

The Citrus Red Mite (*Panonychus citri*): A Pest of Citrus Crops¹

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This publication describes the biology, damage symptoms, and methods of control for the citrus red mite, *Panonychus citri*. This species is becoming a pest of concern on citrus grown under protective screen (also called “CUPS”) and is a commonly observed pest in commercial and dooryard citrus. The target audience includes growers, Extension agents, crop consultants, state and local agencies, and interested gardeners.

Introduction

The citrus red mite, *Panonychus citri* Kuwayama (McGregor) (Figure 1), is a cosmopolitan polyphagous species reported on 113 hosts but mainly found on *Citrus* spp. (Migeon and Dorkeld 2011; Vacante and Gerson 2012). In Florida, *P. citri* is a pest of economic importance in open citrus orchards (Qureshi et al. 2021). The mite is also a major pest in Citrus Under Protective Screen (CUPS), a new undercover production system tested in Florida (Demard 2022; Ferrarezi et al. 2019). Environmental conditions inside CUPS are different from those in open-air systems due to the screen used to exclude the Asian citrus psyllid, *Diaphorina citri*, vector of huanglongbing (HLB), or citrus greening disease. The mean temperatures inside CUPS systems are 3°C to 4.5°C higher in summer and 1.5°C higher in winter than mean temperatures in open-air systems (Schumann and Waldo 2016). Also, humidity ranges average from 70%–80% in CUPS; humidity ranges from 70-80% in CUPS while humidity ranges from 60-70% in outdoor systems (Demard 2022). Although the literature states that high temperature and humidity are detrimental to *P. citri*, it seems that CUPS provides suitable conditions for the pest to develop (Demard 2022).



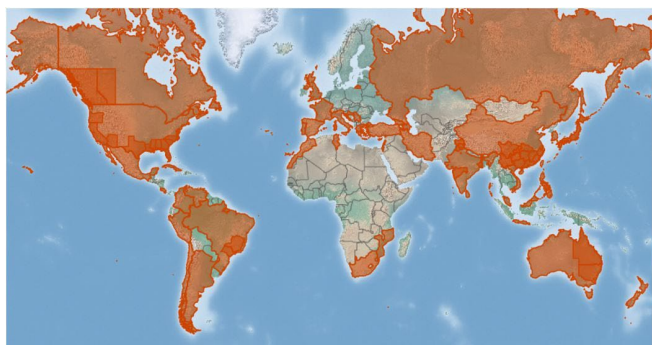
Figure 1. Adult and nymph of *Panonychus citri* (McGregor). The white items visible near the mites are cast-off skins from mites who have molted. These are called *exuviae*.

Credit: Matt Bertone, North Carolina State University

Immatures and adults feed on citrus leaves causing silvery spots called stippling injuries. At high densities, mites feeding on leaves, fruits, and green twigs result in mesophyll collapse, shoot dieback, and leaf and fruit drop (Albrigo et al. 1981; Qureshi et al. 2021).

Distribution

Panonychus citri has a worldwide distribution (Zhang 2003) (Figure 2). The mite is present in citrus-growing regions, mostly along the coasts. It reaches levels of economic importance in areas such as the Mediterranean region (Israel, Turkey, and Spain), the USA (Florida, Alabama, and California), and China.



Caption:  *Panonychus citri* present

Figure 2. Worldwide distribution of *Panonychus citri* (McGregor). Map from CABI 2017. Invasive Species Compendium. Wallingford, UK: CAB International.

Credit:

<https://www.cabi.org/isc/datasheet/33682#toDistributionMaps>

Host Range

Panonychus citri is reported from over 111 species of host plants, including almonds, pears, castor beans, grapes, palms, broadleaf ornamentals, and evergreen shrubs (Zhang 2003; Vacante 2010; Hoy 2011). Also, *Panonychus citri* is found on a variety of citrus. The mite reaches high populations on lemon and grapefruit followed by orange and tangerine (Childers and Fasulo 1995; Fleschner 1958). Troyer citrange is more susceptible than other varieties in California (Childers and Fasulo 1995).

Description

Eggs

Eggs are pale to red, small in diameter (0.13–0.16 mm), and almost spherical but flattened on the bottom (Figure 3) (Zhang 2003).



Figure 3. Eggs of *Panonychus citri* (McGregor).

Credit: Emilie Demard, UF/IFAS

Larvae and Nymphs

Larvae have only three pairs of legs while nymphs have four pairs of legs. There are two nymphal stages called the protonymph (second instar) and deutonymph (third instar). Nymphs resemble adults but are smaller (Figure

1). Between each molt, the mite becomes inactive to shed its old cuticle and move into the next stage. This stage is called the chrysalis stage and is associated with the thin white exuvia (molted skin of arthropods). Numerous exuviae can be seen on the underside of the leaf under high infestations as each mite will produce three exuviae during its lifespan (Figure 1) (Childers and Fasulo 1995).

Adults

Adults are dark red to purplish. Males are smaller and lighter in color compared to females (Figure 4) (Vacante 2010). Males have a slender and elongated abdomen bearing long legs while females have a rounded abdomen with the front legs shorter than the body. The aedeagus (the reproductive organ of male arthropods) is sigmoid, with a broad base. The distal end turns upward (Figure 5B) (Vacante 1985).

Females are about 0.4 mm long (Figure 4B) (Vacante 2010) and have 13 pairs of dorsal setae (stiff hairs or bristles found in arthropods) (Figure 5A) arising from strong tubercles (small projections at the base of the setae) (Zhang 2003; Vacante and Gerson 2012). Their tarsi (the “foot” or last segment of a mite leg) have claw-like empodia (lobes between the claws of the tarsi of some arthropods) with three pairs of hairs (Figure 5C) (Vacante and Gerson 2012).

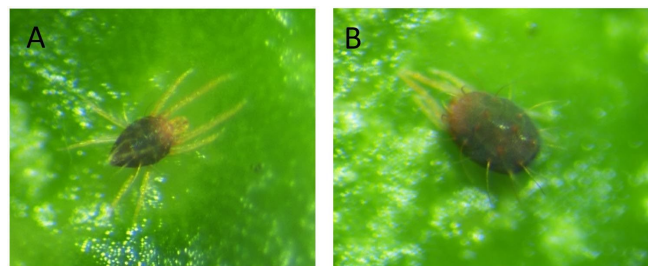


Figure 4. Morphological differences between *Panonychus citri* (McGregor). A: Male, and B: Female.

Credit: Emilie Demard, UF/IFAS

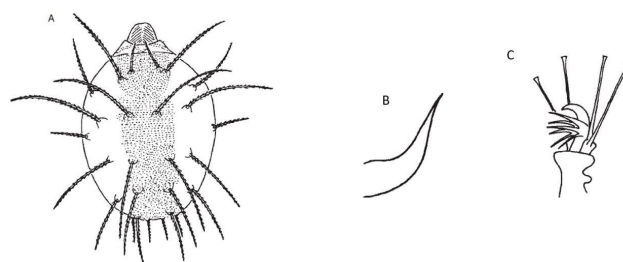


Figure 5. Drawing of *Panonychus citri* (McGregor). A: Dorsal view of female and setae, B: Aedeagus, C: Pretarsus I of female (from Vincenzo Vacante, Mediterranean University of Reggio Calabria).

Credit: Vincenzo Vacante

Panonychus citri is morphologically similar to *P. ulmi* (Koch), the European red mite, except for the color of the tubercles, which are red in the former and white in the latter (Figure 6).



Figure 6. Top: *Panonychus citri* (McGregor) and Bottom: *Panonychus ulmi* (Koch).

Credit: Matt Bertone, North Carolina State University and IRAC (available online at: <https://www.irc-online.org/pests/panonychus-ulmi/>)

Life Cycle

Females lay between 17 to 37 eggs over a period of 11 to 14 days (Childers and Fasulo 1995). At 24°C and 56% relative humidity (RH), eggs hatch in seven to nine days. The larval and the protonymphal stages live for two days each and the deutonymphal stage lasts between one to three days (Vacante 2010). Feeding starts in the protonymph stage. Females take an average of 12 days to develop from egg to adult, while males take 11 days when reared between 24°C–26°C and 50% to 70% RH. The lifespan of adults is about 23 days at 24°C–25°C (Childers and Fasulo 1995). Relative humidity of 65% is optimal for mite development and reproduction (Zhang 2003; Vacante 2010).

Panonychus citri cannot develop under 10°C or above 40°C (Zhang 2003). It is susceptible to high temperatures (all stages die above 40°C) and very dry conditions (RH around 5%). High humidity will also reduce their population growth rate (Childers and Fasulo 1995). The susceptibility of the mite to extreme temperature and ranges of high or low humidity often causes the population to decline during summer (Zhang 2003; Vacante and Gerson 2012). In Florida, the citrus red mite occurs throughout the year but

is most abundant during dry conditions in spring or early summer (March–June) and fall or early winter (September–December) (Jeppson 1978; Qureshi et al. 2021). Population of red mites can increase 8.5 times in 10 days under low humidity conditions (Childers and Fasulo 1995).

In the absence of males, females reproduce through arrhenotokous parthenogenesis, which means that virgin females lay unfertilized eggs that will develop into males only. When males are present, sexual reproduction occurs and mated females produce eggs that will develop into both sexes (Vacante 2010).

Dispersal

Dispersal occurs by wind, and mites float on air streams by holding on to silk threads. The phenomenon is called “ballooning” (Vacante and Gerson 2012). The mite can also be dispersed mechanically by humans during crop maintenance and harvesting activities (Vacante 2010). In a field study, Tashiro (1966) investigated the intra-tree movement of *P. citri* and noticed that adult females moved preferentially upward from the release point rather than horizontally or downward. Adult female maximum migration was 4 feet in a day, and dispersal increased two to three times around 70°F (21°C) compared with 50°F (10°C) (Tashiro 1966).

Economic importance

Panonychus citri is a serious pest of citrus in California, South Africa, Japan, and around the Mediterranean basin, but it is also commonly found in Florida, South America, and India (Hoy 2011). The species occurs on leaves, twigs, and fruit. Heavy infestations result in leaf- and fruit drops, twig dieback, and low-quality fruit (Vacante 2010; Vacante and Gerson 2012). Yield reduction of 17%–41% in “Tahiti” lime relative to control was observed in Florida among four pesticide treatment programs (Childers and Abou-Setta 1999).

Damage

Leaves

Panonychus citri prefers to feed on the upper surface of young and middle-aged leaves, and it is generally located in the exterior canopy (Vacante 2010; Qureshi et al. 2021). All motile stages first orient along the mid-vein, then move to leaf margins when populations increase (Qureshi et al. 2021). *Panonychus citri* uses its piercing-sucking mouthpart to remove cytoplasm contents from plant cells except for some starch grains (Albrigo and McCoy 1974). This causes grey to yellow areas called stippling spots (Figure 7A), and under high infestations, these lesions merge to give the leaf a silvery appearance (Figure 7B). The loss of the photosynthetic tissues and mesophyll collapse may result in leaf fall.

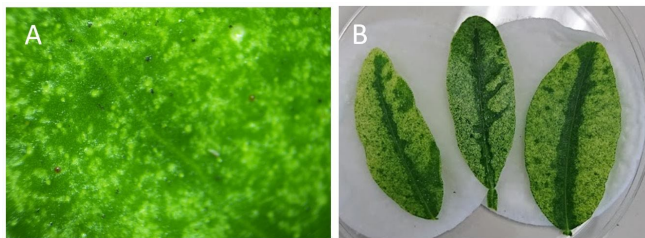


Figure 7. Damage induced by *Panonychus citri* (McGregor) on citrus leaves. A: Mesophyll collapse view with a stereomicroscope B: Stippling damage.
Credit: Emilie Demard, UF/IFAS

Fruits

Damage to fruit may occur when mite population pressure is high, and mites start to colonize fruit. Immature fruit attacked by mites turn pale, but fruit will eventually color and ripen, while damaged mature fruit contains permanent straw yellow markings (Vacante 2010). The negative effects of mite feeding on the inner quality of the fruit are unknown; however, significant damage can cause fruit drop and yield loss.

Sampling Method

Numerous sampling methods have been studied around the world (Vacante 2010). In Florida, Qureshi et al. (2021) suggested a sampling method that provides 25% or less error margins when the motile mite densities (i.e., all stages except eggs) of *P. citri* and other spider mites are above two mites per leaf. Four or eight mature leaves per tree are examined every week or every two weeks. When examining one tree/acre, it is necessary to look at over 10 sample areas within a 10-acre block to achieve accuracy. With five or 10 trees/area, only four or five areas need to be examined. The number of samples declines as the mite densities increase. This method also is useful to determine a relationship between the average number of mites on the leaf and the percentage of leaves infested within a 10-acre block. For example, it helped in determining the treatment threshold for processed fruits, which is an average of five motile spider mites per leaf corresponding to an infestation level of 70%–80%. In California, the citrus red mite populations have been monitored by a presence–absence sampling protocol (Jones and Parrella 1984; Zalom et al. 1986).

Management

Chemical Control

The recommended chemical control of mites includes the use of abamectin, fenbutatin oxide, propargite, diflubenzuron, pyridaben, tolfenpyrad, spirotetramat, and some sulfur products (Qureshi et al. 2021). To avoid development of resistance, no miticide except petroleum oil should be used more than once a year. In China, *P. citri* was found to be resistant to abamectin, pyridaben, and dicofol (Meng et al. 2000; Marčić 2012). In California, resistance to demeton and

parathion was demonstrated by Jeppson et al. (1958). Because resistance to spirotetramat and spirotetramat occurred rapidly in China, bioassay methods were established to detect resistant populations of *P. citri* in San Joaquin Valley in California (Ouyang et al. 2012). However, no report of resistance has been documented yet.

More details can be found in the Florida Citrus Pest Management Guide: Ch. 10 Rust Mites, Spider Mites, and Other Phytophagous Mites: <https://edis.ifas.ufl.edu/cg002>.

Biological Control

Several predatory insects, mites, and pathogens (bacteria and fungi) have been shown to attack *P. citri*. Some common and abundant species are listed in Table 1. Multiple literature reviews also provide an exhaustive list of the natural enemies reported for *P. citri* (Van der Geest et al. 2000; Vacante 2010; Carrillo et al. 2015).

Numerous studies have evaluated the potential of predatory mites from the family Phytoseiidae as biological control agents of the citrus red mite. For instance, in Spain, the predatory mite *Euseius stipulatus* (Athias-Henriot) is a key natural enemy of *P. citri* maintaining the pest population under satisfactory control (Ferragut et al. 1992). This species has been released in California citrus orchards and is produced commercially in Peru for the control of *P. citri* (Aguirre-Gil et al. 2013). *Euseius tularensis* is a common predator of the citrus red mite in California. Fadamiro et al. (2013) showed that three commercial species of predatory mites, *Galendromus occidentalis* (Nesbitt), *Phytoseiulus persimilis* Athias-Henriot, and *Neoseiulus californicus* (McGregor) were effective in reducing *P. citri* populations in Alabama groves. In Florida, *Typhlodromalus peregrinus* (Muma) is an abundant phytoseiid found in Florida citrus grove and CUPS. While this species can develop and feed on *P. citri*, it did not provide good control under field conditions (Fouly et al. 1995, personal observation).

Cultural Control

Drought-stressed trees develop unhealthy root systems and become susceptible to *P. citri* damage (Jeppson et al. 1975). Indeed, high transpiration results in low leaf moisture leading to leaf drop and twig dieback. Hence, adequate irrigation may reduce tree susceptibility to mite damage.

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Table 1. Natural enemies of *Panonychus citri* (McGregor).

Natural enemies	Scientific name	Location	References
Fungi	<i>Beauveria bassiana</i> (Balsamo)	China	Shi and Feng 2006
Fungi	<i>Hirsutella thompsonii</i> Fisher	Florida, USA	McCoy 1981
Bacteria	b-exotoxin <i>Bacillus thuringiensis</i>	California, USA	Hall et al. 1971
Insects Coccinellidae	<i>Stethorus punctillum</i> Weise	China	Tian 1995
	<i>Stethorus siphonulus</i> Kapur	China	Huang et al. 1988
	<i>Stethorus punctum</i> picipes Casey	California, USA	McMurtry et al. 1970; Haney et al. 1987
Chrysopidae	<i>Chrysopa</i> sp.	USA	McMurtry et al. 1970
Thripidae	<i>Scolothrips sexmaculatus</i> (Pergande)	USA	Bailey 1939
	<i>Scolothrips takahashii</i> Priesner	China	Zhou et al. 1991
Anthocoridae	<i>Orius insidiosus</i>	USA	McMurtry et al. 1970
Mites Stigmaeidae	<i>Agistemus floridanus</i> Gonzalez	Florida, USA	Goldarazena et al. 2004
	<i>Agistemus cyprius</i> Gonzalez	(Laboratory only)	
	<i>Agistemus industani</i> Gonzalez		
Stigmaeidae	<i>Agistemus exsertus</i> Gonzalez	China	Yue and Tsai 1995
Phytoseiidae	<i>Euseius tularensis</i> Congdon	California, USA	Hoy 2011
Phytoseiidae	<i>Typhlodromalus peregrinus</i> (Muma)	Alabama, Florida USA	Fadamiro et al. 2009; Childers and Abou Setta 1999
Phytoseiidae	<i>Euseius stipulates</i>	Spain, California, Peru	Ferragut et al. 1992; Aguirre-Gil et al. 2013
Phytoseiidae	<i>Galendromus occidentalis</i> (Nesbitt), <i>Phytoseiulus persimilis</i> Athias-Henriot <i>Neoseiulus californicus</i> (McGregor)	Alabama, USA	Fadamiro et al. 2013
Phytoseiidae	<i>Amblyseius eharai</i> Amitai et Swirski <i>Amblyseius swirskii</i> Athias-Henriot	China (Laboratory only)	Ji et al. 2013

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