Pollen improves thrips control with predatory mites

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Abstract
To achieve permanent suppression of western flower thrips in cucumber repeated introductions of predatory mites are usually needed. This suggests that the resulting thrips population levels are too low to maintain a predator population. A solution may be to provide alternative food, such as pollen, to the predatory mites. Pollen, however, is also a food source for thrips. How pollen affects biocontrol of western flower thrips, has been tested experimentally by applying cattail pollen on cucumber crops on which either *Amblyseius degenerans* or *A. limonicus* was released. In these two experiments, the predator population increased faster, and the thrips population remained smaller, in the compartments with pollen than in those without pollen. Application of *A. limonicus* together with pollen even resulted in negligible fruit damage.

Keywords: western flower thrips, *Frankliniella occidentalis*, phytoseiids, *Iphyseius degenerans, Typhlodromalus limonicus*, alternative food, pollen, biological control, apparent competition

Introduction
In cucumber, repeated introductions of predatory mites are required to achieve control of western flower thrips, suggesting that the resulting thrips levels are too low to maintain a predator population. This problem might be overcome by providing alternative food to the predators. Laboratory experiments and population modelling predicted that a permanent supply of pollen will reduce equilibrium thrips levels, despite the fact that both predatory mites and thrips feed on pollen. However, before the equilibrium is reached, pollen may stimulate thrips growth so as to cause a larger initial peak in thrips density (Van Rijn and Sabelis, 1993). In addition, predators might be applied that can use the available thrips more efficiently as a food source (Sabelis and Van Rijn, 1997).

These methods to improve biological thrips control have been tested experimentally by applying cattail pollen and two different phytoseiid species (*Amblyseius degenerans* or *A. limonicus*) on cucumber crops. The first species has shown to be an efficient pollen feeder (Van Houten and Van Stratum, 1995; Van Rijn and Tanigoshi, 1999), whereas the second has the advantage of a more efficient use of thrips larvae (both small and large) (Van Houten *et al*., 1995; Van Houten, 1996; unpublished results).

Materials & Methods
Amblyseius (Iphiseius) degenerans was originally collected in 1982 in Morocco and was most recently reared on birch pollen (Van Rijn and Tanigoshi, 1999). *Amblyseius (Typhlodromalus) limonicus* was collected in 1996 in New Zealand and reared on broad bean pollen ever since (Van Houten *et al*., 1999).

Each of the two experiments was performed in 4 greenhouse compartments with gauzed windows (2 for the treatment and 2 for the control) at the Research Station for Floriculture and Glasshouse Vegetables (PBG) in Naaldwijk, The Netherlands. Each compartment had 108 cucumber plants with initially 8-9 leaves. Female western flower thrips, *Frankliniella occidentalis*, (1-2 per plant) were randomly released one week after planting. Exactly 4 female predators were introduced on every plant two (*A. degenerans*) or three (*A. limonicus*) weeks later. In the first experiment *A. degenerans* was introduced in the 4th week of 1997. In the second experiment *A. limonicus* was introduced in the 24th week of 1997. At the same time cattail pollen (*Typha latifolia*) was applied on one high leaf of every plant in two of the four compartments. Every other week additional pollen (1-2 gram per compartment) was introduced on a leaf high up in every plant (in the first experiment) or was dusted over the top of each plant (in the second experiment). Previous experiments had shown that cattail pollen supplied on a cucumber crop retains its quality as food source for more than two weeks.

Juvenile thrips and predator populations were estimated based on *in situ* observations of 8-16 representative leaves per plant, on 10 plants per compartment (one plant randomly selected per row). Initially all, but with increasing plant size, one of every two or three leaves were sampled, always including the leaves provided with pollen. To obtain an estimation of the population size per plant, non-sampled leaves were assumed to contain a similar number of mites and thrips as the nearest (pollen-free) sampled leaf. In addition, adult thrips were monitored by two blue sticky traps that were replaced weekly.

Results

Experiment A (winter, A. degenerans)

In the compartments with pollen the predator *A. degenerans* increased in numbers right after its introduction. However in the control compartments, its number declined to virtually zero in the first few weeks, but increased thereafter due to the increased numbers of thrips (Figure 1A1).

The number of thrips larvae increased in a similar way in all compartments during the first 4 weeks. Whereas in the control compartments larval density continued to increase until week 15, in the pollen-treated compartments its growth stopped from week 8 onwards (Figure 1A2). The adult thrips population (sticky trap results not shown) also stopped growing, but with a delay of 3 weeks. In the pollen-treated compartments, thrips densities were 20 times lower than in the control compartments (in week 9 for the larvae and in week 11 for the adults). The much lower thrips numbers in the treated compartments still gave rise to some fruit damage.

The predator population was strongly clustered on leaves with pollen, whereas the thrips concentrated on the young, top leaves.

Experiment B (summer, A. limonicus)

With or without pollen, the predator *A. limonicus* increased in numbers right after its introduction. In the presence of pollen the populations initially increased faster, but levelled off at ca. 250 mites per plant (Figure 1B1).

With or without pollen, the density of thrips larvae increased at the same rate during the first few weeks, but started to deviate from the fourth week onwards. After a sharp decline, the thrips populations (both larvae (Figure 1B2) and adults (results not shown)) in the pollen-treated compartments remained 3-6 times lower than in the control compartments, and fruit damage was virtually absent.

Amblyseius limonicus concentrated on leaves with pollen, but to a lesser extent than *A. degenerans*.

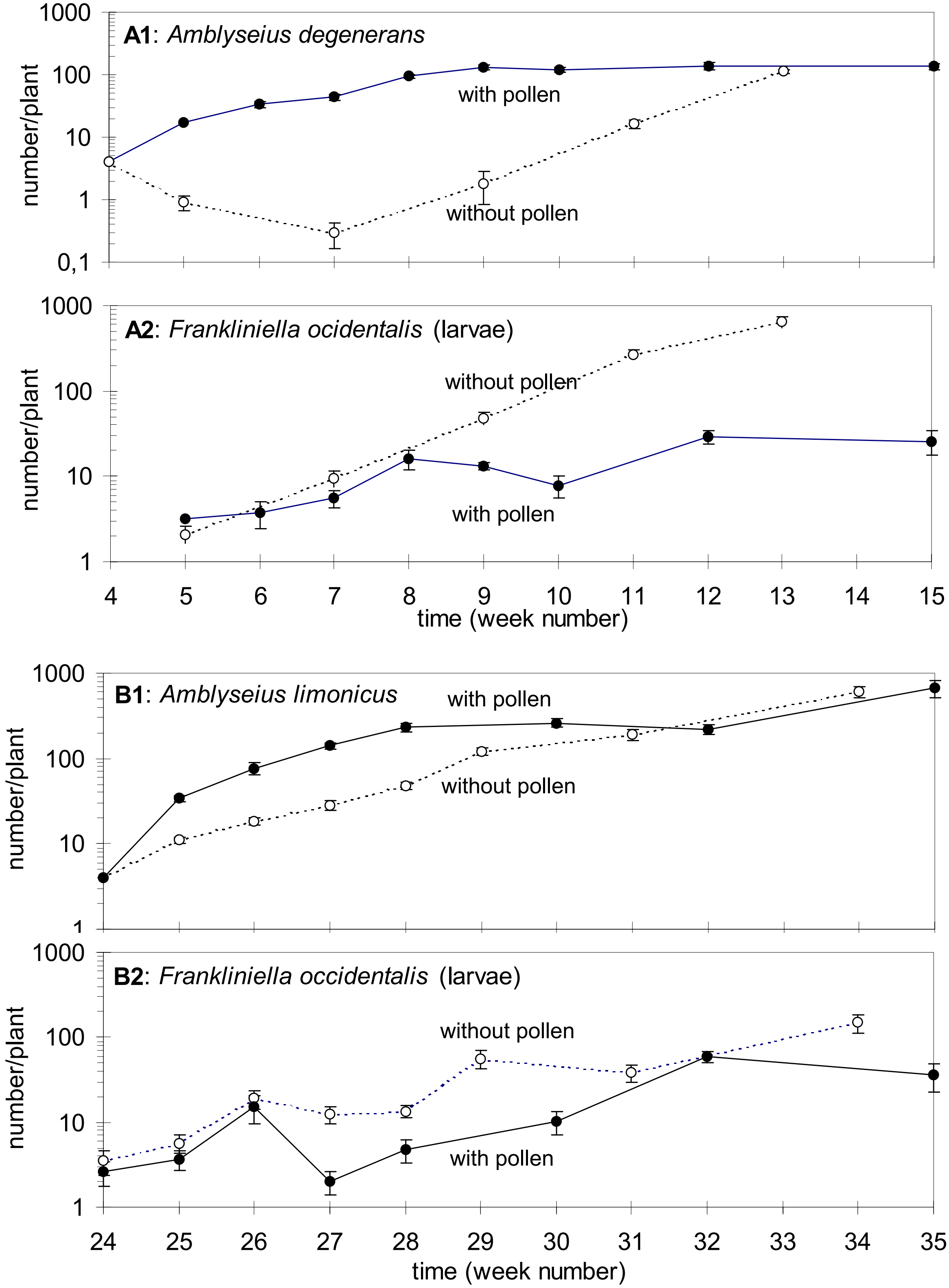

Figure 1: Population dynamics of predatory mites (nymphs and adults; **A1**, *Amblyseius degenerans* and **B1,** *Amblyseius limonicus*) and western flower thrips (larvae; **A2** and **B2**) in absence (open dots, dashed lines) and presence of cattail pollen (closed dots, drawn lines) on cucumber plants. Predatory mites were introduced in the first week indicated on the X-axis. Each point represents a mean of 20 samples (plants) in 2 replicate experiments. Vertical bars represent standard errors over 20 samples.

Discussion

The results of the two greenhouse experiments showed that thrips growth was not stimulated by pollen. Possibly, the aggregation of predators on leaves with pollen prevented the thrips from using the pollen effectively. How the pollen's distribution pattern affects foraging behaviour of thrips and predatory mites, is the subject of further study. In addition, the greenhouse experiments showed that application of pollen ultimately resulted in lower thrips numbers. The amounts of pollen needed to enhance control were still low enough (1-2 gram/100 plants/fortnight) to make practical application feasible.

In absence of pollen, the experiment with *A. limonicus* indicated much lower thrips levels as the one with *A. degenerans*, even though the first was performed in a warmer period of the year. This corresponds with the results obtained by Van Houten (1996) and Van Houten *et al*. (1999). In presence of pollen, the two experiments resulted in similar numbers of thrips per plant, but since the cucumber plants in experiment B had on average twice as many leaves, the thrips numbers per leaf were lower. In addition, the adult trap catches in experiment B were much lower, as well as the amount of fruit damage. Which elements of foraging behaviour are responsible for the differential impact on thrips populations, is subject to further study.

Acknowledgements

We thank Dr. N. Martin (New Zealand Institute for Crop and Food Research, Auckland, New Zealand) for collection and shipment of *A. limonicus*. We thank T. van Lier and M. Raats (PBG) for their assistance with the greenhouse experiments.

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