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# Direct And Indirect Impact of Three New Chemistries Used For Controlling Whiteflies in Vegetables to *Delphastus catalinae* (Col., Coccinellidae), A Predator of *Bemisia tabaci* (Hom., Aleyrodidae)

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***Abstract:*** *Safari®20SGL (Dinotefuran), Molt-X (Azadirachtin), Oberon 2SC (Spiromesifen), are new chemistries used in whitefly management in vegetables. Delphastus catalinae (Horn) is a predator of whitefly commercially produced as a biological control agent especially to Bemisia tabaci biotype "B". The compatibility of these insecticides to longevity of Delphastus catalinae adults were evaluated through direct and indirect exposure to the insecticides. Safari® 20S GL and Molt-X showed lethal impact on the beetle's longevity within the first hours through direct and indirect (to their food) exposure. Interestingly, the high, medium and low rates of Oberon 2S, showed 30, 60 and 70%, survival of the beetles for 15 days during direct exposure, respectively. However, beetles survived approximately 4-8 days through indirect application to their food. Low rate of Oberon 2S showed high compatibility with D. catalinae through direct application for whitefly management and can be used in integrate pest management (IPM) programs of B. tabaci.*
***Keywords:*** *Azadirachtin; Dinotefuran; Spiromesifen; longevity; Delphastus catalinae.*

## I. Introduction

Whitefly is a common pest to the agricultural world. It causes serious damages to crops and transfer of a variety of viruses that has a harmful impact on crops such as the earlier ripening of tomatoes through the tomato yellow leaf curl virus (Goolsby et al., 2005). *B. tabaci* cause direct and indirect injuries by transmitting viruses (Slosser et al., 2004)

*Delphastus catalinae* (Horn) is considered to be a biological control agent of whiteflies, including *B. tabaci* biotype ''B'' and *Trialeurodes vaporariorum* (Westwood) on vegetable and ornamental under greenhouse conditions (Hoelmer et al., 1993; Heinz and Parrella, 1994). In the IPM programs integration between biological and chemical control requires knowledge of the effect of insecticides on biological control agents (Hoelmer et al., 1990). Insecticides are expensive, and there is an increasing resistance of the whitefly to insecticides. Acute toxicity (lethal effect) and selectivity of pesticides have been examined in predators (Zhu et al., 1998 and Qiu et al., 2000), including in predatory coccinellid beetles (Hao et al., 1990; Wu et al., 2007; Urbaneja et al., 2008; Xi D. Q., 2008 and Cabral et al. 2011).However, in addition to their lethal effect, pesticides also can develop various sublethal effects physiological or behavioral (Desneux et al. 2007). Exposure of coccinellids to insecticide residues on plant surfaces and the consumption of contaminated prey may lead to mortality, or sublethal effects resulting in altered searching patterns and foraging, and thus altered success of coccinellids as aphid predators (Singh et al., 2001). Previous studies have indicated that sub-lethal effects of insecticide residues may result in an immediate disruption of predatory behavior and a potential reduction in the efficiency with which coccinellids locate their prey (Singh et al., 2001). Here we studied the impact of new chemistries through different scenarios of exposure on the *D. Catalinae*. Therefore, the main goal of the present work was to provide information about the compatibility of using biological control agent with insecticides in whiteflies IPM programs.

## II. Material and Methods

### 3.1. Insecticides

Three new chemistries used for white fly management in green houses, were used as foliar spray for these experiments. Safari® 20 SG L (Dinotefuran), Molt X (Azadirachtin) and Oberon 2SC (Spiromesifen), were used at low, medium and high rates according to the manufacture recommendations. Deionized water was used as a control in all treatments, showed in Table (1).

**Table (1):** Insecticides used for the toxicity test

| TRADE NAME | ACTIVE INGREDIENT | MOA | RATE | | APPLICATION METHOD | SUPPLIER |
|---|---|---|---|---|---|---|
| Safari® 20 SG L | Dinotefuran | Nicotinic acetylcholine receptor(nAChR) agonists | 1.1-1.7 | gm/L | Foliar vs whitefly eggs on tomato | Valent U.S.A. Corporation Professional Products |
| Molt X | Azadirachtin | uncertain | 1.7-2.8 | gm/L | Foliar vs whitefly eggs on tomato | Bio works, Inc. |
| Oberon 2SC | Spiromesifen | Inhibitors of acetyl CoA carboxylase | 0.5-1.7 | ml /L | Foliar vs whitefly eggs on tomato | Bayer CropScience |

### 3.2. Insects

### 3.2.1. Whiteflies colonies establishment

Whiteflies used in all experiments were from greenhouse colonies maintained at the OSU/OARDC Wooster, Ohio, USA. *Bemisia tabaci* biotype "B", had been reared on empire hybrid tomato plants (Seminis, Batch No: 0100088775), planted in isolated planting room, then transplanted in 12 cm clean pots using PRO-MIX® BX MYCORRHIZAE™ soil, with 22-26 $^{o}$C and 60% RH 14L:10D photoperiod during all months ,(Pickett 1994) photoperiod supplemented by 400W daylight bulbs in holophane lamps when necessary, plants watered using drip irrigation systems ( DOSATRON, D14MZ2) and fertilized by 15-5-15 Cal-Mag ( 181.7 gm) and 20.10.20 (161.5gm) "Everris product" Establishing new whiteflies colonies, we aspirated white fly males and females from the old colonies then transferred to clean tomato plant, let females lay eggs for 2 days in small cages. Tomatoes plants took out from old cages, eggs were counted by hand lens (approximately 1200-1500 egg/leave), then kept in Ziploc plastic bags in refrigerator no more than 1 week in a refrigerator at 5–6 $^{o}$C (Liu and Stansly, 2004).

### 3.2.2. *Delphastus catalinae*

Adult coccinellids *Delphastus catalinae* were purchased commercially from Rincon-vitova insectaries, Incorporation. All coccinellids were kept in a whit bug dorm cage for two days feeding on sugar solution 1:50 dilution before starting bioassay to be sure there wouldn't be any mortality from shipping.

### 3.2.3. Pesticides application

Spraying applications were held in insecticide spraying room 114 OARDC greenhouses using a CO2 powered hand held sprayer equipped with a spray wand and a 6TXVS conejet nozzle. The sprayer was set to be operated at 40 psi and was calibrated to deliver 200 GPA.

### 3.2.4. Toxicity tests

The susceptibility of *D. catalinae* to three new chemistries with different mode of action used for whitefly management on vegetables plants were tested through direct and indirect exposure. Experiment was conducted in a randomized complete block design (RCBD) with 6 blocks and 7 treatments, comprised of selected pesticides with low, medium and high rates as manufacture recommendations.

### 3.2.5. Direct exposure

For each treatment, ten adults of *D. catalinae* were placed in 120 mm Petri dish, to be sprayed with different insecticides different rates before spraying all coccinellids kept in a box contains ice bags for 2-3 min to decrease their movements, then sprayed for 3 sec just one time from left to right direction. All sprayed adults transferred to the arenas 5 cm Petri dished lined with filter paper contain a tomato leaf that was previously infested with *B. tabaci* eggs (approximately 1200 to 1500 eggs/ leave) as soon as possible to avoid long exposure to insecticides, and provided with water using cotton wick changed daily to maintain humidity. Tomato leaves were replaced daily.

### 3.2.6. Indirect exposure

Egg bearing tomato leaves (approximately 1200 to 1500 eggs/ leave), were sprayed with different insecticide different rate. Leaves were placed on a bench and sprayed from left to right direction, then flipped upward on the other face and sprayed again, air dried for 1–2 h and stored in labeled zip-lock plastic bags for no more than 1 week in a refrigerator at 5–6$^{o}$C (Liu and Stansly, 2004). Each sprayed leave placed in the appropriate arena. Ten adults of *D. catalinae* transferred to each arena. Sprayed leaves changed daily, arenas provided with water using cotton wick changed daily to maintain humidity.

**3.2.7. Data recording**
Mortality of *D. catalinae* adults were recorded every two hours over 15 days (25% of adult's life time).

**3.2.8. Data analysis**
For the longevity data, survival (percentage) of adults were transformed to the arcsine square root before analysis to stabilize error variance (Gomez and Gomez 1984) and survival was analyzed using analysis of variance ANOVA followed by mead separation using protected least significant difference (LSD) test. Then a non-parametric test was performed (PROC LIFETEST), (SAS 9.2).

## III. Results

*D. catalinae* shows different respond to tested insecticides, for Safari® 20 SG L, and Molt -X survival rate was declined sharply for all treatment and all rates during first hours Fig (1, 2), results from significant test of equality across all rates, Log-rank and Wilcoxon tests indicates strong evidence of highly significant difference (*P*<0.0001) among the survival curves for all rates compared to untreated beetles, Table (2)

**Table (2): Test of equality over strata for tested insecticides, direct and indirect treatments:**

| Insecticide | Application | Rate | Test | Chi-square |
|---|---|---|---|---|
| Safari® 20 SG L | Direct treatment | Low | Log-Rank | 204.974** |
| | | | Wilcoxon | 200.014** |
| | | Medium | Log-Rank | 224.320** |
| | | | Wilcoxon | 206.947** |
| | | High | Log-Rank | 197.435** |
| | | | Wilcoxon | 197.435** |
| | Indirect treatment | Low | Log-Rank | 291.735** |
| | | | Wilcoxon | 262.778** |
| | | Medium | Log-Rank | 264.159** |
| | | | Wilcoxon | 244.724** |
| | | High | Log-Rank | 249.368** |
| | | | Wilcoxon | 237.672** |
| Molt-X | Direct treatment | Low | Log-Rank | 224.929** |
| | | | Wilcoxon | 203.646** |
| | | Medium | Log-Rank | 235.702** |
| | | | Wilcoxon | 207.391** |
| | | High | Log-Rank | 231.966** |
| | | | Wilcoxon | 207.452** |
| | Indirect treatment | Low | Log-Rank | 158.617** |
| | | | Wilcoxon | 149.444** |
| | | Medium | Log-Rank | 138.612** |
| | | | Wilcoxon | 123.632** |
| | | High | Log-Rank | 186.110 ** |
| | | | Wilcoxon | 171.953 ** |
| Oberon 2SC | Direct treatment | Low | Log-Rank | 7.8921* |
| | | | Wilcoxon | 9.5315* |
| | | Medium | Log-Rank | 14.029* |
| | | | Wilcoxon | 15.052** |
| | | High | Log-Rank | 2.9067 |
| | | | Wilcoxon | 4.5468* |
| | Indirect treatment | Low | Log-Rank | 183.08* |
| | | | Wilcoxon | 163.44** |
| | | Medium | Log-Rank | 213.47** |
| | | | Wilcoxon | 188.90** |
| | | High | Log-Rank | 163.50** |
| | | | Wilcoxon | 146.02** |

** Highly significant, *P* <0.0001. * Significant *P* <0.05.

Oberon 2SC, survival rate have a slight decline within hours after exposure, survival percentage for high, medium and low rates were approximately 30, 60 and 70% respectively. Fig (3) results from the homogeneity tests across all rates showed that Wilcoxon test indicates strong evidence of highly significant difference among the survival curves for medium rate at (*P*<0.0001), significant difference at (*P*<0.05) for low and high rate, and Log-rank test indicates significant difference among the survival curves for low and medium rates only at (*P*<0.05), and no significant for high rate, Table (2).

During indirect application , Oberon 2SC, Fig (3) showed slight decline in survival rates within hours after exposure for all treatment reaching approximately 60% after 48 hours, then continuing to decreases to reach 0% after 150, 170, 220 hours for high, medium and low rate respectively. Table (2) showed results from the homogeneity tests across all rates. Log-Rank test indicate strong evidence of highly significant difference among the survival curves for medium and high rates and Wilcoxon test showed highly significant all rates at (*P*<0.0001), Log-Rank test indicate significant difference at (*P*<0.05) for low rate.

## IV. Discussion

The present study shows the impact of foliar and insecticide residue of three new chemistries used for whiteflies management in green houses on *D. catalinae*. Safari® 20 SG L (Dinotefuran), Molt X (Azadirachtin) and Oberon 2SC (Spiromesifen), were used at low, medium and high rates according to the manufacture recommendations. Present insecticides experiments are designed to test two routes of exposure “direct and indirect” (Banken and Stark, 1998), whereas in the field there are three route of insecticide; direct exposure, contacting with insecticide residue, and feeding on contaminated prey (Longley and Stark, 1996).

For Safari 20 SGL is a dinotefuran, from action structure and mechanism of the neonicotinoids, dinotefuran belongs to the third generation of neonicotinoids. In this experiment this insecticide had a highly toxic impact on the beetles when exposed directly or indirectly to insecticide residue, similarly (Cloyd, et al., 2009) confirmed that dinotefuran, and thiamethoxam were highly toxic to *Atheta coriaria* rove beetles adults. (Li et al., 2014) founded that dinotefuran was extremely toxic to *Trichograma ostriniae*, when applied directly, and also longevities of female wasps were shortened when exposed to its residue.

Molt X is considered as insect growth regulator IGR’s with active ingredients of Azadirachtin, which has been significantly reduce reproduction, feeding and growth in many insects Mordue (Luntz) et al, (1995), Martinez and Van Emden (1999). our results showed that Molt X has a very harmful effect on the beetles when used in a foliar spray directly to the beetles or indirectly to their food, and thus oppose (Mordue (Luntz) and Nisbet 2000), their results showed that using of *M. persicae* and Its parasitoid *E. Formosa* 5 ppm azadirachtin application are compatible together and can prevent nymph production of *M. persicae*. Our result opposes (Cloyd, et al., 2009) they stated that IGR azadirachtin was compatible with *Atheta coriaria*, and any subsequent negative effect may be depending on the solvents not tha active ingredients.

Oberon 2SC a spiromesifen insecticide, it used against phytophagous mites prevents lipid synthesis in pest (Zhou et al, 2009). In our study this insecticide showed slight impact on *D. catalinae* adults for all recommended rated during the direct exposure and believed to be harmful during the indirect scenario and this result are nearer to (Yorulmaz-Salman and Ay, 2013) he directly sprayed *Neoseiulus californicus* with spiromesifen SC and reported that the life span of adults were 19.7 days.

## V. Conclusion

Safari® 20 SG L and Molt X are very lethal to *D.catalinea*. However, Oberon 2SC, has a sublethal impact on the beetles when applied directly, but has the same lethality when applied indirectly to their food, and can be used in IPM programs for whitefly, Table (3).

Table (3): Conclusion

| Insecticides | Treatments | Low rate | Medium rate | High rate |
|---|---|---|---|---|
| Safari® 20 SG L | Direct | - | - | - |
| | Indirect | - | - | - |
| Molt X | Direct | - | - | - |
| | Indirect | - | - | - |
| Oberon 2SC | Direct | + | + | + |
| | Indirect | - | - | - |
| (-) for lethal impact, and (+) for low impact on the beetles | | | | |

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## VII. Figuers :

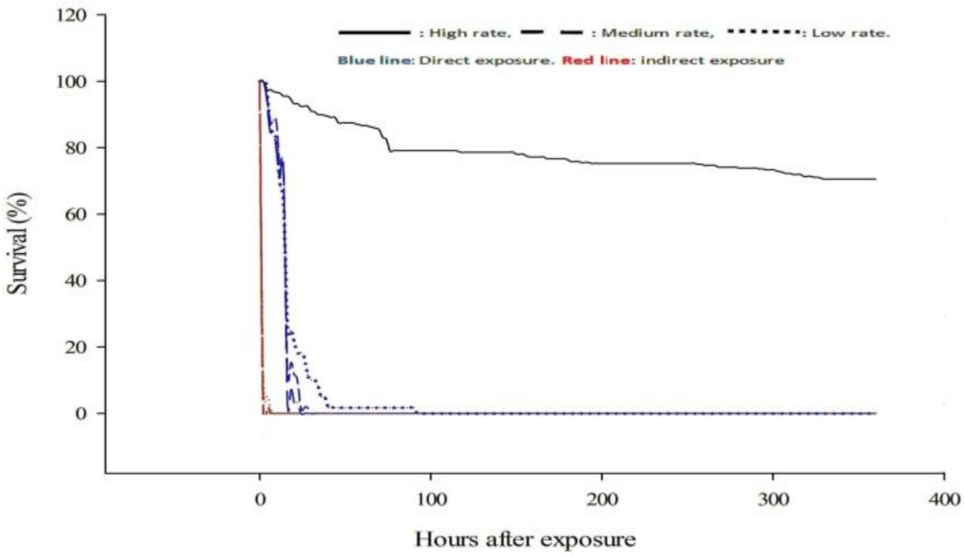


Fig (1): Survival percentage for whitefly predator, *Delphastus catalinae* after exposure to the insecticide, for Safari 20 SG L.

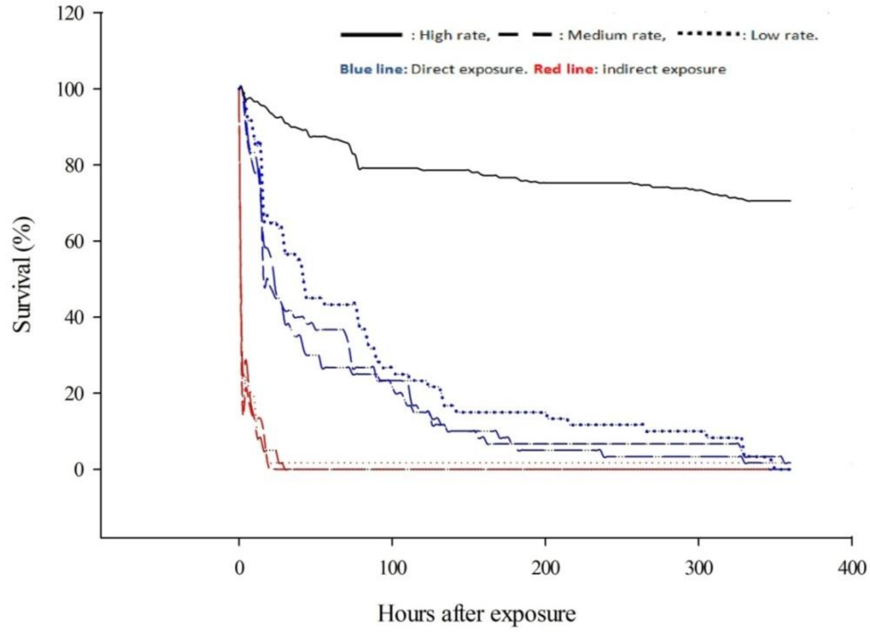


Fig (2): Survival percentage for whitefly predator, *Delphastus catalinae* after exposure to the insecticide, for Molt-X.

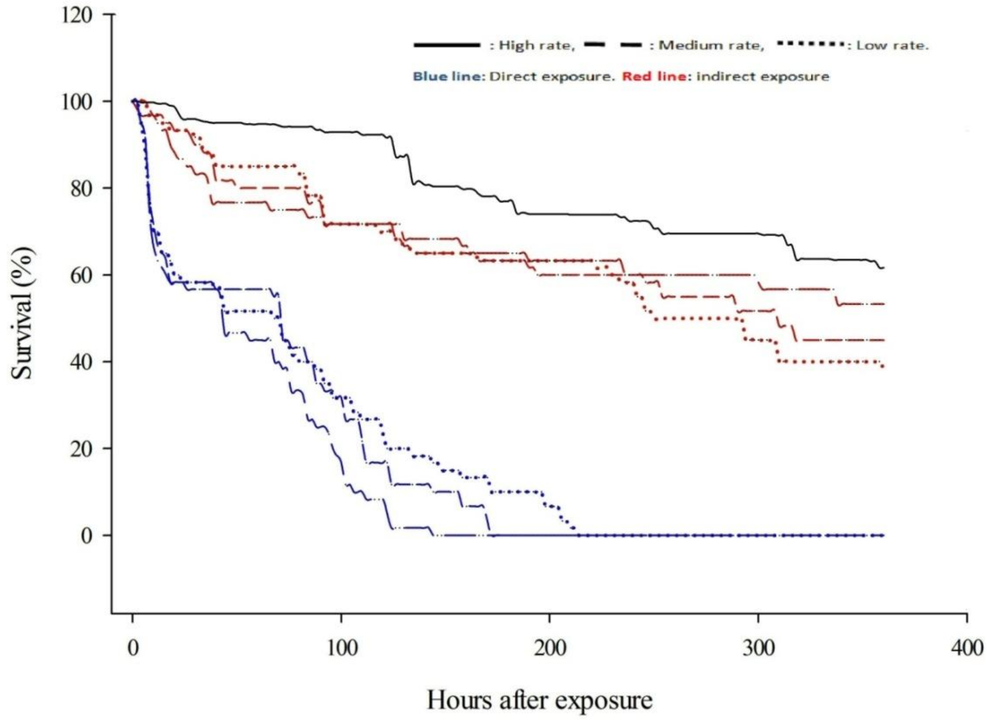


Fig (3): Survival percentage for whitefly predator, *Delphastus catalinae* after exposure to the insecticide, for Oberon 2SC.