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Field Evaluation of a Newly Introduced Thiamethoxam Insecticide and Neem Seed Water Extract Against the Predator *Hippodamia Variegata* in Sudan

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***Abstract* — Naturally occurring biological control agents play an important role in suppressing many important agricultural insect pests under normal conditions. Regrettably, many synthetic pesticides are reported to impose negative impacts on beneficial insects. Therefore, considerable efforts are devoted in recent years to choose selective insecticides for combating noxious pests. Accordingly, field experiments were conducted on potato crop during two consecutive winter (December-March) seasons at Shambat Research Station, Khartoum North, Sudan, to study the side effects of a newly introduced insecticide Actara (thiamethoxam) 25 WG, applied at different rates, and neem seed kernel water extract (NSKWE) at two rates, on larvae of the coccinellid predator, *Hippodamia variegata*. The results indicated that Actara was toxic (IOBC class 4) to the larvae of *H. variegata* under the two experiments, while NSKWE was found to be safe to the predator. Such neem extract at its two rates (2.5% and 5%w/v) showed significantly the highest numbers of the predator in the two experiments. It is concluded that the tested neem treatments can be used safely against potato pests without adverse effect on the predatory larvae of *H. variegata*, but Actara should be avoided when natural enemies are active.**

***Key Words* — Predatory larvae, *Hippodamia*, neem, Actara, Side effect, toxicity, selective insecticide.**

I. Introduction

Natural enemies (predators, parasites and entomopathogens) of insects play an important role in regulating agricultural pests under normal conditions. Therefore, exploitation of these enemies in biological control through various ways (importation, augmentation or conservation) comprises an important component of many integrated pest management programmes at the global level. Nevertheless, the extensive usage of several broad spectrum synthetic insecticides in field and vegetable crops is found to affect the natural enemies negatively [1]-[2]-[3]. The beneficial arthropods (predators and parasitoids) can be exposed to insecticides either directly through sprays or indirectly when get in contact with residues on plant surfaces, or by ingesting insecticide contaminated preys on host. To avoid such problems, harmful synthetic insecticides should be applied selectively (i.e., in terms of place, time and application technique), or otherwise selective chemicals with high or moderate safety to natural enemies may be selected and used.

Thiamethoxam is a second–generation neonicotinoid compound with systemic and contact activity on economic important sucking pests (e.g., aphids and whitefly) of vegetables and other crops [4]. In Sudan, thiamethoxam (viz., Actara 25 WG) was recently recommended for the control of whitefly *Bemisia tabaci* on tomato and *Aphis gossypii* on potato [5]. On the other hand, biologically active substances from neem tree, *Azadirchtca indica* (A. Juss), have been evaluated against agricultural pests and their natural enemies in different parts of the world [6]-[7]-[8]-[9]. Likewise, neem seed water extract was recommended for the control of various pests on different vegetable crops in Sudan [10]-[11]-[12]-[13]. No adverse effects on populations of insect predators were recorded from the application of such neem extract on vegetables [11]-[12]-[14]. However, the important predatory groups recorded on vegetables in Khartoum and other parts of the country included: Coccinellids (e.g., *Hippodamia variegata*, *Scymnus* spp., *Cheilomenes propinqua vicina* and *Coccinella undecimpunctata*), chrysopids (e.g., *Chrysoperla carnea*), syrphids (e.g., *Xanthogramma aegyptium*) and different spiders [9]-[15]-[16]-[17]-[18]-[19]. Among the coccinellids recorded, *H. variegata* is the most abundant and most widespread in different parts of the country [12]-[16]-[19]-[20]. This rich fauna need to be thoroughly investigated and conserved to enhance their biological role in pest control.

Objective: The side effects of Actara 25 WG (thiamethoxam) insecticide and neem seed kernel water extract, used for controlling potato insect pests, were evaluated in this study against the larvae of the coccinellid lady bird beetle, *Hippodamia variegata*, on the same crop (potato).

II. Materials and Methods

Two consecutive field experiments were conducted on potato crop at Shambat, Khartoum North, Sudan, during winter seasons of 2002/03 and 2003/04. It was aimed to evaluate the side effects of Actara (thiamethoxam) 25 WG insecticide at 18.8, 25.0, 31.3 and 37.5g a.i./feddan (=42ha) and neem seed kernel water extract (NSKWE) at 2.5%w/v (25g neem kernel powder/L. water) and 5% (50g/L.) on larval population of the coccinellid predator, *Hippodamia variegata*. Moreover, Actara at 25g a.i/fed. mixed with NSKWE 25g /L. of water were tested in the second season.

A. *Preparation of Neem Treatments*

The NSKWE was prepared according to the method adopted by Siddig (1991) [10]. The major steps included, soaking of neem fruits in water for 12h to remove the seeds, and then followed by manual decortication of seeds to obtain the neem seed kernels. Such kernels were made into fine powder using an electric blender. The kernel powder was thoroughly mixed in water, left to stand overnight and filtered. The extract was diluted with water to prepare the above mentioned concentrations (2.5% and 5%). Liquid soap (1%) was added as an emulsifier and Gum Arabic (1%) as a sticker and as anti-oxidant, and molasses (1%) as anti –UV-light agent [14].

B. *Experimental Layout and Counts*

Potato variety "Alpha" was sown on December 15, 2002 and November 23, 2003, in the two experiments, respectively. The plot size was 3x4 m, with 70 cm spacing between rows and 20 cm between plant holes. All recommended cultural practices were adopted. The experiment was laid out in a Randomized Complete Block design with three replications.

C. *Sprays of Treatments and Insect Counts*

Regarding the insect counts, five potato plants were randomly chosen from each plot and the number of *H. variegata* larvae was recorded, scheduled at 2, 4, and 7 days after sprays (post spray counts). Three sprays and four sprays were applied in the first and the second experiments, respectively. The Data were transformed to $\sqrt{x}$ +0.5 and subjected to ANOVA statistical analysis. The toxicity levels were compared according to IOBC classification. Means comparisons were done according to Duncan's Multiple Range Test.

III. Results and Discussion

The results of all post spray counts of the predatory larvae were summarized in tables 1 and table 2, for the first and second experiments, respectively. The incidence of the predator was found to start as early as the first spray in season 2002/03 (late sown), but it showed a delayed occurrence coincided with the second spray in season 2003/04 (early sown). This may indicate that the predators in potato field generally appear late in the winter season. Therefore, the first count in the second experiment was discarded from table 2. Such results agreed with Satti *et al.* (2003) who found that coccinellid predators started to build up late in winter season showing their highest levels between January and April [14].

It is clear that, all counts of both experiments revealed zero predators in all treatment rates of Actara insecticide, showing significant differences from the untreated controls and neem treatments. This proved the toxic effect of the insecticide Actara against the predatory larvae of *H. variegata* (Figs. 1 and 2). The current results agree with previous findings reported on different natural enemies worldwide. For instances, Torres *et al.* (2003) stated that thiamethoxam was highly toxic for the coccinellid predator *Delphastus pusillus* (Leconte) at all recommended doses and time of application [4]. Williams and Price (2004) found that thiamethoxam was highly toxic to *Anaphes iole* and *Trichogramma pretiosum* [2]. Since thiamethoxam is a new chemical group in Sudan, no research results were found regarding its side effects on predators. Such kind of research is also neglected or rarely addressed for other broad spectrum insecticides in the country, a situation which leads to lack of follow up until the problem has been aggravated. The consequence is that great demolition of indigenous natural enemies of pests besides various environmental pollutions are occurred as a result of extensive usage of conventional insecticides during the second half of the 20th century [15]-[21]-[22]. Therefore, step by step assessments of new chemicals should be stressed to avoid such drawbacks of synthetic toxic chemicals.

On the other hand, neem seed kernel water extract (NSKWE), at 2.5% and 5%w/v, showed significantly the highest population counts of the predator, as compared with those of the control and the synthetic insecticide Actara 25 WG (tables 1 and 2). However, no significant differences were found between the two concentrations of neem extract, suggesting the safety of this extract to the predator under the two dosage rates applied (Figs. 1 and 2). In other way, the detection of higher predators on neem treatments than on the untreated control might be attributed to several reasons; for examples either to possible occurrence of attractant effect in neem treatment besides their safety to the predator or otherwise due to disappearance of prey species from control plots in late counts as a result of high damage. These assumptions need thorough investigations. Generally, the results were in consistency with some previous works which reported the safety of neem extracts against different predators including coccinellid species, as compared with a number of recommended insecticides [12]-[14]-[23]. This safety was largely attributed to lack of contact effect in neem treatments [10]-[24]. Some previous works also revealed higher predators on neem extracts than on the untreated control [12]. Moreover, Smith and Krischik (2000) reported that Azatin, an extract from neem tree, has less effect on four species of coccinellids compared with the carbaryl (Sevin) insecticide which resulted in 100% mortality [25]. Ulrichs *et al.* (2001) and ElShafie and Basedow (2003) stated that NSKWE and Neem Azal-T/S, were less toxic to coccinellid beetles on yard long bean and vegetable crops under field conditions [9]-[26].

IV. Conclusion

It is concluded that neem seed kernel water extract can be applied for potato pests control without adverse effect on the larvae of *Hippodamia variegata* associated with the crop. But, the toxicity of the insecticide, Actara 25 WG, should be avoided whenever high activities of such predators are occurred, or otherwise formulations suitable for drench application which prevent direct contact of predators with the insecticide should be considered. The results also indicated that the usage of neem extract can be

compatible with integrated pest management involved biological control through coccinellid predators, particularly *H. variegata*, on potato crop.

Table 1. Effects of the insecticide Actara (thiamethoxam) 25 WG and neem seed kernel water extract treatments on *Hippodamia variegata* larvae in potato field, Shambat, Sudan (2002/2003).

Treatments	Mean counts of predator larvae/5 potato plants, at different days after sprays						
	1st spray	2nd spray			3rd spray		
	7	2	4	7	2	4	7
Actara 25 WG, 18.8g a.i/f.	(0.7) 0.0a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a
Actara 25 WG, 25.0g a.i/f.	(0.7) 0.0a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a
Actara 25 WG, 31.3g a.i/f.	(0.7) 0.0a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7)0.0 a	(0.7) 0.0 a
Actara 25 WG, 37.5g a.i/f.	(0.7) 0.0a	(0.7) 0.0a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a
NSKWE 25 g/L. water	(0.7) 0.0a	(0.7) 0.0 a	(1.4) 1.5b	(4.8) 15.0b	(2.0) 4.0bc	(4.6) 20.7 b	(2.5) 5.8 b
NSKWE 40 g/L. water	(0.7) 0.0a	(0.7) 0.0 a	(0.7) 0.0 a	(2.2) 7.9 a	(2.9)8.0 c	(4.7) 21.6b	(2.0) 4.0 ab
Untreated control	(2.0)4.0 b	(1.4) 1.8 b	(2.4) 5.8 b	(7.4) 52.0 c	(1.3) 1.5 b	(5.2) 26.5 b	(1.7) 1.3 ab
SE ±	0.2	0.1	0.3	0.3	0.3	0.7	0.4
C.V.%	33.4	26.8		28.8	28.8	69.6	71.3

NSKWE = Neem seed kernel water extract; Means in parenthesis are transformed values to $\sqrt{x+0.5}$; f.= feddan (=0.42ha).
Means followed by the same letter (s), in each column, are not significantly different at P 5% based on DMR test.

Table 2. Effects of the insecticide Actara (thiamethoxam) 25 WG and neem seed kernel water extract treatments on *Hippodamia variegata* larvae in potato field, Shambat, Sudan (2003/2004).

Treatments	Mean counts of predator larvae/5 potato plants, at different days after sprays*						
	2nd spray	3rd spray			4th spray		
	7	2	4	7	2	4	7
Actara 25 WG, 18.8g a.i/f.	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7)0.0a
Actara 25 WG, 25.0g a.i/f.	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7)0.0a
Actara 25 WG, 31.3g a.i/f.	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7)0.0 a	(0.7)0.0a
Actara 25 WG, 37.5g a.i/f.	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7)0.0a
Actara 25 WG, 25.0g a.i.+ NSKWE 25 g/f.	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7) 0.0 a	(0.7)0.0a
NSKWE 25 g/L. water	(0.7) 0.0 a	(1.5) 1.9 a	(1.5) 1.8 b	(2.9) 7.9 b	(4.0)15.6b	(3.3)10.4b	(2.5)5.8b
NSKWE 40 g/L. water	(0.7) 0.0 a	(1.4) .8ab	(2.2)4.3ab	(3.5) 1.8b	(4.4)18.9b	(4.2)17.2b	(1.3)1.2ab
Untreated control	(2.1)4.0 b	(2.3) 4.8 b	(2.0) 4.0 b	(2.7) 6.8 b	(3.1) 9.3 b	(3.2) 9.7 b	(1.3)1.3ab
SE ±	0.2	0.4	0.3	0.3	0.3	0.7	0.4
C.V.%	38	64.8	56.7	28.8	28.8	69.6	66.2

*= The first spray data was discarded due to absence of predator; NSKWE = Neem seed kernel water extract; Means in parenthesis are transformed values to $\sqrt{x+0.5}$; f.= feddan (=0.42ha).
Means followed by the same letter (s), in each column, are not significantly different at P 5% based on DMR test.

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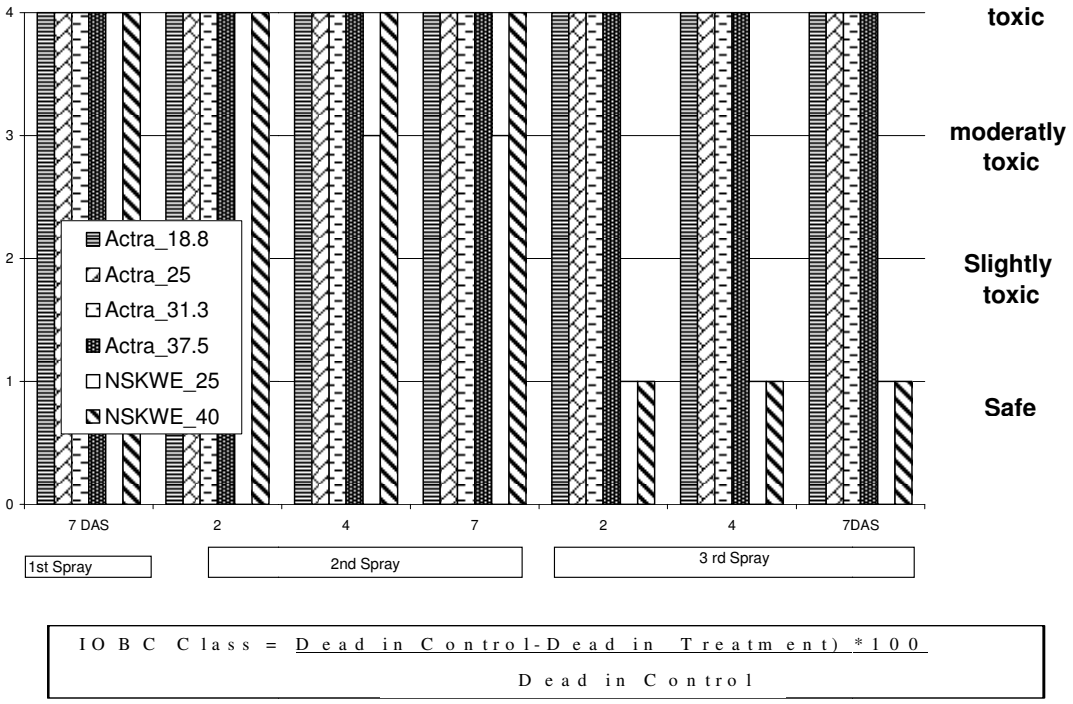

$$\text{IOBC Class} = \frac{(\text{Dead in Control} - \text{Dead in Treatment}) * 100}{\text{Dead in Control}}$$

Fig. 1. Levels of *Hippodamia variegata* larvae as affected by Actara (thiamethoxam) 25 WG and neem seed kernel water extract (NSKWE) treatments (season 2002/03), showing the toxicity levels according to IOBC classification.

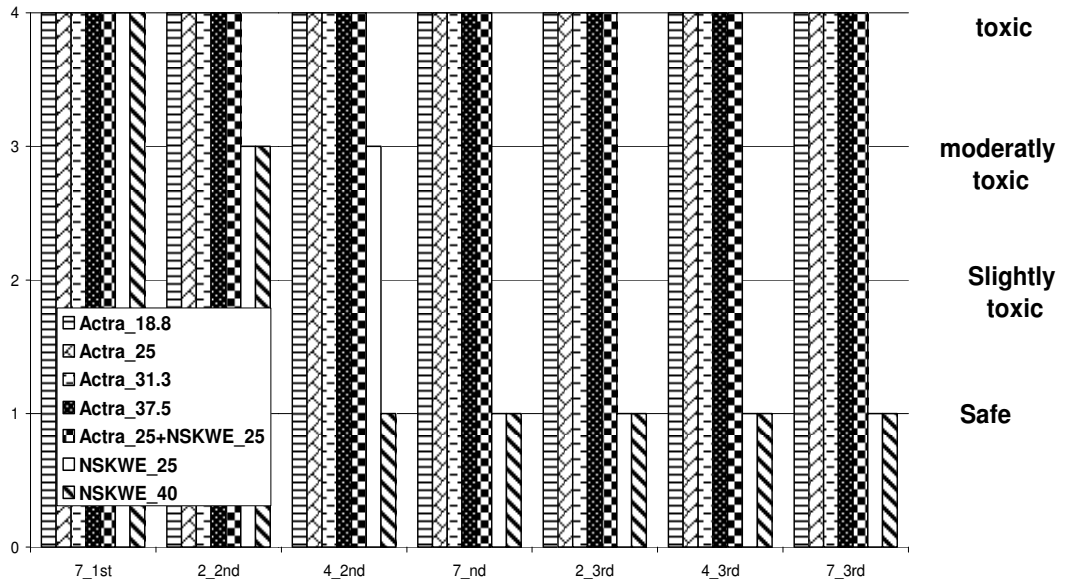

Fig. 2. Levels of *Hippodamia variegata* larvae as affected by Actara (thiamethoxam) 25 WG and neem seed kernel water extract (NSKWE) treatments (season 2003/04), showing the toxicity levels according to IOBC classification.

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