentals	7/20/2006	7 of 7	B	Queen Creek
Cotton	8/10/2006	10 of 10	B	Tucson
Squash	8/10/2006	10 of 10	B	Tucson
Sesame	8/15/2006	10 of 10	B	Tucson
Tomato	11/2/2006	5 of 5	B	Surprise
Poinsettia	11/15/2006	10 of 10	B	Phoenix
Poinsettia	11/16/2006	10 of 10	B	Phoenix
Poinsettia	11/17/2006	10 of 10	B	Mesa
Poinsettia	11/17/2006	10 of 10	B	Phoenix
Poinsettia	11/17/2006	5 of 5	B	Phoenix
Poinsettia	11/21/2006	10 of 10	B	Mesa
Malva parviflora	11/5/2006	10 of 10	B	Tucson
Squash	11/6/2006	10 of 10	B	Tucson
Tomato	11/25/2006	10 of 10	B	Tucson
Lantana	12/15/2006	7 of 7	B	Glendale
Poinsettia	11/22/2006	10 of 10	B	Tucson
Cotton	9/2/2006	10 of 10	B	Marana
Cotton	9/2/2006	10 of 10	B	Maricopa

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The situation of insecticide resistance of Brown planthopper in Mekong Delta, Vietnam.

Brown planthopper (BPH) is the main target rice insect to production in Mekong Delta. The BPH has been the most serious insect pest of rice in S. Vietnam since 1970 based on hopper burns occurring in 1978, 1991, and 1992. The BPH population and infected area are usually much higher and larger than those before 1990 but the severity of damage is not much larger in several years from 1993 to 2005.

The areas infested with BPH and average population densities of BPH declined compared to those five years ago. The recent population decline mainly resulted from unfavorable weather conditions, especially due to typhoons and floods in September and October in 1999-2003. Diversification of genetic background for resistance to BPH in rice varieties is also attributed to suppressing the BPH population build-up. However, its virulence has increased gradually becoming the most harmful compared to others in Vietnam.

Then, in the year 2006, a small outbreak of BPH occurred in the area of 210,000 ha. The main causes of this epidemic are the following:

-The stress due to abnormal weather in Mekong Delta which had fog and late raining.

-The gene source of resistance to BPH has been very simple in the past ten years. There is no change besides the resistant genes from varieties as CR94-13, Ptb 33, Ptb 18, Rathu heenati and Babawee except the only one rice variety of AS 996 crossed by the resistant gene of *Oryza rufipogon.*

-The development of BPH on susceptible aromatic rice varieties such as Jasmine 85, MTL 250, Nang thom cho Dao, ST 1, VD 20, etc. and migrating to other moderately resistant varieties as OM 1490, OM 2514, OM 2717, VNĐ 95-20, OM 2517, OMCS 2000, OM 3536.

-The habit of farmers still remained with high seed rates, more nitrogen application and misuse of insecticides in timing of spraying and methods of spraying.

- The development of BPH virulence.

Besides, some information of farmers reveals that several insecticides have been resisted by BPH in Mekong delta, such as imidacloprid and fenobucarb. In April 2006, a pesticide company reported that two imidacloprid insecticides at recommended dose rate (28 and 20 gram ai/ha respectively) gave very good control of BPH in WS 05-06 rice crops, except in Tien Giang and Long An province. After that, in Jan. 2007, they informed that there is evidence of BPH resistance to imidacloprid in Long An province (Figure 1, Tables 1, and Table 2).

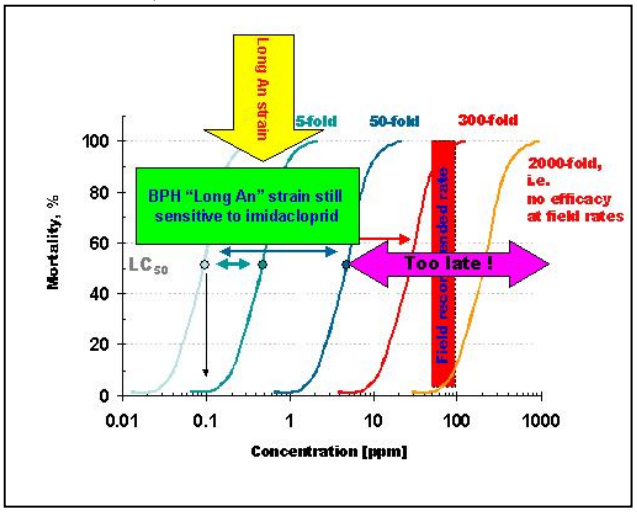


Table 1. Efficacy of Imidacloprid 700 WG demonstration (%)

Province	District	1 DAA	3 DAA	5 DAA	7 DAA	15 DAA
An Giang	An Phu	77	98	90	95	95
An Giang	Cho Moi	74	93	99	99	100
An Giang	Phu Tan	73	92	97	93	95
Dong Thap	Cao Lanh	71	91	91	91	92
Dong Thap	Chau Thanh	75	90	95	98	98
Hau Giang	Long My	70	85	92	91	95
Long An	Moc Hoa				59	
Long An	Tan Hung				70	
Long An	Tan Thanh				72	
Long An	Vinh Hung				60	
Tien Giang	Go Cong Dong	24	61	83		
Tra Vinh	ChauThanh	75	91	95	84	86
Tra Vinh	Tieu Can	72	93	93	87	85

Table 2. Efficacy of Admire 050 EC demonstration (%)

Province	District	1 DAA	3 DAA	5 DAA	7 DAA	15 DAA
An Giang	Chau Phu	50	86	98	98	100
An Giang	Chau Thanh	70	85	89	89	85
An Giang	Thoai Son	78	87	92	93	93
Tien Giang	Go Cong Dong	72	94	94		
Long An	VinhHung – Thuthua – MocHoa		54	73		

In the wet season of 2006, a susceptibility test was carried out at Entomology laboratory (CLRRI) to check the efficacy of some popular use to control BPH in Mekong Delta.

Four application rates, including the recommended rate were, sprayed (table 3) on filter-paper disks with 10 fifth-instar nymphs. Our results show that mortality of Laivung BPH to imidacloprid 700WG, imidacloprid 10WP, buprofezin10WP, fipronil 5SC and etofenprox 10EC were very low (16-62%) when treated at recommended rate and higher rates (table 4).

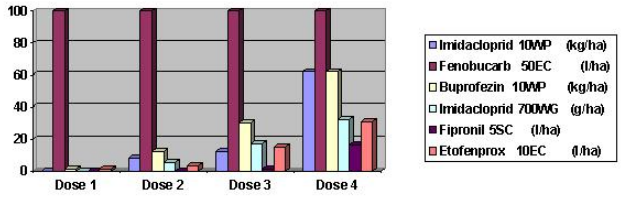
Table 3. Application rate of insecticides

Treatment	Dose 1	Dose 2	Dose 3	Dose 4
Imidacloprid 10WP (kg/ha)	0.2	0.4*	0.6	1.0
Fenobucarb 50EC (l/ha)	1.0	1.2	1.5*	2.0
Buprofezin 10WP (kg/ha)	0.7	1.0*	1.5	2.0
Imidacloprid 700WG (g/ha)	30	40*	50	60
Fipronil 5SC (l/ha)	0.1	0.2	0.3	0.5*
Etofenprox 10EC (l/ha)	0.5	0.7	1.0*	1.5
Untreated control check	water	water	water	water

* recommended rate

Table 4. Mortality of Laivung BPH to insecticides (%) 24 hours after application

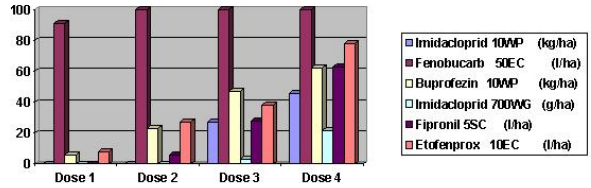
Treatment	Dose 1	Dose 2	Dose 3	Dose 4
Imidacloprid 10WP (kg/ha)	0	8	12	62
Fenobucarb 50EC (l/ha)	100	100	100	100
Buprofezin 10WP (kg/ha)	1	12	30	62
Imidacloprid 700WG (g/ha)	0	5	17	32
Fipronil 5SC (l/ha)	0	0	1	16
Etofenprox 10EC (l/ha)	1	3	15	31
Untreated control check	0	0	0	0
LSD 0.05	1	13	19	32
CV %	58	33	27	40



BPH population of Codo died from 22% to 78% to imidacloprid 700WG, imidacloprid 10WP, buprofezin 10WP, fipronil 5SC and etofenprox 10EC when treated at a higher recommendation rate (table 5).

Table 5. Mortality of Codo BPH to insecticides (%) 24 hours after application

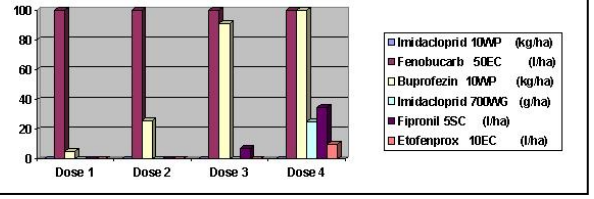
Treatment	Dose 1	Dose 2	Dose 3	Dose 4
Imidacloprid 10WP (kg/ha)	0	0	27	46
Fenobucarb 50EC (l/ha)	91	100	100	100
Buprofezin 10WP (kg/ha)	6	23	47	62
Imidacloprid 700WG (g/ha)	0	0	3	22
Fipronil 5SC (l/ha)	0	6	28	63
Etofenprox 10EC (l/ha)	8	27	38	78
Untreated control check	0	0	0	0
LSD 0.05	9	17	18	26
CV %	59	18	32	34



The susceptibility of Thanhbinh BPH was lowest to imidacloprid 700WG, imidacloprid 10WP, fipronil 5SC and etofenprox 10EC (0-35%) although

Table 6. Mortality of Thanhbinh BPH to insecticides (%) 24 hours after application

Treatment	Dose 1	Dose 2	Dose 3	Dose 4
Imidacloprid 10WP (kg/ha)	0	0	0	0
Fenobucarb 50EC (l/ha)	100	100	100	100
Buprofezin 10WP (kg/ha)	5	26	91	100
Imidacloprid 700WG (g/ha)	0	0	0	25
Fipronil 5SC (l/ha)	0	0	7	35
Etofenprox 10EC (l/ha)	0	0	0	10
Untreated control check	0	0	0	0
LSD 0.05	6	21	12	26
CV %	42	43	89	25

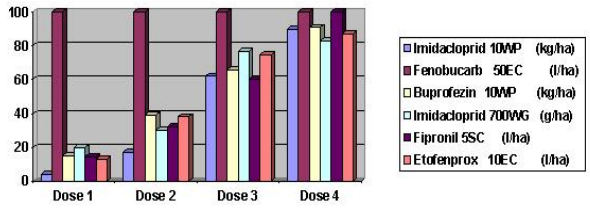


treated at dose 4 (table 6).

Most insecticides caused mortality of more than 50% when Triton BPH is treated at dose 3 and 83-100% when it is treated at dose 4. But imidacloprid 10WP, imidacloprid 700WG, buprofezin 10WP, fipronil 5SC, and etofenprox 10EC were only effective to control BPH when treated at the higher dose than the recommended rate (table 7).

Table 7.Mortality of Triton BPH to insecticides (%) 24 hours after application

Treatment	Dose 1	Dose 2	Dose 3	Dose 4
Imidacloprid 10WP (kg/ha)	4	17	62	90
Fenobucarb 50EC (l/ha)	100	100	100	100
Buprofezin 10WP (kg/ha)	15	39	66	91
Imidacloprid 700WG (g/ha)	20	30	77	83
Fipronil 5SC (l/ha)	14	32	60	100
Etofenprox 10EC (l/ha)	13	38	75	87
Untreated control check	0	0	0	0
LSD 0.05	23	36	33	23
CV %	23	64	37	3



The BPH population was still susceptible to Fenobucarb 50EC, buprofezin 10WP, fipronil 5SC and etofenprox 10EC except imidacloprid 10WP and 700WG (table 8).

Fenobucarb 50EC was most effective to control BPH in Mekong Delta due to the high mortality of all BPH populations.

In conclusion, we can say that BPH populations in Laivung (Dongthap) and in Codo (Cantho) resisted imidacloprid 700WG, imidacloprid 10WP, buprofezin 10WP, fipronil 5SC and etofenprox 10EC, and were only susceptible to Fenobucarb.

While the BPH population in Thanhbinh (Dongthap) was resistant to imidacloprid 700WG, imidacloprid 10WP, fipronil 5SC and etofenprox 10EC, and it is still susceptible to Fenobucarb and buprofezin.

The BPH population in Triton (Angiang) was also resistant to imidacloprid 700WG, imidacloprid 10WP, buprofezin and etofenprox 10EC at the recommended rate but less serious than other population. It is still susceptible to Fenobucarb, fipronil.

The BPH population in Thotnot (Cantho) was only resistant to Imidacloprid, and it is still susceptible to other insecticides.

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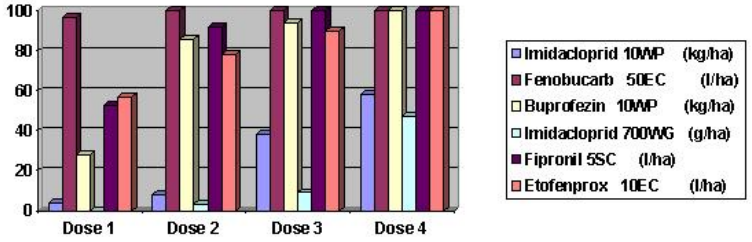
Table 8 Mortality of Thotnot BPH to insecticides (%) 24 hours after application

Treatment	Dose 1	Dose 2	Dose 3	Dose 4
Imidacloprid 10WP (kg/ha)	4	8	38	58
Fenobucarb 50EC (l/ha)	97	100	100	100
Buprofezin 10WP (kg/ha)	28	86	94	100
Imidacloprid 700WG (g/ha)	0	3	9	47
Fipronil 5SC (l/ha)	53	92	100	100
Etofenprox 10EC (l/ha)	57	78	90	100
Untreated control check	0	0	0	0
LSD 0.05	28	22	18	20
CV %	78	76	71	47



Occurrence of resistance to QoI, DMI, and MBC fungicides in Podosphaera xanthii in 2006 in New York and implication for controlling cucurbit powdery mildew

ABSTRACT Monitoring of resistance in commercial cucurbit plantings revealed that strains of the powdery mildew fungus with resistance to QoI fungicides, with moderately high resistance to DMI fungicides and/or with resistance to MBC fungicides were common before these fungicides were applied to cucurbit crops on Long Island, NY, in 2006. QoI and DMI fungicides were ineffective in an experiment there. Based on these results, the fungicides recommended for 2007 are Quintec, Pristine and the DMI fungicide Procure at its highest labeled rate, with all applied in alternation and tank-mixed with protectant fungicides to manage resistance.

INTRODUCTION Application of fungicides continues to be the principal practice for managing powdery mildew in cucurbit crops, but successful control is challenged by development of fungicide resistance (McGrath 2001). While there are varieties with genetic resistant to this disease, an integrated program is recommended to reduce selection pressure for pathogen strains able to overcome the genetic resistance in the plant as well as fungicide resistance. Fungicides effective on lower leaf surfaces, where the disease develops best, are prone to resistance development due to their single-site mode of action. With some fungicides, including MBC (methyl benzimidazole carbamate) fungicides (FRAC Group 1) aka benzimidazoles (e.g. Topsin M) and QoI (quinone outside inhibiting) fungicides (FRAC Group 11) aka strobilurins (e.g. Flint, Cabrio, Amistar), this change renders the pathogen strain completely resistant to the fungicide (qualitative resistance). With other fungicides, including the DMI (demethylation inhibiting) fungicides (FRAC Group 3; Bayleton, Nova, and Procure), pathogen strains exhibit a range in fungicide sensitivity depending on the number of genetic changes they possess that affect the fungicide's ability to function (quantitative resistance). Resistance in the cucurbit powdery mildew fungus has been detected in the US to MBC, DMI, and QoI fungicides, and it has been associated with reduced efficacy of these products (McGrath 2001). The MBC fungicide benomyl was the first fungicide with a single-site mode of action used for powdery mildew on cucurbits. Benomyl-resistant strains were detected in 1967, the first year of field evaluations at US university facilities. This was the first documented case of resistance in the US. Benomyl formulated as Benlate was registered in 1972 for commercial use on cucurbits. The first case of control failure in the field occurred the next year. Bayleton, the first DMI fungicide, was registered for cucurbit powdery mildew in April 1984. The first reported control failure documented through university fungicide efficacy experiments occurred just two years later. Control failure became widespread during the early 1990s. Since resistance to DMIs is quantitative, it was not surprising that Nova, a new DMI being developed at that time, was highly effective when Bayleton failed in university experiments. Nova was registered in May 2000 and another new DMI, Procure, in May 2002. Further shift to a higher degree of DMI insensitivity did not appear to be occurring and these two DMIs were still highly effective when evaluated on Long Island in 2005, providing 82% and 93% control (McGrath and Davey, 2006). Quadris was the first QoI fungicide available for commercial use for powdery mildew on cucurbits in the US. Section 18 emergency exemptions were granted in some states in 1998 because of control failures due to resistance to Bayleton. US federal registration was granted for Quadris in March 1999. Additional QoI fungicides were registered subsequently. Resistance to QoIs was first detected in the US in 2002 (McGrath and Shishkoff 2003). Control failures were reported from several states throughout the US. Impact on control was dramatic, with failure occurring where QoIs were highly effective the previous year, reflecting the qualitative nature of resistance to this group of fungicides.

A resistance monitoring program was started in 2003 on Long Island, NY. This was done because to use fungicides at-risk for resistance wisely, growers need to know the proportion of the pathogen population that is resistant before the first application and how much the population changes with use. In 2003, QoI resistant strains were shown to be present at a low level at mildew onset, their frequency increased greatly during the season, efficacy was affected, and they occurred in pumpkin crops not treated with QoIs (McGrath 2004). Strains with moderate resistance to DMI fungicides were also present. In 2004, strains of the powdery mildew fungus with resistance to QoI fungicides, with moderate resistance to DMI fungicides and/or with resistance to MBC fungicides were common at mildew onset (McGrath 2005b). This information on resistance occurrence, combined with demonstrated superior control with a new fungicide, Quintec, provided justification for granting registration of this new fungicide in NY as an emergency exemption under Section 18 of FIFRA in 2004-2006.

The goal of the work presented here was to conduct the resistance monitoring program in 2006 on Long Island, NY.

MATERIALS and METHODS Fungicide resistance was monitored on Long Island during the 2006 growing season using the seedling bioassay that was used in 2003 (McGrath 2004). Pumpkin seedlings were treated

with fungicide (Flint, Nova, Topsin M, Quintec, Endura), then placed with non-treated seedlings in production and research fields where powdery mildew was developing. Both spray and dip application methods were used and compared. The seedlings were kept in a greenhouse until symptoms of powdery mildew were visible, which took at least one week. Then severity (percent tissue with symptoms) was visually estimated for each leaf. Frequency of resistant pathogen strains in a field was estimated by calculating the ratio of severity on fungicide-treated plants relative to non-treated plants for each group, then determining the field average. Only one representative fungicide in each group is needed because of cross resistance. Several concentrations of Nova were used because DMI resistance is quantitative. Isolates able to tolerate 80 ppm ai Nova, applied as a spray to upper leaf surfaces, are considered to have a moderate-high level of DMI resistance. This is similar to 40 ppm applied to both surfaces by dipping, the procedure used in previous monitoring studies. Quintec and Endura were used in the third (last) bioassay at the end of the season to obtain data on current level of sensitivity to these fungicides, which will be valuable for determining in the future if the pathogen is becoming less sensitive to these fungicides. The active ingredient in Endura, boscalid, is one of the two in Pristine, which is registered for use on cucurbits. The other active ingredient in Pristine is a QoI fungicide.

RESULTS and DISCUSSION For the first assay, seedlings were placed on 26 July at four sites in four spring commercial plantings of squash and a research squash field at LIHREC. Only one planting had been sprayed prior with a fungicide at high-risk for resistance development (Quadris). Resistance to QoIs was found, often at a high level, in all five fields (Table 1). Interestingly, frequency of resistant strains was lowest in the organically-managed field (Farm 2) and second lowest where a QoI fungicide had been applied to the crop once before the bioassay was done (Farm 3). Although Topsin M is rarely used on cucurbit crops since resistance development resulted in control failures in the 1970s, resistance to MBCs was usually at a higher frequency than QoI resistance, which indicates strains of the pathogen with MBC resistance are fit and able to compete with sensitive strains in the absence of selection pressure from fungicide use. Strains of the pathogen moderately-high resistant to DMIs (able to tolerate 40 ppm Nova) also occurred in all fields and often at a high frequency.

The second assay was conducted in six commercial pumpkin fields and two research pumpkin fields at LIHREC on 8 Aug. Resistance to QoIs and MBCs and moderate resistance to DMIs were again common (Table 1). A higher concentration of Nova (80 ppm) was included in this assay. A low frequency of isolates able to tolerate this concentration were detected in a few fields, including at LIHREC where in a fungicide efficacy experiment neither Nova nor Procure, another DMI fungicide, when tested alone on pumpkin were effective, in sharp contrast with 2005.

A third assay was conducted in pumpkin fields on 13 Sep. A very low frequency of isolates were detected able to tolerate 10 ppm Quintec. A higher frequency were able to tolerate 150 ppm Endura.

The high frequency of resistance to QoI and DMI fungicides detected through this monitoring study was associated with ineffective control of cucurbit powdery mildew with QoI and DMI fungicides in a fungicide efficacy experiment conducted at LIHREC with pumpkin in 2006 (McGrath and Davey 2007). The

Occurrence of resistance to QoI, DMI, and MBC fungicides in *Podosphaera xanthii* in 2006 in New York and implication for controlling cucurbit powdery mildew

Table 1. Proportion of cucurbit powdery mildew fungal population estimated to have moderate-high level of DMI resistance, QoI resistance, and MBC resistance based on results from a fungicide sensitivity seedling bioassay.

	DMI moderately-high resistant isolates (%)		QoI resistant isolates (%)		MBC resistant isolates (%)	
Site	7/26	8/8	7/26	8/8	7/26	8/8
1	86		48		81	
2	63		5		78	
Cornell LIHREC	58	83	48	55	50	69
3 (Organic)	67	13	26	18	89	76
4	38	20	24	36	71	85
5		19		22		63
6		4		10		63
7		0		100		100
8		26		15		72
9		21		49		86
10		21		51		85

[z]blank indicates bioassay not conducted at that site on that date.

QoI fungicide Cabrio and the DMI fungicides Procure and Nova (at both rates tested) provided poor to no control of powdery mildew. Procure and Nova were among the most effective products in a similar experiment conducted in 2005 (McGrath and Davey 2006). Nova was tested at the lowest and highest label rates, which provide 1 and 2 oz/A of myclobutanil, the active ingredient. Procure was tested at the middle label rate (3 oz/A triflumizole). Procure was effective in a near-by experiment with butternut squash however, which may reflect crop differences in quantity of fungicide uptake into leaves. Pristine (89% control), which has the same active ingredients as Cabrio (pyraclostrobin) and Endura (boscalid), provided control on the lower leaf surfaces that was similar to Endura (90% control), thus there was no indication of synergistic activity. Endura was used as a tool to investigate activity of Pristine; it is not registered for this use. When Procure was applied in alternation with either Quintec or Pristine starting with Procure, powdery mildew was not controlled as effectively as the alternation product used alone based on AUDPC for the lower leaf surface. The alternation treatment that started with Quintec was as effective as Quintec alone. In conclusion, isolates of the powdery mildew fungus with resistance to QoI and/or MBC fungicides were common before these fungicides were applied to cucurbit crops on Long Island, NY, in 2006, as also occurred in 2005. Therefore fungicides in these groups are not recommended for controlling cucurbit powdery mildew. There appeared to be more isolates with a higher level of resistance to DMI fungicides in 2006 than in 2005. The highest concentration of Nova (40 ppm myclobutanil) tolerated by a high proportion of isolates (37%) in 2006 had been tolerated by few individual isolates tested in previous laboratory assays (10% in 2005 and 5% in 2004)(McGrath and Davey 2006, McGrath 2005a). This concentration was not used in previous bioassays. This apparent shift in the pathogen population was associated with a dramatic loss in efficacy of DMI fungicides (McGrath and Davey 2006, 2007).

The fungicide program currently recommended for managing powdery mildew in cucurbits and resistance entails alternating among high-risk fungicides with different modes of action and mixing these with protectant fungicides. Quintec, Pristine and Procure are considered the current best choices for managing powdery mildew in cucurbit crops. Quintec is only labeled for use on melons. Procure should be used at the highest label rate (8 oz/A), which is equivalent to twice the amount of active ingredient as in the DMI fungicide Nova at its highest labeled rate of 5 oz/A. There unfortunately is not efficacy data from NY to confirm that this higher rate would be more effective on pumpkin than the 6 oz/A rate tested.

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BIOCONTROL OF (*Paratrioza cockerelli*) IN HUSK TOMATO (*Physallis ixocarpus*), IN JALISCO, MEXICO

INTRODUCTION A new plague that is distributed throughout Mexico was recently incorporated to the list of insects that attack the tomato cultivation, mainly solanaceae cultivations.

This new plague is commonly called tomato psílido, but some also call it "plant louse jumper" and "salerillo" (Garzón 1987). Three common names have been used for this tomato psílido insect: potato psílido and potato and tomato psílido. At the present moment, the American Society of Entomology only recognizes of the first of the common names of the insect and organism (Stoetzel, 1989).

During the last three years in the valley of Culiacan, the immature stages of this insect have been

mainly detected; however, during the 2001-2002 autumn-winter agricultural cycle a bigger population was presented, requiring control to diminish populations in the chili and tomato cultivations.

OBJECTIVES Evaluate the biological effectiveness of different insecticides of chemical and biological origin for the control of *Paratrioza cockerelli* in the cultivation of husk tomatoes.

MATERIALS AND METHODS An experiment was conducted in the area of Citala, Municipality of Teocuitatlán, Jalisco, in the cultivation of husk tomato (*Physalis ixocarpa*) for 30 days of emergency. Four applications were made in intervals of 7 days.

Entomopathogen fungus, plant extracts and chemical synthesis products were evaluated (Table 1).

Table 1. Evaluated Treatments to Determine the Biological Effectiveness of Different Products for the Control of *Paratrioza cockerelli*.

TREATMENT	DOSE/ HECTARE Comercial Product/Ha.	Gr. A.I./ha.
1. Nicothiadine	200 g. P.C	100.0
2. Beauveria bassiana	1000 ml. P.C	2.3×10^7 viable fungus conidia's
3. Flufenoxuron	250 ml. P.C	12.5
3. Mineral Oil	2000 ml. P.C	ND
4. Azadiracthine	1000 ml. P.C.	45.0
5. Fipronil	500 ml. P.C	100.0
6. Cypermethrine	500 ml PC	100.0
7. Witness without applying		

* To all the treatments a non ionic surfactant was added in a proportion of 0.25% v/v.

A complete randomize design was used with eight treatments and four replicas, carrying out previous sampling plus 4 after the application. The sample was integrated by 40 leaves randomly taken at each replica, which were transferred to the laboratory of urban plague control at the CUCBA, where the number of live Nymphs in each leaf was determined with the help of a stereoscope. With the obtained data the percentage of effectiveness was determined using Abbott's Formula, correcting the mortality by the witness without applying data. With the obtained effectiveness data, ANOVA and Tuckey's media were carried out to 5% of significance. Following, you can see the results of the four applications.

RESULTS AND DISCUSSION The objective plague to evaluate was the Paratrioza (*Paratrioza cockerelli*) nymphs that were an abundant enough population to evaluate the proposed insecticides.

In the previous sampling, a population average of 4.0 nymphs per leaf was present. In the witness without applying, at the end of the evaluation period, a population of 5.5 nymphs per leaf was obtained. This plague incidence was considered enough to approve the treatments in question. The rehearsal began observing that the incidence of the plague during the experiment was enough to measure the biological effectiveness of the products. With the data of the previous sampling, ANOVA was carried out in which significant differences were not observed among the treatments, which allowed the establishment of the experiment under the experimental design proposed.

In table No. 2 that corresponds to the percentage of control of paratrioza nymphs, it is observed that after four applications of the treatments with intervals of 7 days, significant differences were not present among the treatments; however there are numeric differences among the treatments. It is necessary to point out that the best treatments after three applications in intervals of 7 days were as follows: in the first group treatment 3 (Flufenoxuron 12.5 gr. A.I./Ha.) and treatment 4 (Mineral Oil 2000 ml./Ha.) with 95% of average control after four applications, in the second group treatments 1 (Nicothiadine 100 gr. A.I./Ha.) and treatment 6 (Fipronil 100 gr. A.I./Ha.) with 90% control average respectively, in the third group treatment 5 (Azadiracthine 45.0 gr. A.I. /Ha.) and in the fourth group treatment 2: (Beauveria bassiana 2000 ml. /Ha.) and treatment 7 (Cypermethrine 100 gr. A.I./Ha.) with 70% of average control respectively.

Table No. 2. Average number of nymphs of Paratrioza (*Paratrioza cockerelli*) per leaf. Control percentage and comparison of Tukey's media at 5% of Significance in husk tomato cultivation in the Citala Area, Teocuitatlán, Jalisco. 2006.

TREATMENT	gr. A.I./Ha.	PRE-VIOUS	7 Days after 1ª Aplc.	7 Days alter 2ª Aplic.	7 Days after 3ª Aplic.	7 Days after 4ª Aplic.
1. Nicothiadine	100.0	4.18 ab	1.1**/77.7* b	0.18/95.7 c	0.12/97.6 b	1.8/78.0 b
2. Beauveria bassiana	2.3×10^7 conidia's	4.67 ab	5.2/0.0 a	0.25/94.3 c	0.15/97.0 b	1.1/86.0 b
3. Flufenoxuron	12.5	4.15 ab	0.46/90.9 b	0.15/96.4 c	0.06/98.0 b	1.1/87.0 b
3. Mineral Oil	ND	5.56 a	0.43/91.5 b	0.21/95.0 c	0.09/98.0 b	0.9/89.0 b
4. Azadiracthine	45.0	4.90 ab	2.71/47.5 ab	0.4/90.78 c	0.25/95.2 b	0.7/91.0 b
5. Fipronil	100.0	5.43 ab	1.5/70.48 b	0.68/84 bc	0.18/96.4 b	0.7/92.0 b
6. Cypermethrine	100.0	4.90 ab	1.6/67.4 b	1.5/65.9 b	0.40/92.3 b	1.2/86.0 b
7. Witness without applying	s/a	3.37 b	5.18/0.0 a	4.40/0.0 a	5.28/0.0 a	4.9/0.0 a

* Control percent

It is necessary to mention that after four applications there is an accumulative effect of the product in the plant what would allow spacing the applications in periods of 14 days, since the controls went very similarly to the last sampling after 3rd & 4th application.

It is important to make notice that in none of the cases Phytotoxicity was observed.

CONCLUSIONS

1. In the experiment a considerable incidence of paratrioza (Paratrioza cockerelli) was present at an average of 5 nymphs per leaf in the witness without applying, after five samplings, which allowed to subject on approval the different treatments with the help of Flufenoxuron and Fipronil.
2. Significant differences were observed between the insecticide treatments and the witness without applying. Among the different insecticide treatments significant differences were not observed, but numeric differences were observed.
3. The treatments with the help of Flufenoxuron 250 ml. /Ha. and Fipronil 200 SC in dose of 500 ml./Ha. worked on average, in a similar or better

way than the regional witness in the control of paratrioza nymphs.
4. It is recommended to use the treatments of Flufenoxuron at a dose of 250 ml/Ha. and Fipronil 200 SC at dose of 500 ml/Ha., preferably inserting them between one application and another to not generate resistance.
5. None of the treatments caused phytotoxicity to the cultivation.

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SCENARIO OF INFESTATION AND MANAGEMENT OF EGGPLANT SHOOT AND FRUIT BORER, *LEUCINODES ORBONALIS* GUEN., IN INDIA

Eggplant, a native of India, is grown almost round the year in this sub-continent and is attributed with many local and high yielding varieties. It is an important source of vegetable in South-East Asian countries and has high nutritive and commercial value. Various insect pests and diseases often plague commercial cultivation of eggplant, of which eggplant shoot and fruit borer (ESFB), *Leucinodes orbonalis* Guen, is one of the major constraints contributing up to 70% loss in marketable yield. The pest is active throughout the year on spring, summer, rainy and autumn season crops. Its EIL is reported to be 0.91% on shoots and 0.67% on fruits (Singh and Singh, 2002).

The pest has a specific nature of feeding. It bores into growing tips of young shoots of plants during their early growth phase and later shift to flower buds as well as young fruits on initiation of fruiting. The apparent loss of fruits has been reported to be varying from 20.70 to 88.89% in various parts of the country. The infestation on shoots was observed to be as high as 73.33% during August and reached up to 86.66% in the end of September. A critical stage of infestation shifting to the flowers and fruits follows after that, with 33.33% infestation on shoots and 66.66% on initial fruits.

VARIOUS COMPONENTS OF INTEGRATED PEST MANAGEMENT OF ESFB CURRENTLY BEING FOLLOWED:

A. CULTURAL CONTROL: Cultural control measures are of prime significance in formulating a sustainable pest management program of this pest. Clean cultivation by destroying fallen leaves in eggplant fields will reduce larvae of ESFB pupating in plant debris. Timely and frequent inter-culture operations also help in minimizing the intensity of this pest. Transplanting in the middle of August instead of July for rainy season crop was found to have relatively low incidence of this borer during the fruiting phase of the crop (October to November), due to sudden decline in environmental temperature particularly in Northern part of country, that reduces the insecticidal applications. On the other hand, July planted crop requires more protection technology throughout its vegetative as well as reproductive phase in August – September.

B. PHYSICAL CONTROL: A physical barrier (Nylon net) could be installed erecting from the ground up to 2 m height from ground level around the eggplant crop to prevent the entry and oviposition by the female moths and subsequent damage to crop was suggested by the experts from Asian Vegetable Research and Development Centre, Tiwan (AVRDC, 2000). Mass trapping with pheromone baited traps is found to be a potential eco-friendly alternative technology to control *L. orbonalis.* In further studies, three types of traps *viz.* (Delta sticky trap, Phero-trap and Nomate trap) were assessed for moth trapping. Although Delta trap was found more effective in catching a higher number of moths and reducing shoot and fruit damage, it looses its stickiness over a period of time and as such was required to be replaced 2 - 3 times in a season (Jhala *et al*., 2005). Therefore, Nomate trap, the next best trap, installed at a height of 1.0 m from the ground level was found to be ideal in catching maximum moths during the cropping season.

C. HOST PLANT RESISTANCE: Some wild *Solanum* species, especially *Solanum viarum* (= *khasianum*) and *S. sympifolium*, showed consistent resistance to the pest. However, incorporating the genes for resistance into *S. melongena* proved to be difficult due to breeding incompatibility. At AVRDC, Taiwan, a land race of eggplant code number EG056 showed consistently moderate level of resistance to this pest.

In some genetically transformed hybrids of eggplant *viz.* (MHB-I0, Navkiran, MHB-9 MHB-99, MHB-80, and MHB-4) showed resistance against this pest (Singh *et al*., 2005). MHB-4 was free from shoot borer infestation and others were at par with this hybrid in terms of shoot infestation. Higher shoot infestation in non-transgenic hybrids (0.35 - 4.21%) was recorded in comparison to the transgenics (0 - 1.78%). Fruit yields were also higher in transgenic hybrids (45.60 - 94.86 q/ha) in comparison to non-transgenic (37.11 - 76.71 q/ha). Use of tolerant varieties like Pusa Purple Cluster, Pant Samarat and Pusa Purple Round is also an ecologically sound alternative for management of ESFB. Because of the obvious usefulness of this host plant resistant pest control strategy, breeding of EFSB-resistant eggplant cultivars should not be ignored and needs to be pursued with more focused research.

D. BIOLOGICAL CONTROL: No attempt has been made to import exotic parasitoids into India for the control of ESFB so far. As far as the native biocontrol agents are concerned, scattered information is available on records and reports of biological control using natural enemies of ESFB. The shoot and fruit borer was parasitized by *Peristomerous testaceus* Morl, *Diadegma apostata* (G), *Trathala flavo orbitalis* Cameron, *Eriborus argentiopilosus*, *E. sinicus* (Holgreen), *Phanerotoma* sp., *Campyloneurus mutator* Fab. and *Iphiaulax* sp. (Krishnamoorthy and Mani, 1998). *Trathala flavo orbitalis* is one of the important parasitoids causing considerable larval parasitization. But all the above information remained only on records. No attempts have ever been made to explore, mass multiply and utilize them under field conditions for extensive control of ESFB in India.

Inundative releases of egg parasitoid, *Trichogramma chilonis* in eggplant fields reduced the damage caused by *L. orbonalis*. A release rate of 2.5 lakh adults/ha was attempted to manage the pest population and recorded only about 19% fruit damage at the end. Further reduction in fruit borer damage to 10% was obtained when release of egg parasitoid *T. chilonis* was commenced, coinciding the flower initiation with a release rate of 5.00 lakh adults/ha. From the southern part of India, Visalakshy and Krishnamoorthy (2005) reported that releasing of egg parasitoid *T. chilonis* alone @ 5 lakh/ha minimized infestation of ESFB to 10%, accounting for 80% reduction in borer infestation over control. Release of parasitoid when integrated with weekly spraying of *Bt* formulation @ 1000 g/ha, infestation was 7.4% only. Similarly, a mean borer infestation of 8.3% was recorded when parasitoid release was integrated with spraying of NSKE 4% accounting for 84% reduction over control. In contrast, integration of *Bt* and clipping of damaged shoots with parasitoid release recorded about 7.2% infestation of borers, amounting to 86% reduction over control.

Entomophilic nematodes – EPN (Family: Steinernematidae and Heterorhabdidae) are reported to suppress several insect pests. *In vitro* studies indicated that isolates of *Steinernema* spp. caused 100% mortality of ESFB larvae within 48 h of exposure (Hussaini and Nagesh, 2002). However, in a field study, the infestation varied from 4.4 to 18.1% with a mean fruit damage of 7.9, 7.8 and 7.8% when *S. carpocapsae* was sprayed @ 1.0, 1.5 and 2.0 billion/ha, respectively; that significantly differed from infestation in control. Marketable yield of 28.7, 29.2 and 32.5 t/ha of eggplant were harvested from plots sprayed with 1.0, 1.5 and 2.0 billion/ha of *S. carpocapsae* that were at par to each other but again significantly differed from that of control plots yield (23.8 t/ha).

CHEMICAL CONTROL: Huge quantities of insecticides, alone and in combination, are being used to control ESFB causing ecological pollution in the environment and bad impact on human health. Farmers are still totally depending on this easy adaptable method of pest control and quite often the control failures are being reported across the country. In recent years the pest became resistant to the conventional insecticides due to their indiscriminate use. Unilateral use of the chemical insecticides may be able to suppress the pest incidence in the beginning but in the long run the pest appears in severe form. Hence, change in the group of insecticides having different modes of action, or at least variation in the insecticide selection, is suggested when repeated sprays are necessary. Ali (1994) confirmed that *H. armigera* and *L.orbonalis* have developed resistance to pyrethroid insecticides in Bangladesh. In summer season it has been reported that for controlling ESFB the farmers of Bangladesh are spraying almost daily, where as in West Bengal, India, frequency of application exceed three sprays per week. Under such field conditions the level of natural parasitism recorded was often <2% because of exposure to excessive amounts of insecticides used for control of ESFB. Thus, control failures caused by using many of the insecticides have made management of *L. orbonalis* a challenge in most parts of the country.

Use of soil insecticides like Phorate 10 G and Carbofuran 3 G at the time of planting ensured the protection of the crop from borer infestation during growth phase of the crop and no residual hazards have been reported in early pickings at 55-60 days of the crop. Application of systemic insecticides like dimethoate, monocrotophos or the long persisting contact insecticides like chlorpyrifos or quinalphos may be done in the growth phase as a need based remedy from the attack of borers and other pests as well. The safer insecticides like malathion, endosulfan, deltamethrin etc. may be applied in alternate or in association with *Bt* formulations as per need. The conjugation of *Trichogramma chilonis* released @ 2.5

lakhs/ha and shoot clipping + NSKE (4%) spray was found to reduce fruit damage significantly.

It is thus very imperative from the above information that management of ESFB through sole dependence on insecticides may further accentuate the problem. Control failures are the common feature in farmers' fields who adopted unilateral chemical control strategies. Such insecticide resistant population of ESFB could be managed successfully in the field by integrating various other management strategies *viz.*: clean cultivation, use of resistant/ tolerant varieties, clipping-off of infested shoots and fruits on detection of damage, installation of pheromone traps and baits, inundative releases of parasitoids and integration of biopesticides with need based application of recommended insecticides. However, development of location specific pest management modules to combat ESFB through farmers' participatory research approaches could be appropriate in sustainable management of this pest.

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Management of Insecticide Resistance in Cotton bollworms in Hingoli and Amravati districts of Maharashtra (India)

ABSTRACT Field trials were carried out to study the effect of Insecticide Resistance Management Strategies in management of cotton bollworms on farmers' fields (450) in 30 villages in Hingoli and Amravati districts of Maharashtra during 2004-05. The results revealed that per cent infestation of bollworms in Hingoli and Amravati districts was significantly less in Insecticide Resistance Management plots (7.50 and 8.82, respectively) than non-IRM (15.40 and 15.78, respectively). The population of chrysopids and coccinellids and the yield of seed cotton were significantly high in IRM plots than IRM plots. Economics of treatments in Hingoli and Amravati districts revealed that the number of sprays were reduced by 65.35 and 62.80 per cent while, the cost of plant protection was reduced by 2776.28 and 2822.68 Rs/ha in IRM plots as compared to non-IRM plots.

KEY WORDS: *Bollworms, cotton, insecticide resistance.*

INTRODUCTION Cotton is one of the important commercial crops of India in general and Maharashtra in particular. Damage caused by different insect pests, apart from seasonal factors, has been identified as the main reason for the fluctuating kapas yields and farmers fortunes. Over the past two decades cotton pest management has become complicated and emerged as a tough challenge in recent times. The problem is becoming increasingly difficult due to the development of resistance to almost all the insecticides used especially against bollworms (Armes *et al*, 1992, 1996 and Kranthi *et al*, 2001). Insecticide resistance aggravated the problem of resistance compelling the farmers to use the cocktail mixtures leading to complete collapse of pest control system making cotton production uneconomical, besides adversely affecting the environment. Studies were undertaken during 2004-05 to know the impact of IRM strategies to manage cotton bollworms.

MATERIALS and METHODS Fields trials were conducted on 450 farmers' fields in 30 villages of Hingoli and Amravati districts of Maharashtra. Two treatments viz. insecticide resistance management strategies (IRM) and Non-IRM (Farmers' practice) were designed, evaluated and demonstrated. The IRM package comprised of seed treatment with imidacloprid at 7 g/kg seed, use of sucking pest tolerant genotypes, intercropping with cowpea, soybean, blackgram etc, no

insecticidal spray till 60 days, use of *Trichogramma,* Neem, HaNPV, Endosulfan between 60-90 DAS, use of Spinosad or indoxacarb between 90-110 DAS, endosulfan not beyond 90 days, no organophosphates till 110 days, organophosphates such as quinalphos, chlorpyriphos, profenophos between 110-130 DAS, use of pyrethroids beyond 130 DAS, use of insecticidal sprays based on ETL and hand picking of *Helicoverpa* larvae 2-3 days after spray. All other agronomic recommendations were followed to raise the crop.

RESULTS and DISCUSSION The results (Table 1) revealed that the overall infestation of bollworms (*H. armigera, Earias vittella* Fab. and *Pectinophora gossypiella* Saund.) was significantly less in IRM plots than non-IRM. In Hingoli district, the mean bollworm infestation in IRM plots was 7.50 per cent whereas it was 15.40 per cent in the non-IRM plots. In Amravati district, the bollworm infestation in IRM and non-IRM plots was 8.82 and 15.78 per cent, respectively. The infestation crossed the ETL in non-IRM plots even with more number of sprays.

Table 1. Incidence of bollworms and the population of chrysopids and coccinellids.

Parameter	Treatment	Hingoli district	Amravati district
Bollworm	IRM	7.50 (15.89)*	8.82 (18.01)
Infestation (%)	Non-IRM	15.40 (23.11)	15.78 (24.96)
SE		0.18	0.24
't' value		40.14**	25.37**
Population of	IRM	1.28 (1.33)	1.26 (1.32)
Chrysopids/plant	Non-IRM	1.05 (1.24)	0.87 (1.17)
SE		0.01	0.02
't' value		8.00**	7.90 **
Population of	IRM	2.45 (1.71)	2.10 (1.61)
Coccinellids/plant	Non-IRM	2.00 (1.58)	1.05 (1.24)
SE		0.01	0.02
't' value		11.00**	18.00 **
Yield (q/ha)	IRM	8.87	9.71
	Non-IRM	7.56	8.20
SE		0.14	0.09
't' value		9.35 **	16.77**

* Figures in parentheses are in $\sqrt{x+0.5}$ value

** Significant at 5% level

Similarly the population of chrysopids (Table 1) was significantly more in IRM plots than the non-IRM plots. In Hingoli district, mean population of 1.28 and 1.05 chrysopids / plant was recorded in IRM and non-IRM plots, respectively. In Amravati district, the mean chrysopids population recorded in the IRM plots was 1.26 whereas it was 0.87 per plant in non-IRM plots.

The IRM plots recorded significantly more population of coccinellids than non-IRM plots in both the districts. In Hingoli district, the population recorded was 2.45 per plant in IRM plots whereas it was 2.00 per plant in non-IRM plots. The average population of coccinellids in Amravati district was 2.10 and 1.05 per plant in IRM and non-IRM plots, respectively. It is evident from Table 1 that the IRM based pest management resulted in conservation of natural enemies.

In IRM plots the yield of seed cotton (Table 1) was significantly high in both the districts (Hingoli and Amravati) (8.87 and 9.71 q/ha, respectively). The economics of the treatments revealed (Table 2) that in Hingoli district the adoption of IRM strategies reduced the number of sprays by 65.35 per cent thereby reducing the cost of plant protection by 2776.28 Rs/ha. In Amravati district, the adoption of IRM strategies reduced the number of sprays by 62.80 per cent thereby reducing the cost of plant protection by 2822.68 Rs/ha. In general, the IRM strategies were found to be effective and remunerative.

Table 2. Economics of IRM and Non-IRM Practices.

Sr. No.	Economic Parameter	Hingoli		Amravati	
		IRM	Non-IRM	IRM	Non-IRM
1	No. of sprays	3.52	10.16	3.46	9.31
2	Reduction in no.of sprays (%)	65.35	--	62.80	--
3	Reduction in spray cost (Rs./ha)	2776.28	--	2822.68	--

Kranthi *et.al* (2000), Jhansi *et.al* (2004) and Suruli Velu *et.al* (2004) reported same results in India, Andhra Pradesh and Tamil Nadu, respectively.

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Susceptibility of *Spodoptera littoralis* to Old and New Generation of Spinosyn Products in Five Cotton Governorates, in Egypt

ABSTRACT Two years of field trials utilizing two spinosyn products spinosad (spintor 24SC) and spinetoram (radiant 12 SC) to combat the egg masses of the cotton leaf worm, *Spodoptera littoralis*, were done in Egypt.

In the field, Radiant 12 SC at 5.76, spintor 24SC at 28.8 or Dursban 48EC at 1152 gram active/HA showed 100% mortality of the entire hatched eggmasses 4 days after spray. Majority of the killing effect took place just after hatching for all products. The last rates did not show any feeding damage on cotton leaves up to 10 days. Radiant 12SC at 48ml (5.76 g.active) was equal to spintor 24SC at 120 ml (28.8 g.active)/HA. The last confirmed that radiant 12SC was 5 times stronger than spintor 24SC in the field.

In laboratory testing utilizing IRAC method no.7 and field 2nd instar larvae, radiant 12 SC was 7 times stronger than spintor 24SC based on LC50. Radiant 12 SC showed one of the lowest rates to combat *Spodoptera littoralis* in Egypt

KEY WORDS: Spinosad, spinetoram, *Spodoptera littoralis*

INTRODUCTION The cotton leaf worm, *Spodoptera littoralis* (Boisd) (CLW), is a polyphagous key pest in Egypt. It is active all year round without a hibernation period and attacks cotton as well as more than 29 hosts from other crops and vegetables in Egypt. The rate of CLW infestation could reach up to 120 000 egg-masses /HA. causing severe damage to leaves, flowers and bolls (Maher 1975, Temerak 2002).

CLW has 7 generations all year round with 3 on cotton coming from clover. The most serious one is during June. Before the spraying program, the Ministry of Agricultural (MOA) used to cover the whole area of cotton by having young children (24 000 000 kids)to pick up these eggmasses every 3 days, especially in the recently irrigated fields, for a period of 4-5 weeks. Thirty kids were located per each 12.5 HA every three days. Recently, the government issued a law to prohibit the kids from work in cotton and other work. Hand-picking of CLW egg-masses was practiced as a reliable and safe approach of control, particularly in the first generation of CLW on cotton in Egypt (El-Badawy *et al* 1980). Nowadays, satisfactory hand picking is facing serious problems due to the labour availability as well as the cost.

Furthermore, this process is not enough to control CLW due to its overlapping generations. In addition, when cotton grows too big, this process becomes too difficult. Consequently, the Ministry of Agriculture (MOA) has had to spray the cotton every year despite hand picking (Temerak 2002).

El-Dahan et al (1990) indicated that insect growth regulators (IGRs) were very weak to control egg masses, but Chlorpyrifos ethyl was the best ovicides for all ages of CLW eggmasses (100%). However, MOA cancelled all conventional insecticides from spraying on eggmasses to conserve their natural enemies and uses IGRs mainly for the newly hatched larvae during this period (Temerak 2002).

Peterson et al (1997) indicated that application of spinosad in conjunction with naturally occurring beneficial arthropods are an excellent example of a functional cotton integrated pest management (IPM) program. Spinosad is one of the most promising new chemicals, which has favorable mammalian toxicity and a safe environmental profile (Sparks et al 1995).

For the time being, spinosad (spintor24SC) is the only recommended rapid product by the MOA to face egg masses and conserve the natural enemies.

Current studies were undertaken to evaluate the susceptibility of cotton leaf worm to the new product spinetoram(radiant 12 SC) in comparison to its old generation spinosad (spintor 24 SC), in the field as well as in the laboratory.

MATERIALS AND METHODS

Products used in this study

1-Spinosad (Spintor 24SC), is a metabolite of the Actinomycete, *Saccharopolyspora spinosa* Martz & Yao. It is a naturally occurring mixture of two active spinosyns (spinosyn A & D). It is a trademark of Dow AgroSciences Co. It is considered the 1st generation from the spinosyn group. Used rates were 60, 84 and the recommended 120ml/HA.

2- Sinetoram (Radiant 12SC) is the 2nd new generation of the spinosyn group with the same mode of action. It is a trademark of Dow AgroSciences Co. Used rates were 24, 36, 48 and above ml/HA.
Chemical name :5aR,5bS,9S,13S,14R,16aS,16bR)-13-{[(2S,5S,6R)-5-(dimethylamino)-6-methyltetrahydro-2H-pyran-2-yl]oxy}-9-ethyl-14-methyl-7,15-dioxo-2,3,3a,4,5,5a,5b,6,7,9,10,11,12,13,14,15,16a,16b-octadecahydro-1H-as-indaceno[3,2-d]oxacyclododecin-2-yl 6-deoxy-3-O-ethyl-2,4-di-O-methyl-beta-L-mannopyranoside and (2S,3aR,5aS,5bS,9S,13S,14R,16aS,16bS)-13-{[(2S,5S,6R)-5-(dimethylamino)-6-methyltetrahydro-2H-pyran-2-yl]oxy}-9-ethyl-4,14-dimethyl-7,15-dioxo-2,3,3a,5a,5b,6,7,9,10,11,12,13,14,15,16a,16b-hexadecahydro-1H-as-indaceno[3,2-d]oxacyclododecin-2-yl 6-deoxy-3-O-ethyl-2,4-di-O-methyl-beta-L-mannopyranoside
3-Chlorpyrifos ethyl (Dursban 48EC) at 2.4L/HA for sake of comparisons

Screening for minimum effective doses of Radiant 12 SC

Field trials were done in five governorates to screen for the minimum effective dose of Radiant 12SC on different cotton varieties in 2005. Spray time was 1/6, 5/6, 20/6, 25/6, and 27/6 for Beni-swif, Minia, Qlupia, Sharkia, and Bohira, respectively. Cotton stage was at early flowering.

During June, fresh egg-masses were located and tagged on the lower surface of cotton leaves on cotton plants: twenty eggmasses per each dose. The total eggmasses were 1300 serving all governorates including untreated ones. Plot size was 200 square meters.

More focus on cases of mortality of eggmasses

In order to see if the killing effect took place on eggs before, during or after hatching, a 2nd trial was done in Sharkia in 2006. Tagged eggmasses were 20/dose with total of 160. The number of cotton leaves that showed feeding signs by neonate or newly larvae that hatched from eggmasses 4, 7 and 10 days after being sprayed were counted. Plot size was 200 square meters. A knapsack sprayer was used, and 480 L of water was used to cover one HA. Spraying took place on 8/6/2006. Cotton stage was at early flowering.

Leaf residue dipping technique (IRAC method No.7)

According to Insecticide Resistance Action Committee (IRAC), field eggmasses were collected and transferred to the laboratory during June. Daily feeding on fresh castor bean leaves was done. Eggmasses that hatched at about the same time were selected and separated into 10 containers to wait for the homogenized 2nd instar larvae.

Spinosad formulation utilized in this study was spintor 24%SC. Spinosad was diluted with water to obtain a range of 6 different concentrations (0.05-1.25ppm). Leaves of castor bean were dipped for 5 seconds in different concentrations of spintor24SC and left to dry under laboratory condition for one hour. Four replicates with 10 larvae of 2nd instar/each were used for each concentration. Untreated field strain was served by 4 x 10 larve 2nd instar.

Spinetoram formulation utilized in this study was Radiant 12 % SC. Concentrations were used from 0.0125- 0.25ppm. The same technique of spintoar was applied for radiant. Also, an untreated check was initiated for the sake of comparison. Leaves for the untreated were dipped in water only. The grand total of larvae used was 560 as 2nd instar.

Petri-dishes were used. Statistical analysis data on mortality after 48 hours was subjected to the Abbott Formula for correction wherever required. Probit analysis was determined to calculate LC50 and LC90 (Finney, 1971).

Assessment. During the summer, the period that consumed until hatching in Egypt was 3 days; however, inspection was done 4 days after tagging. By the time of inspection, tagged eggmasses were classified as follows:
1-Eggmasses hatched, showing all live neonate larvae without any kill are referred to as hatched alive larvae.
2-Eggmasses hatched, showing all larvae at the time of inspection as mixed alive and dead neonate larvae/each are referred to as hatched alive/dead L.
3-Eggmasses having the neonate larvae dead inside the eggs (cannot emerge) or on the way to exit referred to as dead during exit or dead inside.
4-Eggmasses having the neonate larvae dead on the top of eggmasses are referred to as dead on the top.

RESULTS AND DISCUSSION

Screening for minimum effective doses of Radiant 12 SC in 5 governorates in the field

Table 1 indicates the direct field observation on mortality of the entire tagged eggmasses of *S.littoralis*, 4 days after being sprayed by Radiant 12SC in comparison to the recommended spintor 24SC in 5 governorates from 2005.

The best and wisest way to control an insect like CLW is to spray the eggmasses or the just hatched neonate larvae before larvae get distributed through neighboring leaves and cause considerable damage.

The field screening revealed that the minimum effective dose for Radiant was 5.76 gai or 48ml/HA. To achieve 100% kill.

Radiant 12 SC at 5.76, spintor at 28.8 and Dursban at 1152 gram active /HA showed 100% kill of the entire hatched eggmasses in the five governorates. Radiant 12SC at 48ml (5.76 G.active) was equal to spintor 24SC at 120 ml (28.8 G.active)/HA. The last confirmed that radiant 12SC is 5 times stronger than spintor 24SC in the field. Furthermore, based on 28.8, 20.16, 14.4 GAI, spintor showed mortality percent as 100, 92, and 48%, while radiant at the same rates indicated 100%. Cotton variety did not affect performance of any product. All are *Gossypium barbadense* type.

Table 1; Screening test for minimum effective dose of spinetoram on tagged eggmasses of *S.littoralis* in five cotton Governortaes, Egypt 2005

Product	Rate/HA	GAI/HA	Mortality% of eggmasses in five governorates					
			Bni-swif	Minia	Kalubia	Bohira	Sharkia	MEAN
Radiant12SC	240	28.8	100	100	100	100	100	100
Radiant12SC	168	20.16	100	100	100	100	100	100
Radiant12SC	120	14.4	100	100	100	100	100	100
Radiant12SC	96	11.5	100	100	100	100	100	100
Radiant12SC	72	8.6	100	100	100	100	100	100
Radiant12SC	48	5.76	100	100	100	100	100	100
Radiant12SC	36	4.3	75	80	75	80	75	77
Radiant12SC	24	2.88	30	50	55	40	50	46
Spintor24SC	120	28.8	100	100	100	100	100	100
Spintor24SC	84	20.16	90	90	95	95	90	92
Spintor24SC	60	14.4	50	50	45	55	40	48
Dursban 48EC	2400	1152	100	100	100	100	100	100
Untreated			0	0	0	0	0	0
Cotton Variety			Giza 80	Gixa 80	Giza 85	Giza 70	Giza 89	

Data based on 20 tagged eggmasses / single dose

More focus on cases of mortality of eggmasses in the field

Mortality percent cases of the entire eggmasses were shown in Table 2. Most eggmasses mortality cases took place after eggmasses hatching for all tested products. Nolting et al (1997) indicated that mortality in treated eggs of *Heliothis* was from larvae ingesting spinosad as they fed on the chorion of the egg during hatching. Mortality percent as 100% of the entire eggmasses was achieved by 5.75, 28.8, and 1152 as GAI/HA for radiant 12SC, spintor24SC and dursban 48EC, respectively.

Cotton leaves damage

Number of cotton leaves showing feeding signs by CLW 4, 7 and 10 days after spray are shown in Table 3 (detected from Table 2).

No damage to cotton leaves was recorded for radiant at 48, spintor at 120 or dursban at 2400 ml/HA. until 10 days after hatching. Untreated showed 150 leaves were severely damaged.

Table 2;Mortality cases of the entire tagged eggmasses of *S.littoralis* , 4 days after being sprayed by radiant 12SC and spintor 24SC, Sharkia governorate, 2006

Treatments	Rate/HA ml	Rate/HA GAI	No of Dead eggmasses as:		No.hatched eggmasses having:		%Mortality of eggmasses
			neonate L on top eggmass	neonate L inside the eggs	alive/dead L	alive larvae	
Radiant12SC	24	2.88	10	0	5	5	50
	36	4.32	15	1	1	3	80
	48	5.76	16	4	0	0	100
Spintor 24SC	60	14.4	10	0	5	5	50
	84	20.16	17	1	1	1	90
	120	28.8	17	3	0	0	100
Dursban48EC	2400	1152	19	1	0	0	100
Untreated		0				20	0

Data based on 20 tagged eggmasses / single dose

According to IRAC recommendation, radiant and spintor are using the same site of action, so they must not alternate each other in any IPM program to elongate its uses and avoid or delay resistance.

It was observed that before neonate larvae die, most morbid larvae were standing vertically.

Leaf residue dipping technique in the laboratory

Probit analysis criteria of 2nd instar larvae of *S.littoralis* is presented in Table 4 utilizing IRAC method No 7. Radiant 12SC and spintor24SC as LC50 were 0.0373 and 0.2681, respectively. Radiant on 2nd instar larvae was 7 times stronger than spintor, based on LC50 mortalities.

Table 3: Number of cotton leaves showing feeding signs after eggmasses being sprayed and hatched,Sharkia, 2006 (based on table 2)

Treatments	Rate/HA ml	Rate/HA GAI	No leaves showing feeding signs after hatching 3 days	7 days	10 days
Radiant12SC	24	2.88	7	10	14
	36	4.32	3	3	2
	48	5.76	0	0	0
Spintor 24SC	60	14.4	7	11	15
	84	20.16	2	2	3
	120	28.8	0	0	0
Dursban48EC	2400	1152	0	0	0
Untreated		0	35	80	150

Data based on 20 tagged eggmasses / single dose

Table 4: Susceptibility of 2nd instar larvae of *S.littoralis* after dippnig in radiant 12SC & spintor 24SC concentrations

Radiant PPM	No of dead larvae	Spintor PPM	No.of dead larvae
0.25	37	1.25	36
0.125	32	1	32
0.1	25	0.5	21
0.05	20	0.25	16
0.025	17	0.1	13
0.0125	12	0.05	8
Untreated	0		0

40 larvae of 2nd instar / each dose

Probit analysis of radiant and spintor after using 2nd instar larvae of *S.littoralis* (IRAC Meth.No.7)based on Table4

Products	Slope	S.E	LC50	upper/lower limit	LC90	upper/lower limit
Radiant 12SC	0.282	0.2761	0.0373	0.0258-0.0500	0.3269	0.2014-0.7545
Spintor 24SC	0.182	0.1283	0.2681	0.1947-0.3618	2.43599	1.4607-5.5809
Fold			7.18		7.45	

The availability of a novel chemical group, with a new mode of action that is different from conventional insecticides in current use, is an asset to insecticide resistance management programs (Horowitz and Ishaaya 1994). Furthermore, Temerak (2003) indicated that spinosad is not easily affected by the existing resistance mechanisms for conventional insecticides in Egypt.

It is generally concluded and recommended that Radiant 12 SC at 48ml/HA or Spintor 24 SC (spinosad) at 120 ml /HA. can replace handpicking of eggmasses in Egypt.

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Research in Resistance Management

Induction of the additional phenoloxidase isoforms in insects under N-acetyl-D-glucosamine and bitoxibacillin action

INTRODUCTION Pronounced biological activity of chitinous compounds isolated from fungi and arthropods has been demonstrated with respect to plants and animals by numerous investigations in the 1990s. In this connection, methods of chitinous compound application in the practice of plant protection and medicine have been devised. Thus, chitin derivatives have begun to be actively used as growth regulators, fungicides and matters increasing general plant resistance (Stotz, Powell, 1993). Antifungal, antitumor, antiinfectious, wound healing, regenerating and immunostimulating actions of the chitin derivatives have been discovered with regard to mammals (Galiaskarova, 1996). Presence in insects of the chitinous structures and the complexes of enzymes degrading them suggests sufficiently important regulatory function of the chitin catabolism products in insect organisms. Thus, chitin oligomers have been shown to increase the humoral immunity level in silkworms through provocation of the antibacterial peptides gene expression (Furucawa, Taniani, 1999), raising the honey bee survival under unfavorable factors (Saltykova et al., 2001) and changing the rate of the Colorado beetle ontogeny processes (Ben'kowskaya et al., 2001). Investigation of the chitin compounds' influence on the systems providing insects with resistance to abiotic, biotic and anthropogenic environment factors are of great interest in connection with the prospective of chitin derivatives application in agriculture.

N-acetyl-D-glucosamine (NAGA) is a monomer of chitin and its derivatives. Furthermore, side by side with some other mono and disaccharides, NAGA is a part of the teichoic acids and polysaccharides of Gram-positive bacteria murein cover. These teichoic acids and polysaccharides vary in different species of microorganisms and stipulate their antigenic capacities. The recognition process of foreign material in arthropods is closely connected with the functioning of the phenoloxidase system (Soderhall, 1982). In particular, the phenoloxidase system components have been shown to participate in the recognition process realizing the cross binding of cell surface with corresponding receptors (Charalambidis et al., 1996). The aim of present work is research of NAGA action on the phenoloxidase system activity in comparison with action of the bitoxibacillin (BTB) – a biopreparation based on Gram-positive bacterium *Bacillus thuringiensis var. thyringiensis.*

MATERIALS and METHODS Second instar larvae, one-day pupas of *Musca domestica* L. and third instar larvae of *Leptinotarsa decemlineata* were used as objects of the investigation. Larvae and pupas of a *M. domestica* laboratory population were supported in the substratum of bran. *L. decemlineata* larvae were collected from potato fields and reared on potato foliage. NAGA and BTB were added to substratum of *M. domestica* larvae and fodder of *L. decemlineata* larvae. NAGA was used in concentrations of 0.001%, BTB – 0.01% for *M. domestica* and 0.1% for *L. decemlineata.* Electrophoresis and the determination of the phenoloxidase activity were carried out after treatment by these preparations beside *M. domestica* on the stage of one-day pupa, but beside *L. decemlineata* larvae in four and twenty-four hours after the treatment.

Electrophoresis of the insect's protein preparation was carried out in 7.5% polyacrylamide gel by B.J.Davis (1962) using vertical gel plates 115x115x1mm under the current strength of 30mA. On electrophoresis termination this gel was placed for colouring in incubative medium contained 0.4% L-digydroxiphenilalanin and 0.15% paraphenilendiamine. Colouring was carried out at 37 ºC for 30 min (Raushenbach, 1997).

Phenoloxidase activity was determined in trys-HCl extracting buffer (pH 7.5) with respect to substratum L-digydroxiphenilalanin with use of the spectrophotometer SP-46 at 475 nm, 37 ºC by optical density change during 5 min. Activity of these enzymes was expressed in activity units/min/protein mg. Protein concentration was measured by Bradford method with using of bovine serum albumin as a standard (Skopes, 1985).

Statistical analysis data was carried out using arithmetical mean, arithmetical mean error and Student t-criterion.

RESULTS and DISCUSSION Spectrum of the phenoloxidase molecular forms were presented by three fractions with Rf 0.38, 0.65 and 0.8 beside *M. domestica* pupas and by two fractions with Rf 0.52 and 0.65 beside *L. decemlineata* larvae (Fig. 1). Addition of NAGA or BTB to the medium of *M. domestica* initiated appearance of the enzyme in additional isoforms with Rf 0.1, 0.12 and 0.52. A maximum quantity of the phenoloxidase additional isoforms was displayed in *M. domestica* pupas after the simultaneous NAGA and BTB action on *M. domestica* larvae.

Addition to fodder of NAGA, BTB or simultaneously NAGA and BTB induced in *L. decemlineata* larvae the same additional phenoloxidase isoforms with Rf 0.12 and 0.4.

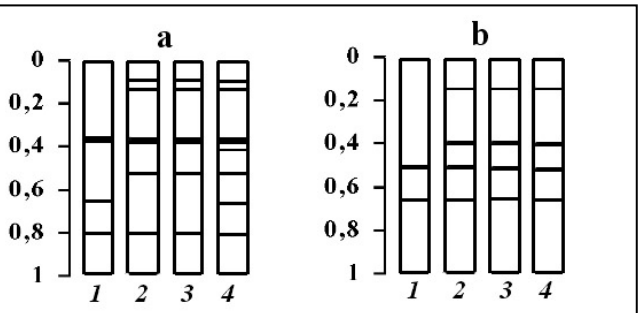

Figure 1. Induction of the phenoloxidase molecular forms in insects under NAGA and BTB action.
a – *M. domestica* pupar, b – *L. decemlinaeta* larvae. *1* – control, *2* – under NAGA action, *3* – under BTB action, *4* – under NAGA and BTB action.

Carrying in the *M. domestica* larvae medium of NAGA, BTB, or simultaneously NAGA and BTB has raised the phenoloxidase activity in one-day pupas (Fig. 2a). Similarly simultaneous and separate addition to fodder of NAGA and BTB raised the phenoloxidase activity in *L. decemlineata* larvae in four and twenty-four hours after treatment (Fig.2b).

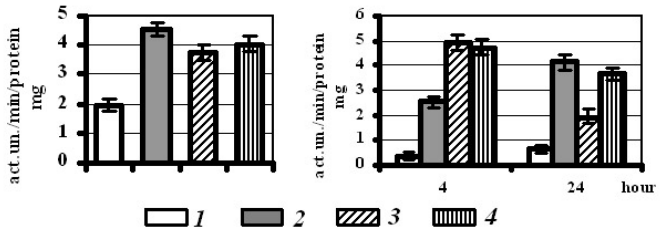

Figure 2. Change of the phenoloxidase activity in insects under NAGA and BTB action.
a – *M. domestica* pupar, b – *L. decemlinaeta* larvae. *1* – control, *2* – under NAGA action, *3* – under BTB action, *4* – under NAGA and BTB action.

In *M. domestica* and *L. decemlineata*, NAGA initiates formation of phenoloxidase isoform spectrum and an increase of general phenoloxidase activity identical to BTB action. It may be supposed that changes of the phenoloxidase isoform spectrum are stipulated by the expression of prophenoloxidase gene and/or posttranslational modifications. Perhaps, the mechanism for the formation of the different molecular phenoloxidase structures, which form under NAGA action, is concluded in the change of the phenoloxidase glycosilation degree, not the influence of substrate specificity on enzymes isoforms, but promoting to their best ability the development of the insect's defensive reaction on infection. Earlier we showed that in hemolymph of *L. decemlineata* titer of the agglutinins specific to chitinous, oligomers consisting of approximately fifteen monomers (NAGA) increase under BTB action (Gayfullina et al., 2005). The identity of the insect's defensive reaction under NAGA and BTB action is possibly explained by presence of the exotoxin in bacterial preparation of glycoside fragments (Dulmage, Rhodes, 1971; Kandybin, 1989). In other words, under treatment of insects with BTB, the additional spectrum of phenoloxidase molecular forms are induced by glycoside fragments concluding, in particular, NAGA. By this point of view, NAGA initiates defensive reaction of phenoloxidase system not causing the complex of the pathological changes typical for antiinfectious response.

Thus NAGA, in absence of a pathogen, renders the eliciting action on an insect organism imitating components of the bacteria cellular wall and inducing some humoral reactions typical of antiinfectious response. This raises general resistance of insects that is necessary to take into account when using chitinous compounds as biologically active substances in the practice of plant protection.

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Detached leaf assay to evaluate transgenic pigeonpea plants for resistance to *Helicoverpa armigera*

ABSTRACT Introduction of transgenic insect-resistant pigeonpea (*Cajanus cajan* (L.) Millsp.), is expected to be useful in minimizing *Helicoverpa armigera* (Hubner) damage, which is the major constraint for its production. In this context, it is important to develop techniques to evaluate effectiveness of transgenic plants for resistance to *H. armigera*. Therefore, we evaluated the usefulness of detached leaf assay to assess the efficacy of transgenic pigeonpea (var; ICPL 88039 and ICPL 87) plants carrying *Btcry1Ab* and *SBTI* genes for resistance to *H. armigera*. The levels of Cry1Ab or SBTI proteins in the transgenic pigeonpea plants were not sufficient to cause significant deterrent effects on leaf feeding, larval survival, and larval weight of *H. armigera*. However, detached leaf assay was found to be quite useful for evaluation of transgenic pigeonpea plants for resistance to *H. armigera*.

Pigeonpea, (*Cajanus cajan* (L.) Millsp.), plays a significant role in nutritional security as an important source of high quality dietary proteins. Over 150 species of insects damage pigeonpea (Shanower *et al*., 1999), of which the pod borer, *Helicoverpa armigera* (Hubner) is the most important pest. It causes an estimated annual loss of US$ 317 million in the semi-arid tropics (ICRISAT, 1992). Despite the identification of a few genotypes with moderate levels of resistance to *H. armigera* in the cultivated germplasm accessions, concerted breeding efforts to transfer insect resistance into improved cultivars has not been very successful (Sharma *et al*., 2005). However, the advances in recombinant DNA technology have made it possible to clone and express the toxin genes to confer resistance to insect pests (Bennet, 1994). The *cry1Ac* gene expressed in chickpea has been found to inhibit the growth of *H. armigera* larvae (Kar *et al*., 1997). Transgenic pigeonpea plants with *Bt cry1Ab* and *SBTI (soybean trypsin inbhibitor)* genes have been developed recently (Sharma *et al*., 2006). The present studies were undertaken to standardize the detached leaf assay to evaluate the performance of transgenic pigeonpea for resistance to *H. armigera.*

MATERIALS AND METHODS The pigeonpea varieties, ICPL 88039 and ICPL 87, were transformed to express *cry1Ab* and *SBTI* genes through *Agrobacterium tumefaciens*-mediated transformation (Sharma *et al*., 2006). The T_2-T_3 plants were raised in a containment (P_2 level) greenhouse at 24 to 28^{o}C and 70 to 80% RH. The plants were analyzed for the presence of transgene in each generation by polymerase chain reaction (PCR), and only those plants showing PCR positive results were used for bioassays.

The *H. armigera* culture was maintained in the laboratory on chickpea flour based diet (Armes *et al*., 1992). The leaf bioassays were performed in plastic cups of 9.5 cm diameter (250 ml capacity). The cups were arranged in a slanting position and 20 ml of agar (3%) solution was poured into each cup and allowed to solidify. Fully expanded tender pigeonpea leaves were detached from the plants and immediately placed in cups with the petiole inserted into the agar substratum. The agar-agar keeps the leaves fresh for a period of one week. Ten neonate larvae of *H. armigera* were released on the upper surface of the leaf using a camel hair brush. Cups were covered with lids and stacked in trays, and were kept at 27°C, 65% RH and 12: 12 (L: D) photoperiod. After 72 h of feeding, the leaf damage was scored visually on a 1 to 9 scale (1 = < 10% and 9 = > 80% leaf area damaged). The number of surviving larvae and their weights were also recorded. The experiment was replicated thrice, and the data were subjected to analysis of variance.

RESULTS AND DISCUSSION The effect of transgenic pigeonpea carrying *cry1Ab* and *SBTI* genes on the growth and development of *H. armigera* was studied for three successive generations using detached leaf bioassay, and the plants showing adverse effects on survival and development of *H. armigera* were selected for testing in contained field trials.

Plant numbers Bt 6.1 (1.7), Bt 1.2 (2.0), SBTI 2.2 (2.0), Bt 6.2 (2.2), Bt 3.6 (2.3), Bt 9.2 (2.3), SBTI 1.4 (2.3), Bt 3.2 (2.7), SBTI 4.3 (2.7) Bt 2.1 (3.0), Bt 6.6 (3.0), and SBTI 2.5 (3.0) showed lower leaf feeding compared to the non-transgenic plants of ICPL 88039 (4.5) (Table 1). Plants Bt 6.1 (10.0%), SBTI 1.4 (13.3%), Bt 3.2 (16.7%), and Bt 6.2 (16.7%) also showed significantly less larval survival than the non-transgenic control, ICPL 88039 (30.0%). The larval weights were lower on Bt 2.1 (0.517 mg), Bt 8.1 (0.542 mg), Bt 3.2 (0.567 mg), Bt 7.2 (0.597 mg), Bt 1.2 (0.600 mg), Bt 6.2 (0.622 mg), SBTI 4.3 (0.628 mg), SBTI 2.5 (0.633 mg), SBTI 1.2 (0.650 mg), and SBTI 7.5 (0.733 mg) as compared to the non-transgenic plants of the respective genotypes.

Five seeds from each plant showing low leaf

feeding, low larval survival, and/or low larval weights were bioassayed in the T_2 generation. Bioassays were continued with a total of six lines namely; Bt 1.2, Bt 2.1, SBTI 1.2, SBTI 2.5, SBTI 4.3, and SBTI 7.5, which showed relatively less leaf damage and larval weight in T_1 generation. Leaf damage was significantly lower on Bt 1.2.1 (2.4), Bt 2.1.1 (2.4), SBTI 7.5.4 (2.4), SBTI 7.5.2 (2.5), and SBTI 7.5.3 (2.5) compared to their respective non-transgenic plants (Table 2). Larvae fed on leaves of SBTI 2.5.1 (0.261 mg) and Bt 2.1.1 (0.285 mg) showed significant reduction in their weights as compared to the larvae fed on the leaves of non-transgenic plants of ICPL 88039 (0.347 mg). The larvae fed on the leaves of SBTI 7.5.4 (0.256 mg), SBTI 7.5.2 (0.264 mg), and SBTI 7.5.3 (0.296 mg) weighed significantly lower as compared to those fed on non-transgenic plants of ICPL 87 (0.402 mg).

Table 1 Relative susceptibility of transgenic pigeonpea plants (T_1) to neonate *H. armigera* larvae fed on leaves (ICRISAT, Patancheru, 2001-02)

Genotype	Line	Damage rating	Larval survival (%)	Larval weight (mg) 3 DAI
ICPL 88039	Bt-1.2	2.0	23.3 (28.8)	0.600
ICPL 88039	Bt-1.3	5.0	26.7 (31.0)	1.161
ICPL 88039	Bt-1.5	4.7	26.7 (31.0)	0.756
ICPL 88039	Bt-1.6	4.2	20.0 (26.6)	0.783
ICPL 88039	Bt-2.1	3.0	20.0 (26.6)	0.517
ICPL 88039	Bt-2.3	4.2	26.7 (30.0)	0.753
ICPL 88039	Bt-3.2	2.7	16.7 (23.9)	0.567
ICPL 88039	Bt-3.5	3.7	26.7 (31.0)	0.761
ICPL 88039	Bt-3.6	2.3	23.3 (28.8)	0.767
ICPL 87	Bt-5.1	3.3	13.3 (21.1)	1.217
ICPL 88039	Bt-6.1	1.7	10.0 (18.4)	1.000
ICPL 88039	Bt-6.2	2.2	16.7 (23.4)	0.622
ICPL 88039	Bt-6.6	3.0	30.0 (33.0)	0.733
ICPL 88039	Bt-7.1	3.7	30.0 (33.0)	0.967
ICPL 88039	Bt-7.2	3.3	30.0 (33.0)	0.597
ICPL 88039	Bt-8.1	4.7	40.0 (39.2)	0.542
ICPL 88039	Bt-8.3	4.0	26.7 (31.0)	0.850
ICPL 88039	Bt-9.2	2.3	20.0 (26.6)	0.883
ICPL 88039	SBTI-1.2	3.8	46.7 (43.0)	0.650
ICPL 88039	SBTI-1.4	2.3	13.3 (21.1)	1.500
ICPL 88039	SBTI-2.2	2.0	20.0 (26.6)	0.783
ICPL 88039	SBTI-2.5	3.0	30.0 (33.2)	0.633
ICPL 88039	SBTI-4.3	2.7	36.7 (37.2)	0.628
ICPL 87	SBTI-5.2	2.0	20.0 (26.6)	0.983
ICPL 87	SBTI-6.4	3.3	23.3 (28.8)	0.950
ICPL 87	SBTI-6.5	2.2	20.0 (26.6)	0.883
ICPL 87	SBTI-7.5	2.7	26.7(31.0)	0.733
ICPL 88039	Control	4.5	30.0 (33.0)	1.000
ICPL 87	Control	3.3	20.0 (26.1)	1.122
SE±		**0.5**	**2.9**	**0.116**
LSD		**1.4**	**8.3**	**0.328**
Fp		**<0.001**	**<0.001**	**<0.001**

*Figures in parentheses are Angular transformed values.
DAI=Days after infestation.

Table 2 Relative resistance of leaves of transgenic pigeonpea plants (T_2) against neonate larvae of *H. armigera* (ICRISAT, Patancheru, 2002)

Genotype	Line	Damage rating	Larval survival (%)	Larval weight (mg) 3DAI
ICPL 88039	Bt-1.2.1	2.4	84.1 (72.8)	0.315
ICPL 88039	Bt-2.1.1	2.4	78.8 (66.4)	0.285
ICPL 88039	SBTI-2.5.1	2.7	90.0 (77.5)	0.261
ICPL 87	SBTI-7.5.2	2.5	85.3 (70.5)	0.264
ICPL 87	SBTI-7.5.3	2.5	82.4 (68.0)	0.296
ICPL 87	SBTI-7.5.4	2.4	78.8 (65.7)	0.256
ICPL 88039	Control	2.9	88.2 (74.3)	0.347
ICPL 87	Control	3.3	89.4 (74.8)	0.402
SE±		**0.13**	**3.3**	**0.02**
LSD		**0.36**	**NS**	**0.056**
Fp		**<0.001**	**0.131**	**<0.001**

*Figures in parentheses are Angular transformed values.
DAI=Days after infestation.

Progenies of four transgenic pigeonpea lines namely; Bt 1.2.1, Bt 2.1.1, SBTI 2.5.1, and SBTI 7.5.2 selected in T_2 generation were also evaluated for resistance to *H. armigera* in the T_3 generation. Plants of SBTI 2.5.1.4 (1.3), SBTI 2.5.1.2 (1.8), Bt 2.1.1.5 (1.8), Bt 1.2.1.2 (2.0), SBTI 7.5.2.6 (2.3) and SBTI 7.5.2.5 (2.5) suffered significantly lower leaf damage as compared to non-transgenic plants (Table 3). The larval survival did not differ significantly from the larvae reared on non-transgenic plants. The larval weights were lower in case of Bt 1.2.1.6 (0.369 mg), Bt 2.1.1.1 (0.282 mg), Bt 2.1.1.4 (0.329 mg), SBTI 2.5.1.1 (0.291 mg), SBTI 2.5.1.2 (0.303 mg), and SBTI 2.5.1.4 (0.312 mg).

In detached bioassays using the transgenic pigeonpea leaves, a lot of variation was observed in the performance of segregating individual plants in terms of leaf feeding, larval survival, and larval weights. In transgenic potato, neonate larvae of tobacco hornworm, *Manduca sexta* (L.) consumed significantly less leaf area as compared to the untransformed potato plants (Cheng *et al.*, 1992). The maximum mortality of diamondback moth, *Plutella xylostella* (L.) larvae has been observed on leaf discs of transgenic cauliflower after 48 h (Chakrabarthy *et al.*, 2002). Adamczyk and Gore, (2003) observed that the bioassay arenas that prevented desiccation of leaf material, Cry1Ac levels remained stable for 10 days after being excised from the plant, whereas in other techniques, Cry1Ac levels increased in excised leaves overtime because of desiccation. In this experiment, the leaves were inserted into agar medium to avoid desiccation, which remained in a turgid condition for over five days, and therefore can be used for evaluation of putative transgenic plants for resistance to insects in the early segregating generations.

The levels of Cry1Ab or SBTI toxic proteins present in the transgenic pigeonpea plants were not sufficient to cause a substantial reduction in leaf feeding, survival and growth of *H. armigera* larvae. As a result, some plants though showed resistance to *H. armigera*; the resistance was not manifested in the progenies, and therefore, there is a need to develop new events with high expression of *cry1Ab* or *cry1Ac* genes for controlling *H. armigera* damage in pigeonpea.

Table 3 Effect of transgenic pigeonpea plants (T_3) on neonate larvae of *H. armigera* fed on leaves (ICRISAT, Patancheru, 2002-03)

Genotype	Line	Damage rating	Larval survival (%)	Larval weight (mg) 3 DAI
ICPL 88039	Bt-1.2.1.1	2.5	73.3 (59.7)	0.536
ICPL 88039	Bt-1.2.1.2	2.0	83.3 (66.6)	0.591
ICPL 88039	Bt-1.2.1.3	2.2	80.0 (63.9)	0.546
ICPL 88039	Bt-1.2.1.4	3.2	90.0 (71.6)	0.856
ICPL 88039	Bt-1.2.1.5	2.7	96.7 (83.9)	0.829
ICPL 88039	Bt-1.2.1.6	2.8	83.3 (70.1)	0.369
ICPL 88039	Bt-2.1.1.1	2.2	66.7 (55.9)	0.282
ICPL 88039	Bt-2.1.1.2	2.8	93.3 (81.1)	0.548
ICPL 88039	Bt-2.1.1.3	2.2	93.3 (81.1)	0.616
ICPL 88039	Bt-2.1.1.4	2.7	76.7 (66.9)	0.329
ICPL 88039	Bt-2.1.1.5	1.8	93.3 (81.1)	0.611
ICPL 88039	Bt-2.1.1.6	2.5	86.7 (72.3)	0.675
ICPL 88039	SBTI-2.5.1.1	3.0	86.7 (68.9)	0.291
ICPL 88039	SBTI-2.5.1.2	1.8	83.3 (66.1)	0.303
ICPL 88039	SBTI-2.5.1.3	3.0	93.3 (77.7)	0.598
ICPL 88039	SBTI-2.5.1.4	1.3	66.7 (55.8)	0.312
ICPL 88039	SBTI-2.5.1.5	2.7	96.7 (83.9)	0.679
ICPL 88039	SBTI-2.5.1.6	3.0	86.7 (68.9)	0.508
ICPL 87	SBTI-7.5.2.1	4.7	90.0 (75.0)	0.426
ICPL 87	SBTI-7.5.2.2	3.5	80.0 (68.9)	0.671
ICPL 87	SBTI-7.5.2.3	3.5	83.3 (70.8)	0.637
ICPL 87	SBTI-7.5.2.5	2.5	83.3 (66.1)	0.680
ICPL 87	SBTI-7.5.2.6	2.3	93.3 (81.1)	0.646
ICPL 88039	Control	2.8	93.3 (81.1)	0.368
ICPL 87	Control	3.2	90.0 (75.0)	0.455
SE±		**0.3**	**7.6**	**0.051**
LSD		**0.7**	**NS**	**0.145**
Fp		**<0.001**	**0.295**	**<0.001**

*Figures in parentheses are Angular transformed values. DAI=Days after infestation.

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News in Resistance Management

New Record of Mediterranean Fruit Fly in Iraq

It was mentioned in my previous article in the RPM Newsletter Vol.16 No.1 that the invasion of the foreigner troops to Iraq has destroyed the agricultural quarantine completely. Due to this fact, a new record of Mediterranean fruit fly *Ceratitis capitata* (Wiedemann) was reported in citrus orchards in October 2006 in Iraq. This pest attacked citrus fruits in 1947 and disappeared after very strict regulations done by the Ministry of Agriculture at that time. The new appearance of such dangerous pest is due to the illegal import of different med fly hosts like citrus, stone fruits, vegetables and others from Syria, Iran, Lebanon, Jordan, and Turkey. This is to certify that the new democracy in Iraq introduce also new agricultural pest like the fruit fly and may be others which are not discovered yet.

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Abstracts

Impact of operational factors on the evolution of resistance to pyriproxyfen by the sweetpotato whitefly

ABSTRACT The sweetpotato whitefly, *Bemisia tabaci*, is a serious crop pest throughout the world. Whiteflies reached outbreak levels in the early and mid-1990s in Arizona, in part due to widespread resistance to broad-spectrum insecticides. Since 1996, whiteflies in Arizona have been effectively managed through the selective use of biorational insecticides such as the insect growth regulator pyriproxyfen. However, laboratory bioassays over the past eleven years reveal an areawide decline in whitefly susceptibility to pyriproxyfen.

While pyriproxyfen continues to function well in the cotton system in Arizona, we sought to better understand the impact of operational factors on the evolution of pyriproxyfen resistance in *B. tabaci* through the use of computer simulations. Resistance evolved slower when pyriproxyfen sprays were timed at the onset of rapid population growth in cotton fields. Decreased action thresholds for pyriproxyfen slowed the evolution of resistance, although more insecticide applications were needed per year. Results reinforced that the current action threshold of three adults per leaf may be optimal from an integrated pest management perspective.

We also analyzed resistance evolution based on regional crop diversity. Although pyriproxyfen is currently only approved for use in cotton in Arizona, the amount of crop diversity could impact the evolution of resistance. Field planted to non-cotton crops can slow the evolution of pyriproxyfen resistance by acting as a source of susceptible insects that will migrate into treated cotton crops. Arizona has at least three distinct crop communities (cotton-intensive, spring / fall melons and summer cotton, and multi-crop). Resistance evolved slowest in regions with multiple crops grown throughout the year, followed by regions with summer cotton followed by fall melons. Resistance evolved fastest in cotton-intensive regions. Thus, increased levels of crop diversity may slow the evolution of pyriproxyfen resistance.

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Resistance to pyrethroids in field populations of the bed bug *Cimex lectularius*

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ABSTRACT Infestations of the bed bug, *Cimex lectularius* L. (Heteroptera: Cimicidae), are increasing around the world at an alarming rate and have become a major public health concern. The evolution of insecticide resistance could be a primary factor in explaining this resurgence. Extremely high levels of resistance to two pyrethroid insecticides, deltamethrin and λ-cyhalothrin, relative to a susceptible colony, were detected in populations collected from human dwellings in Kentucky and Ohio. Offspring of a cross between a resistant and susceptible colony had intermediate susceptibility. Evaluations of populations from across the United States indicate that resistance to pyrethroid insecticides is already widespread. Without the development of new tactics for bed bug management, further escalation of this public health problem should be expected.

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Announcements and Submission Deadlines

Thank you to those who contributed to this issue - you have really made the newsletter a worthwhile reading experience! Our contributors truely increase the newsletter's success at sharing resistance information worldwide.

We encourage all of our readers to submit articles, abstracts, opinions, etc (see the newsletter online at http://whalonlab.msu.edu/rpmnews/general/rpm_submission.htm for submission information).

The Newsletter is a resource to many around the globe. It is also a wonderful and effective way to enhance the flow of ideas and stimulate communication among global colleagues. We appreciate your efforts to support the newsletter and we look forward to your continued contributions.

The next two **submission deadlines** are:

Monday, September 17, 2007
Monday, March 17, 2007

We hope you continue to consider the newsletter as a forum for displaying your ideas and research.

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