

Evaluation of phytoseiid predators for control of western flower thrips on greenhouse cucumber

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Abstract. Ten predatory mite species, all phytoseiids, were evaluated for control of western flower thrips (WFT), *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae), on greenhouse cucumber. This study was done to further improve biological control of thrips on this crop. *Neoseiulus cucumeris* (Oudemans) is at present used for biological control of thrips in greenhouses. Compared to this species, *Typhlodromalus limonicus* (Garman & McGregor), *Typhlodromips swirskii* (Athias-Henriot) and *Euseius ovalis* (Evans) reached much higher population levels resulting in a significantly better control of thrips. *T. limonicus* was clearly the best predator of WFT. Also *Euseius scutalis* (Athias-Henriot) increased to higher populations levels than *N. cucumeris*, but without controlling the thrips, probably because of an unequal distribution of this predator on the plant. *Iphiseius degenerans* (Berlese), *Neoseiulus barkeri* (Hughes), *Euseius finlandicus* (Oudemans) and *Typhlodromus pyri* (Scheuten) did not establish better than *N. cucumeris*. A non-diapausing exotic strain of *N. cucumeris* did not differ from the North European strain. The best performers in this study were all of subtropical origin. *T. limonicus*, *T. swirskii* and *E. ovalis* have good potentials for controlling not only thrips but also whiteflies. Factors affecting the efficacy of phytoseiids on greenhouse cucumbers are discussed.

Key words: biological control, *Frankliniella occidentalis*, Phytoseiidae, *Typhlodromalus limonicus*, *Typhlodromips swirskii*, *Euseius ovalis*, *Euseius scutalis*, *Iphiseius degenerans*, *Neoseiulus cucumeris*, *Neoseiulus barkeri*, *Euseius finlandicus*, *Typhlodromus pyri*

Introduction

Western flower thrips (WFT), *Frankliniella occidentalis* (Pergande) (Thysanoptera: Thripidae), is one of the most serious pest species for greenhouse crops in Europe and North America (Lewis, 1997; Shipp

and Ramakers, 2004). Biological control of thrips with phytoseiid mites started with observations of these mites preying on *Thrips tabaci* (Lindeman) in greenhouse crops (MacGill, 1939; Woets, 1973). First attempts to control thrips populations in greenhouses with predatory mites were undertaken with *Neoseiulus barkeri* (Hughes) (= *Amblyseius mckenziei*) (Ramakers, 1980), but the introduction of another indigenous (North European) species, *Neoseiulus cucumeris* (Oudemans), became more successful (de Klerk and Ramakers, 1986). At present, this mite is the most commonly used biological control agent for thrips in various greenhouse crops. Control of thrips with this predator is particularly successful in sweet pepper (Ramakers, 1988). High population levels can be reached in this crop even in absence of thrips, due to the presence of suitable pollen (Ramakers, 1990; van Rijn et al., 1999). Modern greenhouse cucumbers are parthenocarpic and do not produce pollen. For this reason *N. cucumeris* is less successful in greenhouse cucumbers. Several studies show a weak numerical response of *N. cucumeris* at low pest density, resulting in unacceptable high levels of thrips in greenhouse cucumbers before control is achieved eventually (Ramakers et al., 1989; Gillespie, 1989; Brødsgaard and Hansen, 1992). Nevertheless, this mite is widely used because it is the only commercial species available on a large scale. Repeated inundative introductions may provide a reasonable control of WFT (Jacobson et al., 2001), but are not popular because of the high costs involved. Insecticides are still required in order to make a clean start at the beginning of every planting and in summer plantings insecticides rather than predatory mites are used for controlling WFT.

Other phytoseiid predators may provide a more effective control of WFT on cucumber. *N. barkeri*, *Iphiseius degenerans* (Berlese) and *Typhlodromalus limonicus* (Garman & McGregor) were tested in greenhouse cucumbers. *N. barkeri* (Brødsgaard and Hansen, 1992) and *I. degenerans* (van Rijn et al., 1999) did not establish at low thrips densities, whereas *T. limonicus* survived well on cucumbers even with low levels of WFT and gave excellent control of WFT (van Houten, 1996; van Rijn et al., 1999). This mite is not yet available commercially because of mass-rearing difficulties (Mulder et al., 1999). *I. degenerans* and *N. barkeri* are provided by commercial suppliers, but on a small scale only. *Euseius scutalis* (Athias-Henriot), *Euseius hibisci* (Chant) and *Euseius tularensis* (Congdon) have been evaluated under laboratory conditions in order to improve biological control of

WFT (van Houten et al., 1995), but were never tested under greenhouse conditions.

The objective of the present study was to evaluate a number of phytoseiid predators for control of WFT on greenhouse cucumbers in order to select a more effective predator with *N. cucumeris* as a standard. Ten species were selected, based on assumed adaptation to a greenhouse climate, host plant adaptation and feeding behaviour. Of *N. cucumeris* two strains were included, a North European strain and a non-diapausing strain from New Zealand. They are morphologically identical but genetically different (M. Steiner, personal communication).

The ability of predatory mites to survive the sometimes extreme afternoon temperatures in greenhouses is a limiting factor for their establishment (Mori and Chant, 1966; Shipp and van Houten, 1997). Previous work has shown a decline in predatory ability at temperatures above 30 °C (Skirvin and Fenlon, 2003) for the tropical species *Phytoseiulus persimilis* (Athias-Henriot), but already above 23 °C for the North European species *N. cucumeris* (Shipp et al., 1996). Three of the mite species selected for this study were indigenous to The Netherlands, namely *N. cucumeris* (diapausing), *Euseius finlandicus* (Oudemans) and *Typhlodromus pyri* (Scheuten). The others originated from sub-tropical regions: *E. scutalis*, *Euseius ovalis* (Evans), *I. degenerans*, *N. barkeri*, *T. limonicus* and *Typhlodromips swirskii* (Athias-Henriot) and *N. cucumeris* (non-diapausing).

Also host plant adaptation will influence establishment of predatory mites on cucumber. Plant architecture, leaf morphology and plant chemistry have been shown to affect the successful establishment of predatory mites (Scott Brown et al., 1999). On *Bryonia dioica* Jacq., the only native Cucurbitaceae in The Netherlands, the phytoseiids *E. finlandicus* and *T. pyri* were most abundant (G. Messelink, unpublished). The subtropical phytoseiids *E. scutalis* and *T. swirskii* were frequently found in a survey on cucumber plants in Egypt (Farrag et al., 1998).

Diet specialization of predatory mites is another important factor that influences the abundance and survival of predatory mites on a particular host plant. A more generalist life style can be useful for predators to survive when only low levels of the target prey are present. All mite species tested in this study are generalist predators. *E. finlandicus* and *T. pyri*, for example, are known to feed on mites, eggs and larvae of insects, on pollen, fungal spores and hyphae, honeydew and plant juice (Abdallah et al., 2001; Zemek and Prenerova,

1997). The degree of specialisation may vary between species. *E. finlandicus* appears to be more specialized on pollen feeding than others (McMurtry and Croft, 1997). In this study some additional observations were dedicated to this aspect.

Materials and methods

Cultures

Ten predatory mite species (Table 1) were evaluated in three separate greenhouse experiments in 2003. *I. degenerans* was reared on *Ricinus communis* L. in a small greenhouse as described by Ramakers and Voet (1995). All other species were kept in climate rooms, under long-day illumination (L16:D8), at 25 °C and 70%RH. *N. cucumeris* and *N. barkeri* were reared on *Acarus farris* (Oudemans) and wheat bran (Ramakers and van Lieburg, 1982). The other species were fed with cattail pollen, *Typha latifolia* L. (van Rijn and Tanigoshi, 1999). *T. limonicus* and *T. pyri* were reared on plastic 'arenas' as described by Overmeer (1985), and *E. scutalis*, *E. ovalis*, *E. finlandicus* and *T. swirskii* on sweet pepper leaves (*Capsicum annuum* L. cv Spirit). WFT was reared on flowering plants of chrysanthemum cv. Miramar.

Table 1. Origin of predatory mites used in this study

Species	Plant from which collected	Year of isolation and country
<i>Euseius finlandicus</i> (Oudemans)	<i>Bryonia dioica</i> Jacq.	2003, The Netherlands
<i>Euseius ovalis</i> (Evans)	<i>Cucumis sativus</i> L.	1998, Taiwan
<i>Euseius scutalis</i> (Athias-Henriot)	<i>Ricinus communis</i> L.	1998, Jordan
<i>Iphiseius degenerans</i> (Berlese)	<i>Citrus</i> sp.	1981, Morocco
<i>Neoseiulus barkeri</i> (Hughes)	<i>Capsicum annuum</i> L.	1989, The Netherlands
<i>Neoseiulus cucumeris</i> (Oudemans)	<i>Capsicum annuum</i> L.	1981, The Netherlands
<i>Neoseiulus cucumeris</i> (Oudemans)	<i>Thunbergia alata</i> Bojer	1991, New Zealand
Non-Diapause Strain (nds)		
<i>Typhlodromalus limonicus</i> (Garman & McGregor)	<i>Cyphomandra betacea</i> Sendt	1996, New Zealand
<i>Typhlodromus pyri</i> (Scheuten)	<i>Malus sylvestris</i> Miller	2002, Belgium
<i>Typhlodromips swirskii</i> (Athias-Henriot)	<i>Gossypium hirsutum</i> L.	1997, Israel

Cucumber plants cv. Aramon were raised in rockwool blocks in a greenhouse compartment.

Greenhouse experiments

Greenhouse experiments were carried out in a greenhouse compartment (18 m²) on two tables (1 by 3 m) on which cucumbers were cultivated. An ebb-and-flood fertigation system with recirculating nutrient solution was used. In each experiment three predator species were compared with *N. cucumeris* (Table 2). Each mite treatment was conducted on a clustered group of five cucumber plants. The young plants were at first-leaf stage when the experiments started and remained on the same rockwool blocks during growth. A distance of 1 m was kept between two groups of five plants on each table. Plants were trained vertically up to a 1.5 m high crop supporting wire. Side shoots were not removed, and once shoots reached the crop supporting wire, they were trained to grow down over this wire. Contamination of treatments was avoided by applying insect glue to the crop supporting wires. Treatments remained isolated by this method, which resulted in only one recorded contamination of a few single female predatory mites of the species *T. limonicus* in the neighbouring treatment of *E. ovalis*. Ten females of *F. occidentalis* were collected from the culture using an aspirator and released on each cucumber plant. Ten days later 10 female predatory mites were introduced per plant on the second leaf. Mites were sampled with a fine paintbrush in the

Table 2. Set-up and climate details of three greenhouse experiments for evaluation of predatory mites for control of *F. occidentalis* in greenhouse cucumbers

Experimental details	Experiment 1	Experiment 2	Experiment 3
Mite species	<i>N. cucumeris</i>	<i>N. cucumeris</i>	<i>N. cucumeris</i>
	<i>E. ovalis</i>	<i>N. barkeri</i>	<i>N. cucumeris</i> nds
	<i>T. swirskii</i>	<i>I. degenerans</i>	<i>E. finlandicus</i>
	<i>T. limonicus</i>	<i>E. scutalis</i>	<i>T. pyri</i>
Period	April–May	May–June	August–September
Total duration (days)	31	35	34
Duration with mites (days)	21–22	25	24
Mean temperature (°C)	22.5	23.3	22.6
Temperature range (°C)	18.3–28.0	19.3–28.7	19.1–28.7
Mean r.h. (%)	72	74	75
r.h. range (%)	24–93	35–97	34–100

laboratory and placed on leaf discs of sweet pepper (*C. annuum*) (diameter 2 cm) containing cattail pollen. One leaf disc with ten mites was introduced onto each cucumber plant. Temperature and relative humidity were in each experiment comparable with a minimal variation (Table 2). An assessment of cucumber leaves was conducted at the end of each experiment, 21–25 days after releasing the predatory mites (Table 2). The total number of stem leaves at that time varied between 20 and 25 per plant; including side shoots about 50 leaves per plant. Leaves were collected from each plant at five levels. Stem leaf number 5, 8, 11, 14 and 17, numbered from below, were collected and put separately in plastic bags. In the laboratory leaves were cut in strips of 5 cm wide and assessed under a binocular microscope at 40 times magnification. Both sides of the leaves were scanned and numbers of mites and thrips were counted per leaf. Feeding behaviour of these mites was observed during leaf scanning. All mites were mounted in temporary preparations and species and their life-stage were identified under a microscope.

Statistics

The results were analysed with regression analyses, using a generalised linear model (GLM) accounting for a Poisson distribution of the data (McCullagh and Nelder, 1989). Plants with the same treatment were spatially clustered rather than fully randomised in order to avoid mixing of predatory mite species. Observations per plant were assumed to be independent, though without any blocking structure. Differences between treatments were tested against 5% level of significance using the estimations of the differences and their standard errors on the link scale (Lane and Nelder, 1982).

Results

At the end of the first experiment, the total number of mites, including eggs and thrips larvae per five leaves differed statistically significantly for each species of predatory mites (Table 3). *T. limonicus* reached the highest population levels, followed by *T. swirskii*, *E. ovalis* and *N. cucumeris*. Predatory mite densities were inversely related to thrips densities in all cases. Predatory mites were recorded on all sampled leaves (Figure 1). *N. cucumeris* had the lowest relative abundance compared to the other species. Thrips larvae were equally distributed and present on all leaves on plants with *N. cucumeris* and *T. swirskii*

Table 3. Numbers of predatory mites (including eggs) and thrips larvae per five leaves of cucumber plant at the end of experiment 1

Species	Mean number of predatory mites/plant (\pm se)*	Mean number of thrips larvae/plant (\pm se)*
<i>N. cucumeris</i>	6.8 (2.2) a	140.4 (29.6) d
<i>E. ovalis</i>	28.6 (6.9) b	116.6 (30.8) c
<i>T. swirskii</i>	61.0 (9.1) c	27.4 (8.8) b
<i>T. limonicus</i>	86.4 (13.6) d	0.8 (0.4) a

*Means are significantly different ($p < 0.05$) if they are not followed by the same letter.

(Figure 2). On plants with *T. limonicus* thrips larvae were recorded in very low numbers on lower leaves. On plants with *E. ovalis* the highest thrips densities were recorded on the lower leaf number 8 (Figure 2).

At the end of the second experiment the predatory mite *E. scutalis* reached the highest populations levels, but thrips levels were also the highest (Table 4). The mites *N. cucumeris* and *I. degenerans* had similar population levels, while *N. barkeri* had the lowest densities (Table 4) with very low numbers of eggs (Figure 3). Thrips densities were the lowest with *N. barkeri* and *I. degenerans* (Table 4). *E. scutalis* was abundant on the lowest leaves (Figure 3), whereas thrips larvae

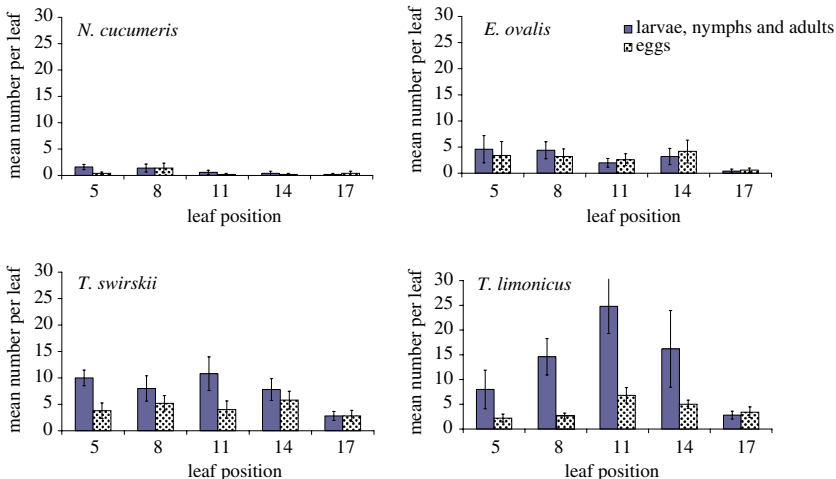


Figure 1. Distribution of predatory mites (means \pm se) in cucumber plants at the end of experiment 1. Leaves are numbered from below.

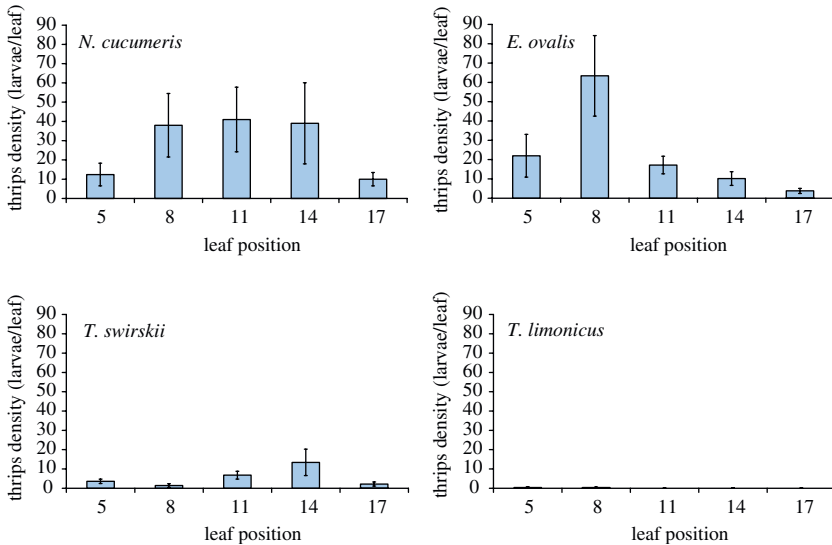


Figure 2. Distribution of thrips larvae (means \pm se) in cucumber plants at four mite treatments at the end of experiment 1. Leaves are numbered from below.

were abundant on the upper leaves of these plants (Figure 4). *I. degenerans* was also most abundant on the lower leaves (Figure 3), but thrips larvae were equally distributed. In the two remaining mite treatments *N. cucumeris* and *N. barkeri*, both mites and thrips larvae were equally distributed on the plants (Figures 3 and 4).

At the end of the third experiment the numbers of predatory mites remained low in all treatments and no significant differences were found among the mite species (Table 5). The mite *T. pyri* disappeared completely. Consequently, thrips population was highest in this

Table 4. Numbers of predatory mites (including eggs) and thrips larvae per five leaves of cucumber plant at the end of experiment 2

Species	Mean number of predatory mites/plant (\pm se)*	Mean number of thrips larvae/plant (\pm se)*
<i>N. cucumeris</i>	23.6 (5.9) b	159.2 (39.1) b
<i>N. barkeri</i>	16.3 (1.4) a	137.5 (45.2) a
<i>I. degenerans</i>	27.5 (7.2) b	139.0 (23.3) a
<i>E. scutalis</i>	55.8 (6.0) c	300.8 (54.9) c

*Means are significantly different ($p < 0.05$) if they are not followed by the same letter.

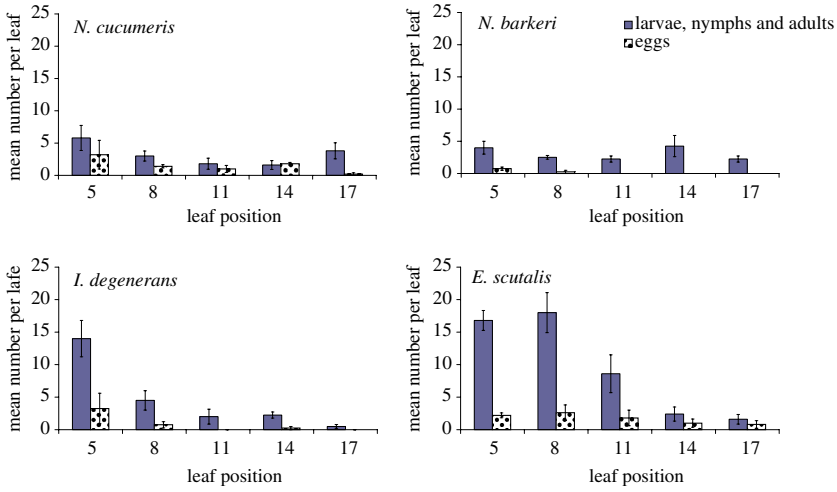


Figure 3. Distribution of predatory mites (means \pm se) in cucumber plants at the end of experiment 2. Leaves are numbered from below.

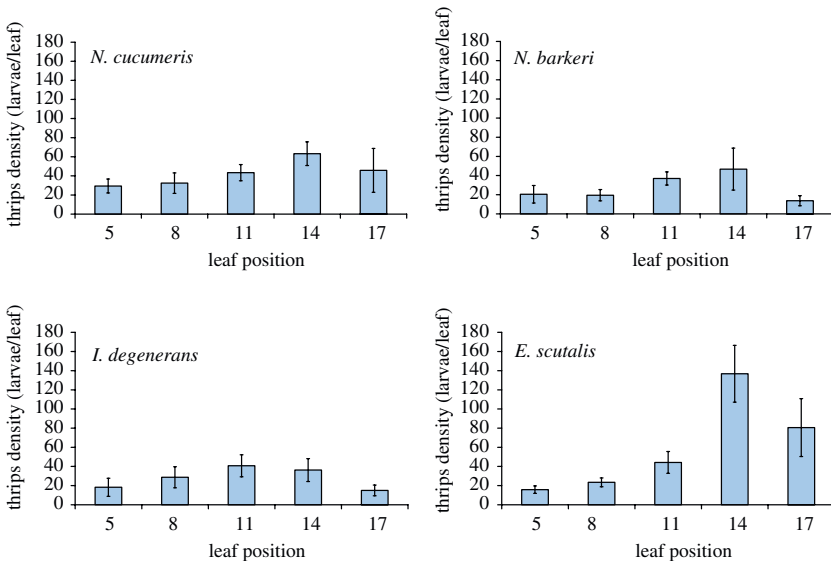


Figure 4. Distribution of thrips larvae (means \pm se) in cucumber plants at four mite treatments at the end of experiment 2. Leaves are numbered from below.

treatment. Population levels of thrips larvae were not different between the two strains of *N. cucumeris*, whereas *E. finlandicus* had the lower thrips densities (Table 5). Overall density of predators in this

Table 5. Numbers of predatory mites (including eggs) and thrips larvae per five leaves of cucumber plant at the end of experiment 3

species	Mean number of predatory mites/plant (\pm se)*	Mean number of thrips larvae/plant (\pm se)*
<i>N. cucumeris</i>	2.4 (0.7) a	112.4 (24.9) b
<i>N. cucumeris</i> nds	1.2 (0.6) a	113.8 (30.0) b
<i>E. finlandicus</i>	1.2 (0.6) a	70.6 (17.9) a
<i>T. pyri</i>	0.0 (0.0) a	197.6 (51.5) c

* Means are significantly different ($p < 0.05$) if they are not followed by the same letter.

experiment was too low to collect information about spatial distribution. Distribution of mites and thrips larvae on the plants from this experiment is not shown because of low mite numbers.

Sex ratios based on the total number of adult mites from the assessed leaves, differed by mite species. *I. degenerans*, *N. cucumeris* and *E. scutalis* had relatively high numbers of males compared to other species (Table 6). Final populations of *I. degenerans*, *N. cucumeris*, *E. scutalis*, *T. limonicus*, *T. swirskii* and *E. ovalis* all consisted of more than 46% of immature and egg stages, whereas these stages were present in relatively low numbers in the population of *N. barkeri*, 33% (Table 6). *T. pyri* and *E. finlandicus* were excluded from this analysis because of the low numbers found at the end of the experiment.

Table 6. Comparative distribution of life stages of predatory mite species (percentages) and their sex ratios from the total number of collected cucumber leaves in all three experiments

Species	Egg	Larva	Nymph	♂	♀	♀ with egg ⁴	Sex ratio (%♀)	n
<i>I. degenerans</i> ¹	15	5	25	25	22	7	54	110
<i>N. cucumeris</i> ²	31	4	27	15	16	5	59	164
<i>E. scutalis</i> ³	15	14	18	18	25	9	66	271
<i>T. limonicus</i> ³	23	18	28	6	18	7	79	433
<i>T. swirskii</i> ³	35	11	27	5	17	5	83	306
<i>N. barkeri</i> ¹	6	3	24	9	39	18	86	66
<i>E. ovalis</i> ³	49	14	15	2	13	8	91	143

¹ Total number of 20 cucumber leaves from 1 experiment (loss of one plant).

² Total number of 75 cucumber leaves from 3 experiments.

³ Total number of 25 cucumber leaves from 1 experiment.

⁴ Visible under microscope.

Discussion

T. limonicus was clearly the best predator of WFT in greenhouse cucumber, confirming earlier experiments (van Houten, 1996; van Rijn et al., 1999). *T. limonicus*, *T. swirskii* and *E. ovalis* reached both significantly higher population levels and gave a significantly better control of thrips than the standard species *N. cucumeris*.

E. scutalis increased to higher populations levels than *N. cucumeris*, but thrips levels were also high. High densities of this predator were present on the lower leaves, whereas thrips reached high densities on the upper leaves in this treatment. Thrips control was insufficient for *E. scutalis*, probably because of this unequal distribution. However, it should be mentioned that this situation only represents one moment, 25 days after introduction of the predatory mites. It may be possible that at a later moment this predator, due to its high number, is able to suppress the thrips population. Interacting populations of predator and prey often show strong fluctuations initially, which means that the result depends on the moment of sampling (van Rijn et al., 2002). A possible mechanism responsible for the unequal distribution of *E. scutalis*, might be a mutual avoiding behaviour, since thrips feed on mite eggs (Faraji et al., 2002). A second mechanism might be that the speed of predator response to prey fluctuations differs among predator species, due to differences in predation rate, development and reproduction.

I. degenerans also preferred the lower leaves (Figure 2), but that did not result in higher numbers of thrips larvae. *I. degenerans* may still provide reasonable thrips control since this mite is relatively large and may be more successful in capturing thrips larvae.

The species *I. degenerans*, *N. barkeri*, *E. finlandicus* and *T. pyri* did not establish better than *N. cucumeris* on cucumber.

The best performers in this study were all sub-tropical, probably better adapted to the greenhouse climate. Host plant characteristics such as plant architecture, leaf morphology, leaf physiology or microclimate, may play a role for the establishment of predatory mites on cucumber. Observations under the microscope did not suggest any physical disruption by plant hairs, on the contrary, hairs were often used for attaching eggs. The indigenous species *E. finlandicus* and *T. pyri* were abundant on a wild cucurbit, but did not establish better on cucumber than *N. cucumeris* did.

Final populations of *I. degenerans*, *N. cucumeris*, *E. scutalis*, *T. limonicus*, *T. swirskii* and *E. ovalis* all consisted of minimally 46% of immature and egg stages. This indicates that abundant food was

present for these predatory mites (Kreiter et al., 2002). The ability of immature predators to seize thrips larvae upon attack differs between phytoseiid species (Sabelis and van Rijn, 1997). Such differences may produce different life stage distributions and might explain the relatively low numbers of immature stages in the population of *N. barkeri*, since this species is relatively small compared to the other tested phytoseiids.

On greenhouse crops, alternative food may be scarce. Moreover modern greenhouse cucumber varieties do not produce pollen. The ability to feed on additional food sources like plant tissue, nectar or fungal spores might improve establishment of predatory mites. A recent study suggested that *E. scutalis* feeds on plant tissue of cucumber unlike *T. swirskii*, based on their higher mortalities on cucumber leaves treated with a systemic insecticide (Nomikou et al., 2003). It is observed that *T. limonicus* often has green gut content, suggesting that this predator also feeds on plant tissue (G. Messelink, personal observations).

The mites tested in this study are all generalist predators and able to feed on various insects and mites, however the prey suitability of thrips for these mites might differ per species. *N. cucumeris* was described before as *Typhlodromus thripsi* (MacGill, 1939), but other authors associated this predator with spider mites (Nesbitt, 1951). References about *T. swirskii*, *E. ovalis* and *E. scutalis* as thrips predators are scarce. *T. swirskii* was reported feeding on *T. tabaci* (Hoda et al., 1986) and *Retithrips syriacus* (Mayet) (Swirski et al., 1967). *E. ovalis* was mentioned as a predator of the thrips species *Scirtothrips dorsalis* (Hood) (Manjunatha et al., 2001) and *E. scutalis* was noted to feed on *F. occidentalis* (van Houten et al., 1995), *Scirtothrips citri* (Moulton) (Bonfour and McMurtry, 1987) and *R. syriacus* (Swirski et al., 1967). Direct observations of these mites under a binocular microscope also showed feeding on thrips larvae (this study). Other prey was not present in the current study.

Prey suitability of WFT for predatory mites can be determined by measuring rates of predation and oviposition on a diet of *F. occidentalis* larvae. Van Houten et al. (1995) showed in a study with seven phytoseiid species that *T. limonicus* had the highest predation rate (6.9 larvae/female/day) and the highest oviposition rate (3.2 eggs/day) on a diet of first instar *F. occidentalis* larvae. *N. cucumeris* was second best with a predation rate of 6.0 larvae/female/day and an oviposition rate of 2.2 eggs/day. *E. scutalis* showed a much lower predation rate (1.3 larvae/female/day) and oviposition rate (0.3 eggs/day). In our

experiment though, *E. scutalis* reached a much higher population level than *N. cucumeris*. These results show that predation rates on plants with thrips can differ from a laboratory situation where larvae of thrips are offered on leaf discs. Predation and oviposition rate are just part of a number of factors that determine the success or failure of phytoseiid predators in a greenhouse situation. Observations under the microscope showed a higher searching activity of *T. limonicus*, *T. swirskii*, *E. scutalis* and *E. ovalis* than *N. cucumeris*, that could be more typified as a 'sit and wait predator'. Higher searching rates will possibly result in more encounters and higher predation rates.

T. swirskii and *E. scutalis* have recently shown to be able to suppress populations of *Bemisia tabaci* on cucumber plants (Nomikou et al., 2002). Feeding and reproduction on *B. tabaci* were also observed for the species *T. limonicus* (Swirski and Dorzia, 1969) and *E. ovalis* (Borah and Rai, 1989). Thus, it is possible that one species of predatory mite can suppress populations of both thrips and whiteflies, the two main pest problems in greenhouse cucumbers. Control of whiteflies with *T. swirskii* on cucumber was much better when pollen was added, because of the higher numbers of predators on leaves with pollen (Nomikou, 2003). WFT and whiteflies are present most of the time in a greenhouse situation, at least in low numbers. Predators that feed on thrips and whiteflies will probably establish better and reach higher numbers that might result in better control of both pests.

The predatory mites *T. limonicus*, *T. swirskii* and *E. ovalis* seem to have the best potential for biological control of thrips and possibly whiteflies in greenhouse cucumbers. Commercial availability of these mites will depend on the interest of producers of natural enemies and the costs related to mass production of these species.

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