Predatory Mites Released on Transplants Can Protect Greenhouse-Grown Peppers from Early Broad Mite Infestations

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Abstract

The minute broad mite, *Polyphagotarsonemus latus* (Banks), can cause serious damage to peppers (*Capsicum annuum*) when infestations occur at early plant developmental stages. A first study was set to evaluate biological control strategies during seedling development. Timing of release of *Neoseiulus californicus* McGregor, a commercially reared predatory mite, was investigated in scenarios of pest and predator presence to simulate preventive and curative strategies of control. Undamaged seedlings were produced when two predators per seedling were released preventively. Curative control strategies were not effective for producing undamaged or broad mite-free transplants. Further studies were carried to evaluate the effectiveness of *N. californicus* on pepper seedlings that host a few broad mites and are transplanted into the production greenhouse. *N. californicus* released at different times and densities, and conventional control methods (micronized-sulfur sprays) were evaluated for pest control, plant damage, and fruit yield. Yields of red fruits from plants with four predators per plant released at any of the release times (a week before, at, or four days after transplanting) or with sulfur sprays were not significantly different from an uninfested control treatment. Releases of two predatory mites per plant led to yields similar to the uninfested control only when introductions were a week before transplanting, while later introductions led to serious plant damage and significantly lower yields. Early broad mite infestations in pepper crops grown in greenhouses might be effectively controlled with *N. californicus* released at early seedling developmental stages in the nursery and at transplanting in the fruit production greenhouse.

INTRODUCTION

Infestations of broad mite [*Polyphagotarsonemus latus* (Banks); (Acari: Tarsonemidae)] initiated at early developmental stages of pepper (*Capsicum annuum*) can lead to severe plant damage in greenhouses where transplants or fruit are produced (de Coss-Romero and Peña, 1998; Gerson, 1992; Weintraub et al., 2003). Seedlings will appear undamaged when they become infested with the minuscule mite a few days before transplanting but they carry the pest to crops transplanted in greenhouses. Biological control programs initiated at early pepper crop stages are disrupted by multiple sprays of the commonly used pesticides (e.g., sulfur, abamectin, and dicofol). *Neoseiulus californicus* McGregor (Acari: Phytoseiidae), a predaceous mite released on greenhouse-grown vegetables for biological control of two-spotted spider mite [*Tetranychus urticae* Koch (Acari: Tetranychidae)], has been reported to feed on broad mites as well (Castagnoli and Falchini, 1993; Peña and Osborne, 1996). *N. californicus* can reproduce when feeding on broad mites (Castagnoli and Falchini, 1993). Preventive releases may provide effective pest management as the predator can remain on plants for short periods when prey is absent (de Courcy Williams et al., 2004). This manuscript presents selected results of research that evaluated the use of *N. californicus* as a broad mite management

strategy when infestations where initiated during pepper seedling development.

MATERIALS AND METHODS

In a first experiment, seedlings of bell pepper cv. 'Legionnaire' (Rogers-Syngenta, Boise, Idaho) were grown in commercial nursery flats (Speedling Inc., Sun City, Fla.) separated by water barriers, and in a controlled environment (L:16h and D: 8h, with air temperatures 24 ± 1°C and 19 ± 1°C, and air relative humidity 70 ± 10% and 80 ± 10%, respectively). Seedlings were infested with two gravid female broad mites at three seedling developmental stages (unfolded cotyledons, two leaves, and four leaves) creating 16 pest-predator scenarios. Two *N. californicus* (Biotactics, Romoland, Calif.) were released on seedlings with a) unfolded cotyledons at either 0, +15, or +24 days from initial infestation (DFI), b) two leaves unfolded at either –15, 0, or +9 DFI, and c) four leaves unfolded, at either –24, –9, or 0 DFI. Additionally, separate groups of seedlings remained mite-free (non-infested control), and other groups were either infested with *P. latus* only or had releases of *N. californicus* only at the three seedling developmental stages. From each flat, two seedlings were sampled every third day until day 42 after seeding. Mites were recovered using a washing procedure and counted under the microscope (Jovicich, 2007). Seedling growth variables, such as leaf area, were measured.

In a second experiment, seedlings with nine unfolded leaves were transplanted in a passively ventilated greenhouse in March, three days after each had been artificially infested with two broad mites. Treatments included a) release of either 2 or 4 *N. californicus* per plant at either –3, +3, or +7 DFI, b) five weekly micronized-sulfur sprays (80% sulfur at a rate of 3.4 $kg \cdot ha^{-1}$) initiated at either –3 or +3 DFI, c) infested with no pest management, and d) non-infested control. Plots with commercial plant arrangements were isolated with polyethylene film barriers to prevent cross contamination of mites. Top plant canopy leaves were sampled weekly for mite recovery, and early marketable yield of red fruit was harvested. All experiments were arranged as randomized complete block designs with three replications. Analyses of data, including those for repeated measurements, were performed with the PROC MIXED procedure (SAS Inst., 2001) with appropriate variable transformations for mite counts and yield percentages.

RESULTS AND DISCUSSION

In the first experiment, undamaged 42-day old seedlings were produced when two predators per seedling were released preventively (up to 24 d before seedlings were infested with broad mites). The leaf area in seedlings that had two predators released on the same day of the infestation, or before the day of the infestation, was not significantly different from uninfested seedlings (Fig. 1). However, these undamaged seedlings still hosted *N. californicus* and a few broad mites at 42 d after seeding. Higher predator release densities may be needed for obtaining pest-free seedlings in transplant flats with a widespread infestation of broad mite. Releasing two predators per seedling as a curative control strategy was not effective for producing undamaged or broad mite-free transplants. These seedlings had reduced leaf area and hosted 16 to 226 broad mites.

In the second experiment, no marketable fruit was harvested in plants where broad mites were left uncontrolled (Fig. 2). Marketable fruit loss was due to damage caused by the pest to terminal shoots, flowers, and fruits. Yields of red fruits from plants with four predators per plant released at any of the release times (a week before, at, or four days after transplanting), or with sulfur treatments, were not significantly different from the uninfested control treatment (Fig. 2). Releases of two predatory mites per plant led to yields similar to the uninfested control only when introductions were a week before transplanting, while later introductions led to serious plant damage and significantly lower yields (Fig. 2). With sulfur sprays, broad mite populations resurged after the spray program was interrupted (fifth spray) while pest populations at fruit harvest were nil in plants treated with *N. californicus*.

In tropical and subtropical regions, broad mites infest pepper crops at any time during the crop development. Crops are most vulnerable when early crop infestations occur and pest management is delayed. Broad mite infestations in pepper crops grown in greenhouses could effectively be controlled with *N. californicus* released at early seedling developmental stages in the nursery and at transplanting in the fruit production greenhouse. Released on transplants, the predator may control early infestations of broad mites and two-spotted spider mites, and become established on the transplanted crop. This is an important pest management tool for growers who intend to produce pesticide-free crops, with a minimum use of pesticides, or follow organic production standards.

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Figures

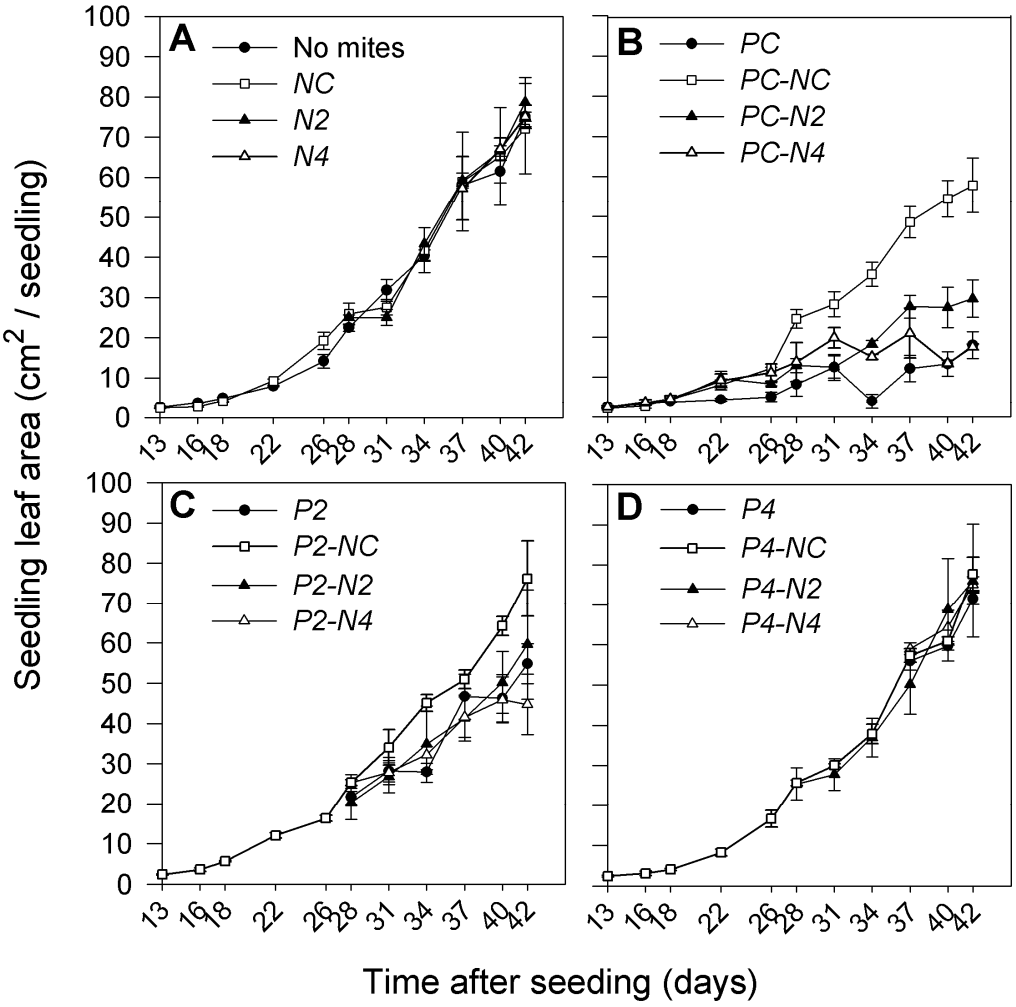

Fig. 1. Leaf area increase in pepper seedlings after *P. latus* and *N. californicus* were introduced at three seedling growth developmental stages. A) seedlings were grown mite-free or had only *N. californicus* (*N*) introduced at unfolded cotyledons (*C*), two unfolded leaves (*2*), or four unfolded leaves (*4*) (*NC*, *N2* and *N4*); B) seedlings were infested with two *P. latus* (*P*) at unfolded cotyledons without (*PC*) or with *N. californicus* released 0, +15, or +24 days from initial infestation (DIF) (*PC-NC*, *PC-N2*, *PC-N4*, respectively); C) seedlings were infested with two *P. latus* at unfolded two leaves without (*P2*) or with *N. californicus* released –15, 0, or +9 DFI (*P2-NC*, *P2-N2*, *P2-N4*, respectively); D) seedlings were infested with two *P. latus* at unfolded four leaves without (*P4*) or with *N. californicus* released –24, –9, or 0 DFI (*P4-NC*, *P4-N2*, *P4-N4*, respectively). Plotted for each sampling date: mean ± SEM, n = 3. Treatment × time: $F = 3.65$; df = 101, 83; $P < 0.001$.

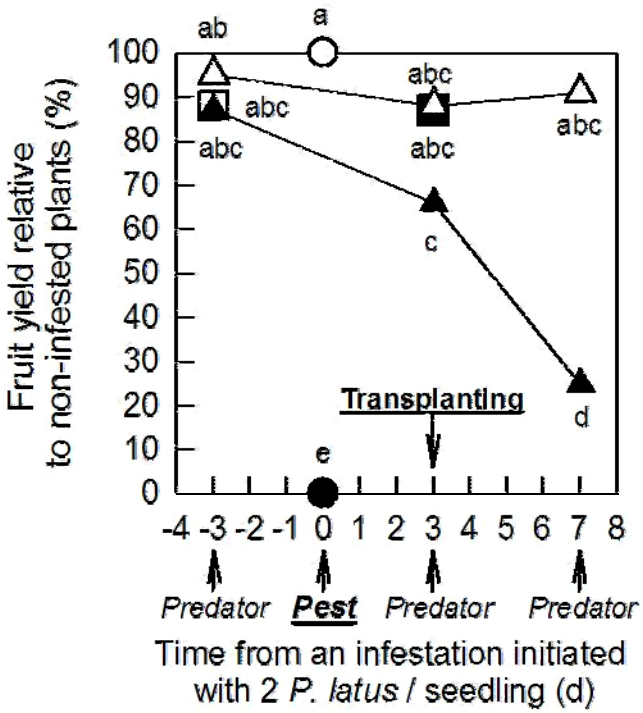

Fig. 2. Marketable fruit yield (88 days after transplanting, DAT) in greenhouse-grown bell pepper plants that were infested with two *P. latus* (–3 DAT) and had the pest managed with a) *N. californicus* (released at either –6, 0, or 4 DAT, at predator release densities of two, ▲, or four, Δ, per plant), b) sulfur (5 weekly sprays started at either –6 DAT, □, or 0 DAT, ■). Yield was 100% in non infested plants (○) and 0% in infested plants with no pest management (●). Letters for comparisons are based on Tukey-Kramer test for mean separation.