Mite Population and Damage Caused by Broad Mites (*Polyphagotarsonemus latus* [Banks]) Infesting Bell Pepper (*Capsicum annuum* L.) at Different Seedling Developmental Stages

Elio Jovicich and Daniel J. Cantliffe
Horticultural Sciences Department
University of Florida, IFAS
1251 Fifield Hall
Gainesville, FL 32611-0690, USA

Lance S. Osborne
Entomology and Nematology
Mid-Florida Research and Education Center
University of Florida, IFAS
2725 Binion Rd.
Apopka, FL, 32703-8504, USA

Peter J. Stoffella
Indian River Research and Education Center
University of Florida, IFAS
2199 South Rock Rd.
Ft. Pierce, FL 34945-3138, USA

Keywords: greenhouse, nursery, transplant, mite-days

Abstract

Because of their small size, broad mites are unnoticeable until they cause serious damage to apical leaves in pepper seedlings. Changes in broad mite population and seedling damage over time were measured after artificial mite infestations of seedlings with unfolded cotyledons, or with unfolded two, or four true leaves. With infestations occurring at these seedling developmental stages, symptoms of elongation and curling of apical leaves were observed five days after infestation. The mite populations first increased exponentially as days after seeding (DAS) increased and populations developed more rapidly in older seedlings that were infested. At 38 DAS (transplanting age, with 6 leaves unfolded in uninfested seedlings), seedling damage was greater in those infested at younger developmental stages. Mite population in seedlings infested at two and four leaves were still increasing at 38 DAS. Damage increased more rapidly with increased cumulative mite-days in seedlings infested at the cotyledonary stage. The relative growth loss caused by one mite-day was generally greatest shortly after infestation occurred. At 38 DAS, cotyledonary-infested and 2-leaf-infested seedlings showed necrosis in cotyledons and leaves while in 4-leaf-infested seedlings, symptoms of mite damage were just starting to be noticeable. This may indicate that transplants with no symptoms, which are a potential source of infestation in greenhouse-grown crops, become infested at the end of the transplant production cycle. Ongoing research is being conducted to evaluate the effectiveness of broad mite control using biological control at different seedling developmental stages and under different temperatures.

INTRODUCTION

In regions with warm and mild winter climates such as in Florida, pepper (*Capsicum annuum* L.) crops grown in greenhouses can be seriously damaged by broad mites. Broad mites can be particularly destructive at early plant developmental stages (de Coss-Romero and Peña, 1998). Broad mite-infested transplants can be an entry of these mites into a fruit production greenhouse (Weintraub et al., 2003). Seedlings may become infested in the nursery greenhouse or during seedling hardening periods outside the greenhouse.

Broad mites feed by sucking plant juices and, possibly, inject toxic compounds in tender plant tissues, where they prefer to feed (Gerson, 1992). During vegetative growth, the damage is mainly limited to the terminal shoots and young leaves. Typical symptoms are distorted leaves that later become necrotic. After the terminal growth has been

damaged and if mites are then successfully controlled, the recovery of the plants is very slow. As a consequence, the damage caused by these mites at early stages of development reduces the stand of plants and/or substantially delays plant growth.

Since broad mites are very small (body length between 100 and 200 microns), they are unnoticeable until serious damage occurs rapidly to apical leaves. Growers who are not familiar with the plant symptoms associated with the presence of broad mites can first confuse symptoms with a virus, phytotoxicity from a sprayed product, or a nutrient related disorder (Gerson, 1992).

This study was conducted to determine at which seedling developmental stage broad mite infestations cause the greatest damage on seedlings prior to transplanting and to measure changes of broad mite populations in the infested seedlings. The study also investigated how early in the transplant production cycle broad mite infestations would occur in a situation where damage symptoms are not noticeable at transplanting time. This information was needed for subsequent studies on biological control strategies on pepper transplants.

MATERIALS AND METHODS

The study was conducted inside a walk-in growth chamber where light, temperature, and humidity were controlled (day: 12 h, 24 °C, 150 $\mu mol \cdot s^{-1} \cdot m^{-2}$, night: 20 °C. RH: 70-80%). Bell pepper 'Cubico' (DeRuiter Seeds Ltd., Bergschenhoek, Holland) was seeded in a 70% peatmoss : 30% vermiculite (v/v) substrate mix (Terra-Lite Plug Mix, Terra Asgrow, Apopka, FL) in 128-cell (width × width × height: 2.5 × 2.5 × 6.5 cm) polystyrene transplant flats (Speedling Inc., Sun City, FL).

Changes in broad mite population and seedling damage over time were measured after broad mites (two adult females) were placed on seedlings at three different developmental stages: a) two cotyledons unfolded, b) two leaves unfolded, and c) four leaves unfolded. Uninfested seedlings were used as control.

Seedlings from each infestation treatment and from the uninfested control were collected every two to five days after cotyledons unfolded until 41 days after seeding (DAS). The control treatment reached the transplant size (five to six leaves) 38 DAS. Seedling damage was measured as the growth loss relative to that in the uninfested seedlings. The seedling growth variables measured included dry weight, fresh weight, water content, stem diameter, stem length, and leaf area. Seedling shoot and leaves were washed in an ethanol solution (70%) (Weintraub et al., 2003). With aid of a stereomicroscope, the total mite population per seedling was determined by counting all broad mites recovered in the ethanol solution. The levels of broad mite populations were also calculated as cumulative mite-days (de Coss-Romero and Peña, 1998) per seedling. The variable mite-day combines in a single unit the information on the number of mites and the time that these mites are present on the host plant. In our experiments, one mite-day equaled to one mite (at any stage but egg) per seedling for one day. The calculation of mite-day was used to relate mite number and time to the damage caused on plants. The responses of damage to increased cumulative mite-days were calculated using regression analysis. The slope of the regression lines indicated how fast the measured growth loss variables responded to the presence and number of mites when infesting seedlings at different developmental stages. The damage caused by one mite-day was calculated for infestations made at different seedling developmental stages.

Seedlings were watered as needed directly over the cell media without wetting the seedling foliage. Seedlings were fertilized with 200 ppm N weekly after the first 2 leaves unfolded using a commercial soluble source of 20-20-20 of N-P-K. Plug trays with transplants were placed over trays with water and distanced 1 m from each other to avoid mite contamination among treatments. Plant growth measurement data and mite number per seedling data are means from 2 to 3 seedlings collected at each sampling date.

RESULTS

Changes in Broad Mite Population

Mean counts of mites recovered first increased exponentially as DAS increased (Fig. 1). Mite populations increased more rapidly in older seedlings that were infested. With broad mites infesting at the cotyledonary stage, the mite population rose to 1769 at 23 days after infestation (DAI) when seedlings were 33 days old. In the 8 days that followed the peak of mite population, the number of mites decreased to 592. Seedlings could not support increasing numbers of mites perhaps due to the low plant quality attributed to the mite damage. With the infestation of seedlings with 2 leaves unfolded, the mite population was 2940 per seedling and still rising 13 DAI when seedlings were 41 days old. With the infestation at 4 leaves unfolded, the mite population was 889 per seedling and still rising 8 DAI when seedlings were 41 days old. Seedlings at transplanting age (38 days old) hosted 1264, 652, and 119 broad mites when infested at stages with cotyledons, 2 leaves, or 4 leaves unfolded, respectively.

Damage Symptoms on Infested Seedlings

In all three seedling developmental stages, symptoms of elongation and curling of unfolded apical leaves were observed five days after infestation. Five and seven days after infesting cotyledons, damage by feeding was first evident on the abaxial side of cotyledons and on leaf primordia. At 38-days old, these seedlings had only two necrotic cotyledons and the first two leaves, which were small, cupped down and with zigzagged veins. These seedlings died soon after 38 DAS. The hypocotyl region did not increase in diameter and was not able to vertically support the cotyledons. At 38 DAS, the seedlings that were infested at the 2-leaf stage had the 1st and 2nd pairs of leaves curled and partially discolored. At this time, the symptoms of mite damage in seedlings infested at the 4-leaf stage were barely noticeable.

Damage Measurements at Transplanting Age

At 38 DAS, seedlings infested at the cotyledonary stage were the most damaged (Fig. 2). Reductions on fresh weight, dry weight, water content, or leaf area as compared to uninfested seedlings were more than 80% in seedlings infested at the cotyledonary stage, near 20% in seedlings infested when two leaves unfolded, and less than 10% in seedlings infested when 4 leaves unfolded. Reductions on stem length and diameter were about 50 and 60%, respectively, in seedlings infested at the cotyledonary stage, 30 and 10% in seedlings infested when two leaves unfolded, and 10 and 0% in seedlings infested when 4 leaves unfolded.

Relationship between Level of Seedling Damage and Number of Mites Present

The loss of dry weight increased more rapidly with larger number of mite-days in seedlings infested at cotyledonary stage than at two leaves and at four leaves (Fig. 3). Also, the same number of mite-days caused greater damage in early than in late-infested seedlings. For example, it was estimated that 1000 mite-days led to percentages of dry weight loss with respect to uninfested seedlings of 58% in seedlings infested at the cotyledonary stage, 8% in those infested when two leaves unfolded, and of 3% when four leaves unfolded. Estimations were calculated for all other growth parameters measured and, similarly as with dry weight, damage increased more rapidly with increased cumulative mite-days in earlier infestations and losses were greater on infestations of younger seedlings at a same number of mite-days.

Damage Caused By One Mite-Day

The relative growth loss caused by one mite-day was generally greatest shortly after infestation occurred. With fresh weight loss (Fig. 4), as with other growth variables measured, the damage caused by one mite-day was greater with infestations occurring at early developmental stages.

DISCUSSION

Depending when (during the transplant production cycle) seedlings are infested with broad mites, their presence on the seedlings may or may not be easily detected by searching for symptoms of damage. Damage symptoms will appear in a few days after infestation occurs and early infestations will cause great losses in nurseries. As with infestations in citrus (Peña, 1990), higher infestation densities than 2 female mites may lead to earlier appearance of damage symptoms than those reported in this study for pepper seedlings. Because of the serious damage on early infested seedlings, these seedlings will be easily recognized and not used for saleable transplants but they would be foci of infestation from where mites will disperse to other uninfested seedlings. Perhaps late broad mite infestations lead to transplanting 'broad mite-free-like' pepper seedlings which host broad mites.

Recognition of an early mite infestation is only possible by means of periodically scouting the seedlings. Careful and frequent scouting with a hand lens (with at least 10X magnification) will be needed in greenhouses where broad mites are a common problem. At the moment apical leaves show damage symptoms, mite populations are already large enough that a high level of damage has been caused to the seedlings and effective control of the mite is then more difficult to achieve. In this study, minimum damage symptoms were noticeable in seedlings that were infested at the 4-leaf stage; however, growth reductions already had occurred in these seedlings (Fig. 2). Strategies of pest control in regions where broad mite problems are frequent should probably be based on prevention of mite infestations and early control of infestation. Chemical control at the seedling stage with the commonly used pesticides (such as sulfur) can cause phytotoxicity. Investigation is being conducted to measure broad mite damage under different environmental conditions as these will greatly affect reproduction rates of this mite (Jones and Brown, 1983). In addition, the effectiveness of biological control strategies using predatory mites (Fan and Petitt, 1994; Peña and Osborne, 1992; Weintraub et al., 2003) will be evaluated.

ACKNOWLEDGMENTS

Florida Agricultural Experimental Station Journal Series No. N-02509.

Literature Cited

de Coss-Romero, M. and Peña, J.E. 1998. Relationship of broad mite (Acari : Tarsonemidae) to host phenology and injury levels in *Capsicum annuum*. Florida Entomologist 81:515–526.

Fan, Y.Q. and Petitt, F.L. 1994. Biological control of broad mite, *Polyphagotarsonemus latus* (Banks), by *Neoseiulus barkeri* Hughes on pepper. Biological Control 4:390–395.

Gerson, U. 1992. Biology and control of the broad mite, *Polyphagotarsonemus latus* (Banks) (Acari, Tarsonemidae). Experimental and Applied Acarology 13:163–178.

Jones, V.P. and Brown, R.D. 1983. Reproductive responses of the broad mite, *Polyphagotarsonemus latus* (Acari, Tarsonemidae), to constant temperature-humidity regimes. Annals Entomological Society America 76:466–469.

Peña, J.E. 1990. Relationships of broad mite (Acari, Tarsonemidae) density to lime damage. Journal of Economic Entomology 83:2008–2015.

Peña, J.E. and Osborne, L.. 1996. Biological control of *Polyphagotarsonemus latus* (Acarina: Tarsonemidae) in greenhouses and field trials using introductions of predacious mites (Acarina: Phytoseiidae). Entomophaga 41:279–285.

Weintraub, P.G., Kleitman, S., Mori, R., Shapira, N. and Palevsky, E. 2003. Control of the broad mite [*Polyphagotarsonemus latus* (Banks)] on organic greenhouse sweet peppers (*Capsicum annuum* L.) with the predatory mite, *Neoseiulus cucumeris* (Oudemans). Biological Control 27:300–309.

Figures

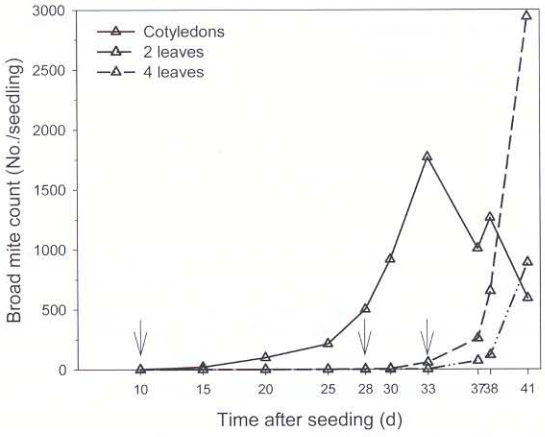

Fig. 1. Changes of total number of broad mites with time in pepper seedlings infested at several developmental stages. Vertical arrows indicate the day when seedlings were infested.

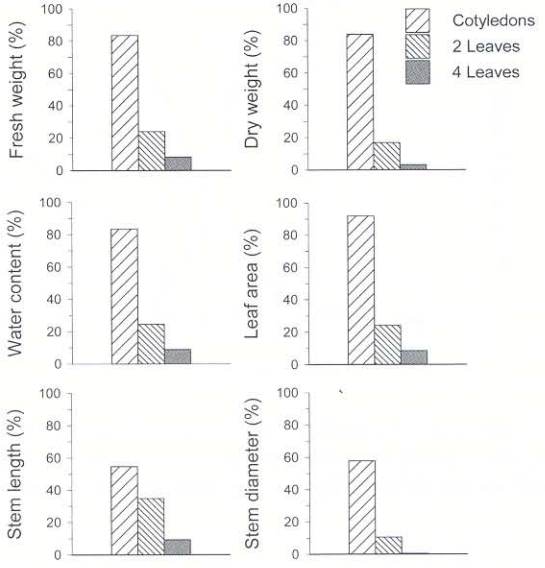

Fig. 2. Reductions on growth variables in pepper seedlings infested at different developmental stages at transplanting age (38 days old) as compared to uninfested seedlings with 5-6 unfolded leaves.

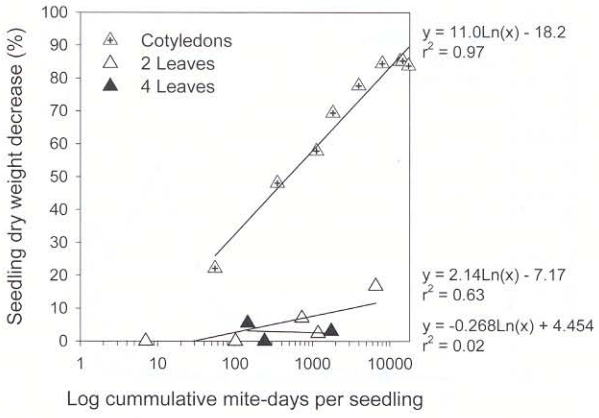

Fig. 3. Responses of seedling dry weight loss to increased cumulative mite-days in seedlings infested at several developmental stages.

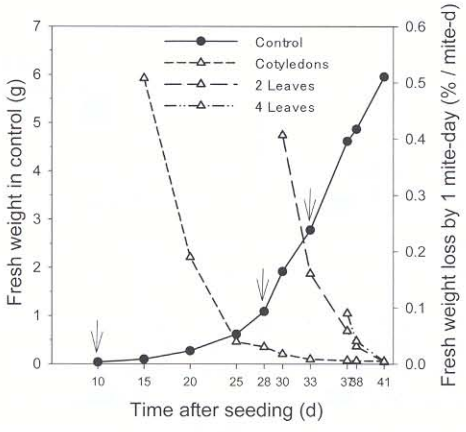

Fig. 4. Responses of fresh weight vs. seedling age in control (uninfested) seedlings and damage caused by one mite-day in seedlings infested at several developmental stages. Vertical arrows indicate the day and fresh weight of seedlings at infestation.