

## The different effects of two preparations of neem (*Azadirachta indica*) and of Sumicidin® on the aphid predator *Hippodamia variegata* (Goeze) (Coleoptera: Coccinellidae)

### Die unterschiedlichen Wirkungen von zwei Präparaten auf der Basis von Neem-Samen (*Azadirachta indica*) und von Sumicidin® auf den Blattlausräuber *Hippodamia variegata* (Goeze) (Coleoptera: Coccinellidae)

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#### Summary

Greenhouse experiments were conducted at Khartoum (Sudan) with the aphid predator *Hippodamia variegata*, two botanical and one synthetic insecticides: neem seed water extract (25 g fresh seed powder per l of water), NeemAzal T/S® (1 % azadirachtin A) and fenvalerate (Sumicidin® 20 % EC). An equivalent of 400 l/ha was applied with a plastic hand sprayer, containing 0.2 l Sumicidin (40 g/ha fenvalerate), 1.6 l NeemAzal (16 g/ha azadirachtin A) or 10 kg of neem seed powder (ca. 30 g/ha azadirachtin A was applied as neem seed water extract). The beetles were fed on *Aphis gossypii* reared on cucumber leaves. Four different stages of the predator were sprayed topically with the test preparations. In addition, beetles were fed on *A. gossypii* either topically sprayed or collected from cucumber plants, which soil was treated four days earlier. The preparations varied in their effects on the different stages of the predator. Neem seed water extract was less harmful to the predator than NeemAzal T/S. In topical treatments with NeemAzal T/S the corrected mortality (%) was: eggs 37.7, larvae 40.0, pupae 38.2, and adults 16.7; with neem seed water extract: eggs 15.1, larvae 26.7, pupae 29.4, and adults 10.0; with fenvalerate: eggs 86.8, larvae 100, pupae 73.5, and adults 100. Feeding L2 larvae and adults on contaminated aphids resulted in the following corrected mortalities (%): Sumicidin 100, NeemAzal ca. 40 and neem seed water extract 20/17 (larvae/adults). Feeding on aphids treated via the soil with neem seed water extract resulted at maximum in 26.4/16.7 % corrected mortality (larvae/adults), while no effects on the longevity of adults could be observed. So, in contrast to Sumicidin, neem preparations (being effective against pests) proved to be harmless for the beneficial beetle. The results are discussed concerning their importance for plant protection.

**Key words:** aphid predator; *Hippodamia variegata*; neem preparations; Sumicidin; survival; treated prey

#### Zusammenfassung

In Khartoum, Sudan wurden Gewächshausversuche mit zwei botanischen und einem synthetischen Insektizid und dem Blattlausräuber *Hippodamia variegata* (Coccinellidae) durchgeführt: Neem-Saat-Wasser-Extrakt (25 g frisch gemahlene Kerne pro l Wasser), NeemAzal T/S® (1 % Azadirachtin A) und Fenvalerate (Sumicidin® 20 % EC). Mit einem Hand-Sprühgerät wurde mit einem Äquivalent von

400 l/ha Brühe behandelt, entsprechend 0,2 l Somicidin (40 g Fenvalerate), 1,6 l NeemAzal T/S (16 g/ha Azadirachtin A) und 10 kg/ha Neem-Samen-Wasser-Extrakt (ca. 30 g/ha Azadirachtin A). Die Marienkäfer wurden mit *Aphis gossypii* auf Gurkenblättern gefüttert. Vier Stadien des Prädatoren wurden mit den Test-Präparaten besprüht. Zusätzlich wurden Larven und Käfer mit topikal oder über den Boden behandelten Blattläusen gefüttert. Die Präparate wirkten unterschiedlich auf die verschiedenen Stadien des Käfers. Neem-Samen-Wasser-Extrakt war weniger schädlich für die Art als NeemAzal T/S. Die topikal Spritzungen zeigten die folgenden korrigierten Wirkungsgrade (%): NeemAzal T/S: Eier 37,7, Larven 40,0, Puppen 38,2, Adulte 16,7; Neem-Samen-Wasser-Extrakt: Eier 15,1, Larven 26,7, Puppen 29,4, Adulte 10,0; Somicidin: Eier 86,8, Larven 100, Puppen 73,5, Adulte 100. Die Verfütterung behandelte Läuse an Larven und Adulte zeigte korrigierte Mortalitätsraten von 100 % bei Somicidin, von ca. 40 % bei NeemAzal T/S und 25/17 % bei Neem-Samen-Wasser-Extrakt (Larven/Adulte). Verfütterung von über den Boden mit Neem-Samen-Wasser-Extrakt behandelte Blattläuse führte maximal zu 26,4/16,7 % korrigierter Mortalität (Larven/Adulte). Die Lebensdauer der Adulten wurde weder durch Verfütterung topikal mit Neem-Präparaten behandelte noch durch über den Boden behandelte Blattläuse gegenüber Wasserbehandlung verändert. Im Gegensatz zu Somicidin waren die Neem-Präparate harmlos für den Prädatoren. Die Bedeutung der Befunde für den Pflanzenschutz wird diskutiert.

**Stichwörter:** behandelte Beutetiere; Blattlausräuber; *Hippodamia variegata*; Mortalität; Neem-Präparate; Somicidin

## Introduction

*Hippodamia variegata* (Goeze), a palaeartic but now very widespread coccinellid species, is also occurring in the Sudan. It has been used successfully for the control of *Aphis gossypii* on cucumber under greenhouse conditions in Morocco (EL HABI et al. 2000). In the Sudan, the production of vegetables, being restricted to irrigated areas, is increasing (DABROWSKI et al. 1994). Target pests of insecticides, partly polyphagous species like *Bemisia tabaci* (Genn.) (Homoptera: Aleyrodidae), can attack several crops in one area, thus making intense vegetable production unsustainable, since resistance to synthetic insecticides increasingly develops (EL KADY and DEVINE 2003). It is important, therefore, to test botanical insecticides as an alternative to synthetic ingredients, not only against pests (EL SHAFIE and BASEDOW 2003), but also concerning their effects on beneficial insects like *H. variegata*, because these help to reduce crop pests (ELLIOT et al. 2000). In 2003/04, the effects of fenvalerate (Somicidin®) and two neem preparations on this beneficial species have been compared under greenhouse conditions in Khartoum. The results are presented and discussed here.

## 2 Materials and methods

### 2.1 *Aphis gossypii* (Glove) and *Hippodamia variegata*

Both, prey and predator, were collected from the field and reared (when it was evident that they were not parasitized) on cucumber plants (plus aphids as prey for *H. variegata*) in cages which were covered with muslin gauze from all sides and above. The cages had a wooden frame of 46 × 46 × 64 cm.

### 2.2 Insecticide preparations

Commercial Somicidin® (20 % a. i.) was sprayed at a concentration of 5 ml/l (200 ml = 40 g/ha fenvalerate). The neem seed water extract was prepared by milling decorticated neem seed to fine powder. Twenty-five g/l of this powder were solved in water over night and then filtered. According to ERMEL (1995), African neem seeds contain ca. 0.3 % azadirachtin A; thus, ca. 30 g azadirachtin A/ha was applied as neem seed water extract, which had been extracted from 10 kg/ha seed. The commercially formulated neem preparation NeemAzal T/S® contained 1 % azadirachtin A; 1.6 l/ha NeemAzal

T/S (16 g azadirachtin A) were applied. Insecticide spraying was performed with a plastic hand sprayer at an equivalent of 400 l/ha.

### 2.3 Experimental design

**Direct sprays:** Eggs, L2 larvae, pupae and adults of *H. variegata* were sprayed with the preparations and concentrations shown above.

**Offering aphids as food, topically sprayed with the test ingredients:** L2 larvae and adults were offered aphids sprayed with the Somicidin, NeemAzal T/S and neem seed water extract *ad libitum* in Petri dishes.

**Offering aphids as food from plants treated with Neem seed water extract via the soil:** Four days after soil treatment (in pots, filled with 1 kg of soil) with neem seed water extract (25, 50 or 75 g milled seed per pot), aphids which had been settled four days on young cucumber plants in the pots were fed to L2 larvae and adults in Petri dishes.

### 2.4 Replicates and statistics

Eggs were grouped as 20 with four replicates, all other stages of *H. variegata* were 10 per treatment, all with four replicates. The collected data were analysed using the SPSS programme ANOVA, and means were separated by Duncan's multiple range test (DMRT). The corrected mortality was calculated according to HENDERSON and TILTON (1955).

## 3 Results

### 3.1 Direct sprays

The effects of spraying the test preparations on the four stages of the predator are given in table 1. The preparations varied in their effects on the different stages of the predator. The eggs of *H. variegata* showed a corrected mortality of 86.8 % after Somicidin treatment, 37.7 % with NeemAzal T/S, and 15.1 % with neem seed water extract. Somicidin therefore proved to be most detrimental for the eggs, while the neem preparations, especially neem seed water extract showed a lower loss of eggs. The corrected mortality (%) of larvae was 100 for Somicidin, while the mortality induced by NeemAzal T/S

Table 1. Survival and corrected mortality rates of different stages of *Hippodamia variegata* after different direct insecticide sprayings in the greenhouse on cucumber plants

Treatment (400 l/ha)	Eggs (20 per treatment, four replicates)		L2 larvae (10 per treat- ment, four replicates)		Pupae (10 per treatment, four replicates)		Adults (10 per treatment, four replicates)	
	Surviving (4 dat)	Corrected mortality (%)	Surviving (7 dat)	Corrected mortality (%)	Surviving (5 dat)	Corrected mortality (%)	Surviving (7 dat)	Corrected mortality (%)
Somicidin, 0.2 l/ha	1.75 ± 0.83a	86.8	0 ± 0a	100	2.25 ± 0.83a	73.5	0 ± 0a	100
NeemAzal T/S, 1.6 l/ha	8.25 ± 1.48b	37.7	4.5 ± 1.12b	40	5.25 ± 1.09b	38.2	6.25 ± 0.83b	16.7
NSWE, 10 kg/ha	11.25 ± 0.83c	15.1	5.5 ± 0.5b	26.7	6 ± 0.7bc	29.4	6.75 ± 0.43bc	10
Untreated (water)	13.25 ± 1.79c	–	7.5 ± 0.5c	–	8.25 ± 0.82c	–	7.5 ± 0.5c	–

was 40 and by neem seed water extract 26.7. So, again, Sumicidin proved to have the worst effect. Like the eggs, only 73.5 % of the pupae were killed by Sumicidin. The corrected mortality (in %) in NeemAzal T/S was 38.2 and in neem seed water extract 29.4. The mortality after water treatment was 15 %. In summary, also pupae were affected most by Sumicidin, but less by the neem preparations (significant in NeemAzal T/S). Adults of *H. variegata*, when sprayed directly with Sumicidin, were killed at a rate of 100 % like the larvae, while the NeemAzal T/S showed 16.7 %, and neem seed water extract 10 % corrected mortality.

### 3.1 Offering sprayed aphids as prey

The results of these experiments are shown in table 2. The effects on both stages (larvae and adults) were rather similar. Feeding on surviving aphids treated with Sumicidin led to a mortality of 100 %. Feeding upon aphids treated with NeemAzal T/S induced a corrected mortality of ca. 40 % in both stages, while in the case of neem seed water extract the corrected mortality was 25 % for larvae and 17 % for adults. The longevity of the adults averaged two days after feeding on Sumicidin and 57 days in the water control. The longevity of the adults was unaffected by rearing them on aphids treated with the neem preparations Neem Azal T/S and neem seed water extract (58 and 62.3 days, respectively).

### 3.2 Offering aphids as prey from plants treated with neem seed water extract *via* the soil

The results of these experiments are shown in table 3. The effects on larvae and adults should be regarded separately. With increasing concentrations of neem seed water extract in the soil, feeding on aphids from the potted plants increased corrected mortality of L2 larvae from 8.8 to 26.4 % where

Table 2. Survival and corrected mortality rates of L2 larvae and adults of *Hippodamia variegata* (10 each, with four replicates) seven days after *ad libitum* feeding on topically treated *Aphis gossypii* with different ingredients in Petri dishes

Treatment (see table 1)	Larvae (L2)		Adults	
	Surviving	Corrected mortality (%)	Surviving	Corrected mortality (%)
Sumicidin	0 ± 0.a	100	0 ± 0a	100
NeemAzal T/S	4.25 ± 0.83b	39.3	4.25 ± 0.82b	41.4
Neem seed water extract	5.25 ± 0.83b	25	6 ± 0.7c	17.2
Water	7 ± 0.71c	–	7.25 ± 0.43d	–

Figures followed by different letters are significantly different at  $P = 0.05$  (DMRT).

Table 3. The effects of feeding on aphids from plants four days after treatment of the soil with different concentrations of neem seed water extract on the survival of larvae and adults (10 per treatment, four replicates) of *Hippodamia variegata*

Treatment	Larvae (L2)		Adults	
	Surviving	Corrected mortality (%)	Surviving	Corrected mortality (%)
Water only	8.5 ± 0.5a	–	9 ± 0.71a	–
25 g Neem seed powder/kg of soil	7.75 ± 0.83ab	8.8	8.75 ± 0.83a	2.8
50 g Neem seed powder/kg of soil	7 ± 0.71bc	17.6	8 ± 0.71a	11.1
75 g Neem seed powder/kg of soil	6.25 ± 0.43c	26.4	7.5 ± 0.87a	16.7

Figures followed by different letters are significantly different at  $P = 0.05$  (DMRT).

only the higher concentrations gave a significant increase in mortality compared to the control (Table 3). The mortality of adults did not show significant differences between treatments and there were no differences in longevity of the adults compared to the control, which ranged from 55 to 59 days (Table 3).

#### 4 Discussion

The experiments have shown that Sumicidin with its active ingredient fenvalerate has, in contrast to the neem preparations, detrimental effects on all stages of *H. variegata*. The neem preparation effects are within a range that can be tolerated in IPM programmes (CANDOLFI et al. 2000). Since neem preparations have been shown to be effective against a great number of pests (SAXENA et al. 1984; NISBET et al. 1996; BASEDOW et al. 1997; BASEDOW et al. 2002; SCHMUTTERER 2002), they should be preferred in pest control. In aubergines and potatoes in the Sudan, NeemAzal T/S proved to be as efficient in the control of *Bemisia tabaci* Genn. (Homoptera: Aleyrodidae) and *Jacobiasca lybica* de Berg (Homoptera: Cicadellidae) as Sumicidin (EL SHAFIE and BASEDOW 2003).

It was interesting to see that (like in pest control; EL SHAFIE and BASEDOW 2003) non-formulated neem seed water extract had a lower effect than formulated NeemAzal T/S which contained a lower amount of azadirachtin A. BASEDOW et al. (2002) reported that the formulation of NeemAzal T/S alone had a marked control effect on white flies (*Trialeurodes vaporariorum*).

In the present work, aphids that were offered to the predator as food were taken from plants treated with neem seed water extract *via* the soil four days after application. This period may have been too short to give the full effect. BASEDOW et al. (2002) found in *Vicia faba* that the maximum concentration of azadirachtin A was reached after five days. Unfortunately, at Khartoum, the content of azadirachtin A could not be measured in the cucumber plants. But in previous experiments AHMAD et al. (2003) showed that in *Coccinella septempunctata* the same differences occur between direct neem treatments and treatments *via* soil/plant: the latter effects were lower, as found with *H. variegata* in the present work. The results reported here are also in line with those of other authors, working with different coccinellids and neem preparations (LOWERY et al. 1993; SIMMONDS et al. 2000).

Stenophagous aphid antagonists were reported to show a numerical response to aphid density (BASEDOW 1982; TENHUMBERG 1992). Hence, if damage to the aphid antagonists should be limited to a minimum, neem preparations should be applied early in the infestation phase, before the antagonists are attracted by the pest to the site. Effects found in greenhouse are usually more severe than those that occur in the field (VOGT et al. 1998; HERMANN et al. 1997). This has to be taken into account in interpreting the results of the present study.

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