Pak. J. Agri. Sci., Vol. 56(4), 1045-1055;2019
ISSN (Print) 0552-9034, ISSN (Online) 2076-0906
DOI: 10.21162/PAKJAS/19.8082
http://www.pakjas.com.pk

TOXIC EFFECTS OF OXAMYL AND PYRIDABEN ON SEVEN PREDATORY MITES: A CALL AND ATTENTION

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Extensive use of pesticides in public health and agricultural programs has caused many environmental problems as well as toxic effects on non-target organisms including predatory mites. This study has been conducted to determine toxic effects of two acaricides; oxamyl and pyridaben at their three different concentrations. Effect of spray was observed on eggs, immatures and adults of seven predatory mites; *Neoseiulus cucumeris* (Oudemans) (Acari: Phytoseiidae), *Amblyseius cydnodactylon* (Shehata and Zaherand), *Phytoseius plumifer* (Canestrini and Fanzago), *Typhlodromips swirskii* (Athias-Henriot), *Euseius scutalis* (Athias-Henriot), *Neoseiulus barkeri* (Hughes) (Acari: Phytoseiidae) and *Agistemus exsertus* (Gonzalez) (Acari: Stigmaeidae) under laboratory conditions. Immature stage of these predatory mites was found to be more susceptible than adults to both oxamyl and pyridaben. The latter was found to be more toxic to immatures and adults than oxamyl. Effect of both pesticides on hatching was found to be insignificant because more than 50% of their eggs were successfully hatched even at the DRD. This study has shown that oxamyl and pyridaben can disrupt biological control due to their toxicity to predatory mites, so extra care must be taken with over application of these acaricides.

Keywords: Acaricides, Oxamyl, Pyridaben, Predatory Mites, Toxicity, eggs.

INTRODUCTION

Found in greenhouses and orchards, tetranychid phytophagous mites grow rapidly in number, especially during warm weather (Zhang and Sanderson, 1990). Due to their high biotic potential they cause great economic damage by reducing the quantity and quality of the produce (Sato *et al.,* 2007; Fiedler and Sosnowska, 2014). Chemical control of pests is most common as it is quick and safe to plants but its repeated use causes the pests to become resistant, as well as result in elimination of pest's natural predators (Price *et al.,* 2002; Van Leeuwen *et al.,* 2007). Therefore, alternative control strategies that may reduce reliance on pesticides are being examined to reduce mite populations. Alternative control strategies consist of the use of predator mites together with pesticides rather than the use of only pesticides in agricultural production areas. An important biological control agent is Phytoseiidae mites, which are used against various pests in different agricultural domains such as orchards, greenhouses, and citrus groves (Hassan, 1977; Cloyd *et al.,* 2006).

Chemical pest treatment has many drawbacks, among them, disturbing the ecological balance owing to the loss of many beneficial organisms, briskly increasing costs of production, increasing contamination of agricultural products and the environment generally with toxic materials, and the acquisition of resistance to the pesticides used by pest organisms. Thus, it is essential that the toxicity of pesticides toward beneficial organisms used for pest control in greenhouse crops can be ascertained. In order to formulate proper recommendations for integrated use, it is essential to perform compatibility studies of biological and chemical control agents (Fiedler and Sosnowska, 2014). Moreover, wide spectrum pesticides which are used in agriculture affect all natural enemies and predator mites. Many Phytoseiidae mites such as *Neoseiulus californicus* and *Phytoseiulus persimilis* are adversely affected by these agricultural pesticides and are unable to maintain their population levels (Cloyd *et al.,* 2006). It is important to determine the effects on natural predators of the pesticides used when developing integrated control systems. Thus, choosing the pesticides used for pests and diseases which least affect beneficial insects is essential in integrated control programs. Of particular importance are regular studies of pesticides and mites to identify side effects for the development of integrated control systems in order to determine which compounds recommend themselves. After the studies, pesticides identified as harmless or not very harmful chemical compounds to predatory mites can be used in production areas. A decrease in the use of pesticides is also believed to decrease the development of resistance in pests (Yourlmaz Salman and Turan, 2017). Nevertheless, the pesticides employed in the Integrated Pest Management (IPM) of orchards also affect the population stability of the predatory mites, and their performance (Kreiter *et al.,* 2010). Furthermore, resistance to pesticides, even to organophosphorous insecticides or pyrethroids which have high mortality rates, increases in *Typhlodromus pyri* (Bonafos *et al.,* 2007). However, side effects of pesticides are found among *T. pyri*, such as reduced fertility among females and increased mortality at different stages (Overmeer and Zon, 1981; Bulmel *et al.,* 2000; Kreiter *et al.,* 2010). A necessity for the successful integration of biological and chemical pest control methods is using products for the protection of plants with low toxicity against natural enemies as well as using pesticide-resistant predatory mites (Hassan *et al.,* 1991). For this reason, it is necessary to know the impact of various pesticides on beneficial organisms in order to understand their usefulness in an IPM program (Salman *et al.,* 2015).

Phytoseiidae are a family of mites which are the main natural enemy of spider mites and other pest insects, and aid in suppressing their populations (Hoy and Glenister, 1991). Several predatory mites have been extensively used for the control of spider mites in greenhouse environments such as, *Amblyseius andersoni*, *Amblyseius swirskii*, and *Phytoseiulus persimilis* (Fiedler and Sosnowska, 2014). The latter was a major predator of the two-spotted spider mite, *Tetranychus urticae* Koch, an important agricultural crop pest, which although native to the Mediterranean basin is now released in commercial strains globally on vegetables and ornamentals (Helle and Sabelis, 1985; Gerson and Weintraub, 2007). *P. persimilis* is sometimes killed by synthetic and organic pesticides used in the control of pest mites (Duso *et al.,* 2008). Therefore, to maximize the role of *P. persimilis* as a bio-agent it is necessary to know the impact of pesticides upon it. There has been major interest by several researchers in recent years into the research of side-effects of pesticides on the natural predators of arthropod pests. Various working groups (e.g. Hassan, 1985; Sterk *et al.,* 1999) have performed comparative studies on a relevant number of beneficial organisms, including *P. persimilis*, and these have positively suggested their use in various agro-ecosystems for IPM. Additionally, the use of *P. persimilis* together with acaricides could reduce the dangers which come from the spread of pesticide resistance and thus be of utmost utility in the control of *T. urticae* populations (Liburd *et al.,* 2007). Different means of testing how pesticides affect *P. persimilis* have been advanced since the 1970s (Samsøe-Petersen, 1983). The first step is laboratory testing to determine the toxicity, followed by semi-field and field tests when a pesticide demonstrates harmful effects in the laboratory (EPPO, 1990). The benefits and drawbacks of these testing methods have been analyzed (Duso *et al.*, 2008).

Little groundwork has been prepared for crucial taxonomic studies of agricultural mites in Saudi Arabia (Al-Atawi, 2011). As a result, there has been little investigation of plant feeding and predatory mites, so there is insufficient data concerning their ecology and biology (Al-Atawi and Halawa, 2011). This information is essential to successfully implement (IPM) programs. Additionally, this information would help to improve agricultural programs recently implemented in Saudi Arabia such as biological control programs and organic farming (Fouly and Al-Rehiani, 2011). However, no predatory mites have been recorded but they have been located on other plants other than vegetable crops (Soliman and Al-Yousef, 1979; Dabbour and Abdul-Aziz, 1982). From the various research conducted in Saudi Arabia, only an identification key for thirteen phytophagous and predacious prostigmatid mite species found on some important agricultural crops in Riyadh has been provided (Soliman and Al-Yousef, 1979), and none of these various studies has provided sufficient information about the distribution or the description of the mites identified (Al-Atawi, 2011). Furthermore, the geographic distribution as well as population density of several predatory mites are directly affected by the extensive application of many acaricides. Nevertheless, toxicity of many acaricides on predatory mites has never been evaluated in Saudi Arabia. Therefore, this study was aimed to evaluate the toxic effects of oxamyl and pyridaben on three different stages (egg, immature and adults) of seven predatory mites, *A. cydnodactylon*, *P. plumifer*, *A. exsertus*, *N. cucumeris*, *T. swirskii*, *E. scutalis* and *N. barkeri*.

MATERIALS AND METHODS

***Collection of plants and mites*:** Grown up females and males of predatory mites, *A. cydnodactylon*, *P. plumifer*, *A. exsertus*, *N. cucumeris*, *T. swirskii*, *E. scutalis* and *N. barkeri* that were used in this study were collected from heavily plagued citrus, fig, olive, castor, strawberry, tomato and eggplant leaves at deserted orchards and greenhouses in the Qassim region of Saudi Arabia.

***Pesticides and spray formulations*:** Commercial formulation of oxamyl (Fymate 24%, oxamyl) was obtained from Astra Company. Pyridaben (Spidy 20% w/v, pyridaben) was obtained from Montajat Pharmaceuticals company. The recommended doses were 400ml/100L for oxamyl and 100g/100L for pyridaben for direct spray mixture.

***Experimental protocol*:** Experiments were performed during June 2018 in the Laboratory at the Department of Plant Production and Protection, College of Agriculture and Veterinary Medicine, Qassim University, Saudi Arabia.

Poisonous effects of both acaricides on the predatory mite were assessed on excised leaf disc in the laboratory. Leaf discs made, were round – shaped with 3 cm diameter. The leaf discs were positioned on cotton bed in Petri dish (4 cm × 2 cm) the under surface turned upward. To keep the leaf discs fresh, the cotton bed was kept wet by soaking it with water twice daily. The leaf discs were observed under a microscope to ensure that no carnivorous insects, mites or their eggs are there, only then mites were transferred to the leaf discs. A ring of Vaseline was put around the leaves so that mites may not escape.

The experimental design utilized was completely randomized. There were twenty grown-ups, immatures and eggs per plot, three treatments of acaricides during a week's time and one untreated group as a control treated with distilled water.

Grown-ups, immatures and eggs of predatory mites were counted using a stereomicroscope, to determine the initial distribution and density of the predatory mites as a pre-spray counts. Thereafter, direct spray was applied on the Petri-dishes by using a small knapsack sprayer (1L). Each experiment was done thrice and an average was reported. After spraying, carnivorous mites were shifted (Predators that did not die) to another substance that contained two-spotted spider mite, *T. urticae* and Tomato russet mite, *Aculops lycopersici* as preys for the survival of predatory mites that were not affected by acaricides, so that the effect of acaricides does not get mingled with that of hunger. To determine post-spray count, observations were made after one week after the application.

***Statistical analysis*:** The equation of Henderson and Tilton (1955) was used to determine the mortality percentage of predatory mites:

$$\text{Corrected}(\%) = (1 - \frac{\text{n in Co before treatment} \times \text{n in T after treatment}}{\text{n in Co after treatment} \times \text{n in T before treatment}})*100$$

Where: n = Number of predatory mites, T = Treated, Co = Control.

The death rate of predatory mites was counted based on direct observation. To calculate the average from this data and to determine the percentage of larvae hatched from eggs, Microsoft Excel was used. Statistically, all variables were assessed with the use of one-way analysis of variance (ANOVA).

RESULTS

***Effect of oxamyl on immature and adult predatory mites*:** Effect of three formulations of oxamyl on mortality of immature and adult predatory mites is shown in Table 1. Decreasing order of mortality for seven species of immature predatory mites after seven days when treated with HRD, RD and DRD is given below:

HRD: AC >ES >PP >NC >TS = NB >AE
RD: AC >PP >ES >NC >TS = NB >AE
DRD: AC >ES >TS >PP >NC >NB >AE

Immature mites of species, *A. exsertus* are most resistant towards oxamyl, showing 20, 35 and 45% mortality and that of *A. cydnodactylon* are least resistant showing mortality of 60, 80 and 95% at HRD, RD and DRD, respectively.

Decreasing order of mortality for adult predatory mites after seven days when treated with HRD, RD and DRD is given below:

HRD: AC >ES >PP >NC >TS >NB >AE
RD: AC > NB >PP >ES >TS >NC >AE
DRD: AC >PP >ES >NB >TS >NC >AE

Adult mites of species *A. exsertus* are most resistant towards oxamyl, showing 15, 25 and 40% mortality and that of *A. cydnodactylon* are least resistant showing mortality of 36.90, 57.90 and 79.00% at HRD, RD and DRD, respectively.

Low mortality has been observed in adults as compared to their immatures.

***Effect of pyridaben on immature and adult predatory mites*:** Effect of three formulations of pyridaben on immature and adult predatory mites is shown in Table 2. Decreasing order of mortality for seven species of immature predatory mites after seven days when treated with HRD, RD and DRD is given below:

HRD: NC >AC >PP >AE >NB >ES >TS
RD: AC >AE >PP >NC >NB >ES = TS
DRD: NB >AE >PP = NC = ES = AC >TS

Immature mites of species, *T. swirskii* are most resistant towards oxamyl, showing 21, 63 and 89.5% mortality at HRD, RD and DRD, respectively. Highest mortality with pyridaben is shown by different species of mites at HRD, RD and DRD. Highest mortality is shown by *N. cucumeris* (45%) at HRD, by *A. cydnodactylon* (83.4%) at RD and by *N. barkeri* (100%) at DRD.

Decreasing order of mortality for seven species of adult predatory mites after seven days when treated with HRD, RD and DRD is given below:

HRD: NC >AC >PP >AE >ES > NB >TS
RD: AC >AE >PP >ES >NC >NB >TS
DRD: AE >PP >AC >NB >NC >ES >TS

Again *T. swirskii* has shown lowest mortality at all doses that is 16, 50, 77.50% at HRD, RD and DRD, respectively. Highest mortality is shown by NC, AC and AE at HRD, RD and DRD which is 60, 73 and 88.3%, respectively.

***Comparative efficacy oxamyl and pyridaben on immature predatory mites*:** Comparative efficacy of the two acaricides, oxamyl and pyridaben against immature mites of the seven selected species is shown in fig 1. *A. cydnodactylon* has shown highest mortality at all doses of the both pesticides with one exception in case of pyridaben, where *N. barkeri* at DRD has shown highest mortality (100%). Among oxamyl treated mites, lowest mortality is shown by *A. exsertus* and in case of pyridaben lowest effected specie is *T. swirskii* at all concentrations. Fig 1 also shows that pyridaben is relatively more toxic to predatory mites than the oxamyl.

***Comparative efficacy oxamyl and pyridaben on adult predatory mites*:** Fig 2 reflects strange results when adult mites are treated with pyridaben. At HRD, RD and DRD different species of mites that is *N. cucumeris, A. cydnodactylon* and *A. exsertus, respectively,* have shown highest mortality. In general, pyridaben is more toxic than the oxamyl against all selected species of mites.

***Efficacy of oxamyl and pyridaben on hatching of eggs*:** Effect of oxamyl and pyridaben on hatching of eggs is given in tables 3 and 4, respectively and their comparison in fig 3.

When eggs are treated with oxamyl at RD, maximum and minimum hatching is 85% and 60%, respectively. With pyridaben, highest hatching is 85% and minimum value is 65%. From fig 3, it can be observed that oxamyl and pyridaben have almost the same effect on hatching at all doses.

Table 1. Effect of three concentrations of oxamyl on immature and adult predatory mites, *A. cydnodactylon*, *P. plumifer*, *A. exsertus*, *N. cucumeris*, *T. swirskii*, *E. scutalis* and *N. barkeri* under laboratory conditions.

		No. of immature predatory mites			No. of adult predatory mites		
Species	**Conc.**	**Average pre-spray count**	**Average post-spray count ***	**Mortality % ****	**Average pre-spray count**	**Average post-spray count ***	**Mortality % ****
A. cydnodactylon (AC)	Control	20.00	20.00	0.00 a	20.00	19.00	0.00 a
	HRD	20.00	8.00	60.00 b	20.00	12.00	36.90 b
	RD	20.00	4.00	80.00 c	20.00	8.00	57.90 c
	DRD	20.00	1.000	95.00 d	20.00	4.00	79.00 d
P. plumifer (PP)	Control	20.00	19.00	0.00 a	20.00	19.00	0.00 a
	HRD	20.00	12.00	36.00 b	20.00	15.00	22.00 b
	RD	20.00	7.00	63.00 c	20.00	10.00	47.00 c
	DRD	20.00	3.00	84.30 d	20.00	5.00	73.0
A. exsertus (AE)	Control	20.00	20.00	0.00 a	20.00	20.00	0.00 a
	HRD	20.00	16.00	20.00 b	20.00	17.00	15.00 b
	RD	20.00	13.00	35.00 c	20.00	15.00	25.00 c
	DRD	20.00	11.00	45.00 d	20.00	12.00	40.00 d
N. cucumeris (NC)	Control	20.00	19.00	0.00 a	20.00	19.00	0.00 a
	HRD	20.00	13.00	31.00 b	20.00	15.00	21.10 b
	RD	20.00	8.00	57.00 c	20.00	11.00	42.20 c
	DRD	20.00	4.00	79.00 d	20.00	7.00	63.00 c
T. swirskii (TS)	Control	20.00	20.00	0.00 a	20.00	20.00	0.00 a
	HRD	20.00	14.00	30.00 b	20.00	16.00	20.00 b
	RD	20.00	9.00	55.00 c	20.00	11.00	45.00 c
	DRD	20.00	3.00	85.00 d	20.00	6.00	70.00 d
E. scutalis (ES)	Control	20.00	20.00	0.00 a	20.00	19.00	0.00 a
	HRD	20.00	12.00	40.00 b	20.00	14.00	26.40 b
	RD	20.00	8.00	60.00 c	20.00	10.00	47.00 c
	DRD	20.00	3.00	85.00 d	20.00	5.00	73.70 d
N. barkeri (NB)	Control	20.00	20.00	0.00 a	20.00	18.00	0.00 a
	HRD	20.00	14.00	30.00 b	20.00	15.00	16.00 b
	RD	20.00	9.00	55.00 c	20.00	9.00	50.00 c
	DRD	20.00	5.00	75.00 d	20.00	5.00	73.00 d

*Counts made one week post treatment. ** Mortality values calculated with the Henderson-Tilton equation. Different letters in the horizontal rows denote significant difference between control, HRD, RD and DRD within a specie, (F-test, $P < 0.05$, $P < 0.01$).

Table 2. Effect of three concentrations of pyridaben on immature and adult predatory mites, *A. cydnodactylon*, *P. plumifer*, *A. exsertus*, *N. cucumeris*, *T. swirskii*, *E. scutalis* and *N. barkeri* under laboratory conditions.

Species	Conc.	No. of immature predatory mites			No. of adult predatory mites		
		Average pre-spray count	Average post-spray count *	Mortality % **	Average pre-spray count	Average post-spray count *	Mortality % **
A. cydnodactylon (AC)	Control	20.00	18.00	0.00 a	20.00	19.00	0.00 a
	HRD	20.00	10.00	44.50 b	20.00	12.00	36.90 b
	RD	20.00	3.00	83.40 c	20.00	5.00	73.70 c
	DRD	20.00	1.00	94.45 d	20.00	3.00	84.30 d
P. plumifer (PP)	Control	20.00	20.00	0.00 a	20.00	20.00	0.00 a
	HRD	20.00	12.00	40.00 b	20.00	14.00	30.00 b
	RD	20.00	4.00	80.00 c	20.00	6.00	70.00 c
	DRD	20.00	1.00	95.00 d	20.00	3.00	85.00 d
A. exsertus (AE)	Control	20.00	18.00	0.00 a	20.00	17.00	0.00 a
	HRD	20.00	11.00	38.88 b	20.00	12.00	29.50 b
	RD	20.00	3.00	83.34 c	20.00	5.00	70.60 c
	DRD	20.00	1.00	95.50 d	20.00	2.00	88.30 d
N. cucumeris (NC)	Control	20.00	20.00	0.00 a	20.00	20.00	0.00 a
	HRD	20.00	15.00	45.00 b	20.00	16.00	40.00 b
	RD	20.00	6.00	70.00 c	20.00	8.00	60.00 c
	DRD	20.00	1.00	95.00 d	20.00	4.00	80.00 d
T. swirskii (TS)	Control	20.00	19.00	0.00 a	20.00	18.00	0.00 a
	HRD	20.00	15.00	21.00 b	20.00	15.00	16.00 b
	RD	20.00	7.00	63.20 c	20.00	9.00	50.00 c
	DRD	20.00	2.00	89.50 d	20.00	4.00	77.80 d
E. scutalis (ES)	Control	20.00	19.00	0.00 a	20.00	20.00	0.00 a
	HRD	20.00	14.00	26.40 b	20.00	15.00	25.00 b
	RD	20.00	7.00	63.15 c	20.00	7.00	65.00 c
	DRD	20.00	1.00	95.00 d	20.00	4.00	80.00 d
N. barkeri (NB)	Control	20.00	20.00	0.00 a	20.00	18.00	0.00 a
	HRD	20.00	13.00	35.00 b	20.00	14.00	22.30 b
	RD	20.00	6.00	70.00 c	20.00	8.00	55.60 c
	DRD	20.00	0.00	100.00 d	20.00	3.00	83.30 d

*Counts made one week post treatment. ** Mortality values calculated with the Henderson-Tilton equation. Different letters in the horizontal rows denote significant difference between control, HRD, RD and DRD within a specie, (F-test, $P < 0.05$, $P < 0.01$).

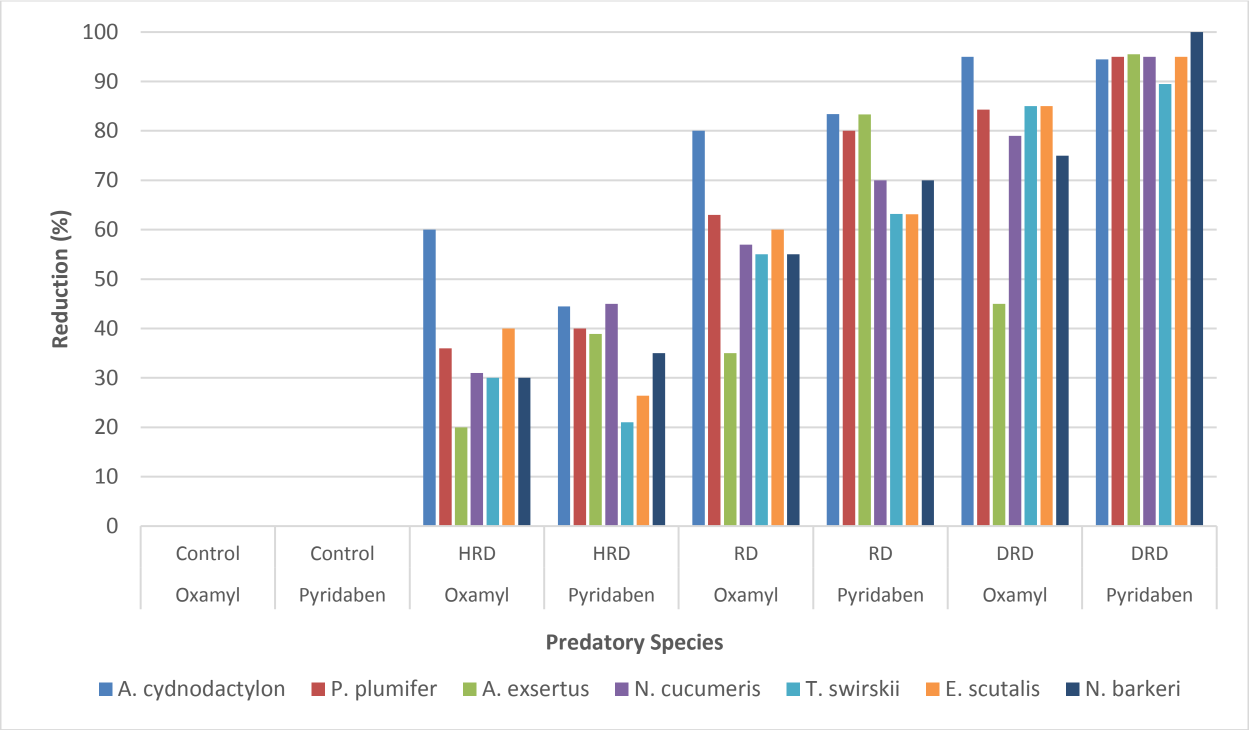

Figure 1. **Side effects of three concentrations of oxamyl and pyridaben on immature predatory mites under laboratory conditions.**

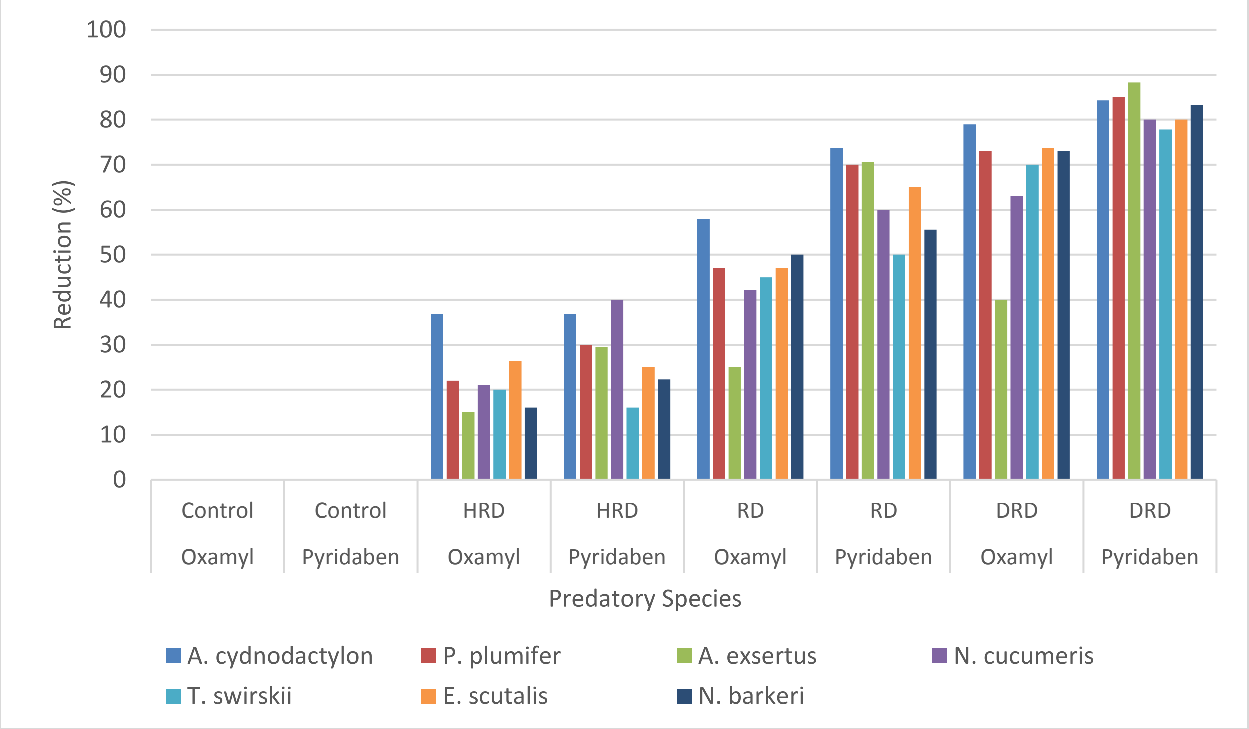

Figure 2. **Side effects of three concentrations of oxamyl and pyridaben on adult predatory mites under laboratory conditions.**

Table 3. Number of larvae hatching from eggs of the predatory mite, *A. cydnodactylon*, *P. plumifer*, *A. exsertus*, *N. cucumeris*, *T. swirskii*, *E. scutalis* and *N. barkeri* treated with three concentrations of oxamyl under laboratory conditions.

Species	Conc.	No. of eggs and larvae		
		Average number of eggs pre-spray count	Average number of larvae post-spray count *	Hatching (%) **
A. cydnodactylon	Control	20.00	20.00	100.00 a
	HRD	20.00	17.00	85.00 b
	RD	20.00	16.00	80.00 b
	DRD	20.00	14.00	70.00 c
P. plumifer	Control	20.00	20.00	100.00 a
	HRD	20.00	16.00	80.00 b
	RD	20.00	12.00	60.00 c
	DRD	20.00	10.00	50.00 d
A. exsertus	Control	20.00	20.00	100.00 a
	HRD	20.00	18.00	90.00 b
	RD	20.00	17.00	85.00 b
	DRD	20.00	15.00	75.00 c
N. cucumeris	Control	20.00	20.00	100.00 a
	HRD	20.00	15.00	75.00 b
	RD	20.00	15.00	75.00 b
	DRD	20.00	14.00	70.00 b
T. swirskii	Control	20.00	20.00	100.00 a
	HRD	20.00	18.00	90.00 b
	RD	20.00	16.00	80.00 c
	DRD	20.00	15.00	75.00 c
E. scutalis	Control	20.00	20.00	100.00 a
	HRD	20.00	18.00	90.00 b
	RD	20.00	15.00	75.00 c
	DRD	20.00	13.00	65.00 d
N. barkeri	Control	20.00	20.00	100.00 a
	HRD	20.00	17.00	85.00 b
	RD	20.00	15.00	75.00 c
	DRD	20.00	12.00	60.00 d

*Counts made one week post treatment. ** Hatching percentage calculated with Excel Microsoft program. Different letters in the horizontal rows denote significant difference between control, HRD, RD and DRD within a specie, (F-test, $P < 0.05$, $P < 0.01$).

Table 4. **Number of larvae hatching from eggs of the predatory mite, *A. cydnodactylon*, *P. plumifer*, *A. exsertus*, *N. cucumeris*, *T. swirskii*, *E. scutalis* and *N. barkeri* treated with three concentrations of pyridaben under laboratory conditions**.

Species	Conc.	No. of eggs and larvae		
		Average number of eggs pre-spray count	Average number of larvae post-spray count *	Hatching (%) **
A. cydnodactylon	Control	20.00	20.00	100.00 a
	HRD	20.00	18.00	75.00 b
	RD	20.00	16.00	80.00 b
	DRD	20.00	12.00	60.00 c
P. plumifer	Control	20.00	18.00	100.00 a
	HRD	20.00	16.00	80.00 b
	RD	20.00	13.00	65.00 c
	DRD	20.00	10.00	50.00 d
A. exsertus	Control	20.00	20.00	100.00 a
	HRD	20.00	18.00	90.00 b
	RD	20.00	14.00	70.00 c
	DRD	20.00	11.00	55.00 d
N. cucumeris	Control	20.00	20.00	100.00 a
	HRD	20.00	17.00	85.00 b
	RD	20.00	14.00	70.00 c
	DRD	20.00	11.00	55.00 d
T. swirskii	Control	20.00	20.00	100.00 a
	HRD	20.00	18.00	90.00 b
	RD	20.00	14.00	70.00 c
	DRD	20.00	13.00	65.00 c
E. scutalis	Control	20.00	20.00	100.00 a
	HRD	20.00	17.00	85.00 b
	RD	20.00	15.00	75.00 c
	DRD	20.00	15.00	75.00 c
N. barkeri	Control	20.00	20.00	100.00 a
	HRD	20.00	19.00	95.00 b
	RD	20.00	17.00	85.00 c
	DRD	20.00	16.00	80.00 c

*Counts made one week post treatment. ** Hatching percentage calculated with Excel Microsoft program. Different letters in the horizontal rows denote significant difference between control, HRD, RD and DRD within a specie, (F-test, $P < 0.05$, $P < 0.01$).

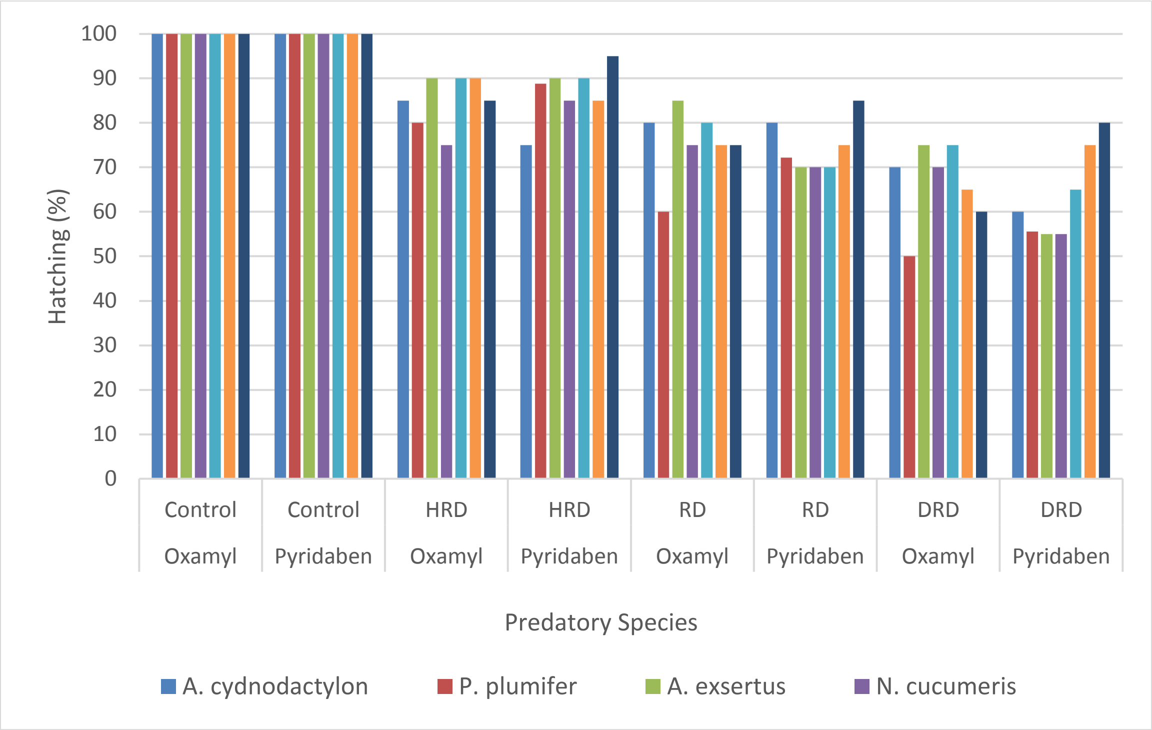

Figure 3. Number of larvae hatching from eggs of the predatory mites treated with three concentrations of oxamyl and pyridaben under laboratory conditions.

***Discussion*:** Pesticides in agriculture have indispensable importance across the world and in Saudi Arabia as well. Although, pesticides provide quick protection to the crop and help to increase commercial value of the final product, at the same time they kill predatory mites and disrupt natural control system. By protecting predatory mites and encouraging their population, crops can be saved in green houses and agricultural fields (Flint and Dreistadt, 1998). The current study was designed to determine toxic effects of oxamyl and pyridaben at three different stages (egg, immature and adult) of seven predatory mites, *A. cydnodactylon*, *P. plumifer*, *A. exsertus*, *N. cucumeris*, *T. swirskii*, *E. scutalis* and *N. barkeri*. The obtained results showed that all these predatory mites were susceptible to both oxamyl and pyridaben. The latter was more toxic to the mobile stages (immature and adult) than oxamyl. The immature stage was found to be more sensitive to both acaricides. In addition, eggs of all seven predatory mites were less sensitive to both acaricides as the hatching percentage was more than 50% even at the DRD. Thus, it can be assumed that both acaricides are unable to penetrate the egg shell, so hatching was successful. However, it is unclear whether, the hatched mites are healthy, like the untreated, or not as this is beyond the scope of this study. These findings were consistent with the observations of Carlo *et al.* who reported in 2008 that pesticides did not affect the egg-hatching of *P. persimilis* females exposed to pesticides.

It is become more pronounced that many conventional acaricides might not kill predatory mites but exposure to any can lead to reduction in feeding as well as activity, so that resulted in losing proper performance. For example, exposure to indoxacarb causes insects to cease to feed in a few hours, to demonstrate reduced mobility, and possibly to show convulsions and slight tremors. Even though, it is more toxic to Lepidoptera. Therefore, it could be used without major impact on non-target organisms to reduce lepidopteran pests in agro-ecosystems (Bosanian *et al*., 2004). Nevertheless, it might be argued that field tests can definitely assess the environmental effects of a certain pesticide, and only field tests can examine the impact of a pesticide on natural occurring populations in their natural habitat rather than laboratory tests. However, even the results of one field test cannot necessarily be applied to another field situation. Despite the use of pesticides, the availability of food sources and environmental conditions within and between seasons can be quite different. These differences can be a part of the systems that determine which direct and indirect effects of a pesticide manifest themselves on non-target organisms (Pozzebon *et al*., 2010).

Laboratory results are limited as they do not involve environmental factors which also influence the impact of a pesticide on natural occurring populations in their natural habitat.

This study emphasizes that toxic effects of any new or currently in use acaricide must undergo an evaluation test to ascertain their effects on non-target organisms. For example, new pesticides in Europe must be evaluated for their effects on non-target organisms, including many beneficial organisms, before they are authorized for use (Pozzebon *et al.,* 2015). Therefore, such regulations must be applied worldwide for all pesticides being used to ensure that they are not toxic to non-target organisms.

***Conclusion*:** Acaricides when used for plant protection in green houses and fields, also kill non-target organisms which provide natural control over phytophagous mites. Pyridaben is more toxic to predatory mites than oxamyl at all concentrations. Hatching process is not affected significantly, when mite eggs are treated with acaricide spray. Therefore, field studies are essential to determine the actual impact of acaricides on mortality of predatory mites under field conditions.

***Acknowledgement*:** The authors gratefully acknowledge Dr. Mahmoud M. Al-Azzazy for revising this manuscript.

***Conflict of interest*:** The author declares that there is no conflict of interest.

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