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Evaluation of Phytoseiid and Iolinid Mites for Biological Control of the Tomato Russet Mite *Aculops lycopersici* (Acari: Eriophyidae)

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Simple Summary: The tomato russet mite (TRM), *Aculops lycopersici* (Eriophyidae), causes severe damage to tomato plants *Lycopersicon esculentum,* which results in a wilted, russetted appearance with desiccated leaves. This study focused on the search for a suitable biological control agent against TRM, as an alternative to commonly used sulfur or chemicals. The efficacy of several potential predatory mite species was assessed. *Pronematus ubiquitus* proved successful in preventing the development of TRM and damage symptoms. The potential of iolinid predatory mites for the biological control of eriophyids is discussed.

Abstract: Our search for a suitable biological agent to control the tomato russet mite (TRM), *Aculops lycopersici*, was initiated in 2013. *Neoseiulus californicus*, *Amblyseius andersoni,* and *Neoseiulus fallacis* showed a promising pest reduction potential in a curative control strategy. Although these beneficials had a low survival on tomato and were not able to eradicate the pest, plants did not present typical TRM damage. However, their inability to establish in the tomato crop means that their commercial use would require repeated introductions, making their use too expensive for growers. Other predatory mites in the survey, such as the iolinids *Homeopronematus anconai* and *Pronematus ubiquitus*, showed the potential for a preventative strategy as they can establish and reach high densities on tomato with weekly or biweekly provision of *Typha angustifolia* pollen as a food source. When the tomato crop was adequately colonized by either iolinid, the development of TRM and any damage symptoms could be successfully prevented. The potential of iolinid predatory mites for biological control of eriophyids is discussed.

Keywords: Acari; Iolinidae; *Homeopronematus*; *Pronematus*; tomato; greenhouse; biological control; small iolinid mites; big impact on TRM

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1. Introduction

The tomato russet mite (TRM), *Aculops lycopersici* Massee (Eriophyidae), is a cosmopolitan pest of unknown geographical origin and original host [1]. The species is found in almost all agricultural regions where solanaceous crops are cultivated [1–3]. Due to the fact that TRM infestations usually remain undetected at the base of the tomato plant, the mite is able to progress towards the canopy [4]. The pest causes serious damage to the head of the tomato plants, resulting in a wilted, russetted appearance with desiccated leaves [5,6]. The abaxial side of the lower leaves is often silvered, and the stems lose trichomes and develop a brown color, often with small fissures. Fruits can become bronzed on highly infested plants. To avoid serious crop damage, tomato growers in northwestern Europe increasingly use preventative sulfur sprays (or evaporation) and chemical control measures with compounds such as abamectin and/or spiromesifen upon the first signs of plant damage (Juliette Pijnakker, personal experience). Since TRM is difficult to detect early-on

and has a high reproduction capacity, with populations doubling in less than three days at 25 °C [7], the eradication of the pest is difficult.

Studies investigating the use of predatory phytoseiid mites against TRM (Duso et al., 2010) [6] are mostly limited to relatively small-scale laboratory experiments. Several phytoseiid predators have been observed feeding on TRM, including the phytoseiid mites *Amblyseius andersoni* (Chant) [8], *Amblydromalus limonicus* (Garman and McGregor) [9–11], *Amblyseius swirskii* (Athias-Henriot) [12–14], *Neoseiulus californicus* (McGregor) [8,15], *Neoseiulus cucumeris* Oudemans [8,16,17], *Neoseiulus fallacis* (Garman) [16], and *Typhlodromus* (*Anthoseius*) *recki* Wainstein [18]. Even though TRM is a suitable prey for some phytoseiids [16], their impact in terms of biological control is often insufficient [8,11,16]; therefore, phytoseiid mites are rarely used in commercial tomato crops against TRM. The capacity of phytoseiid mites to survive, move, and reproduce—and thus establish—on the tomato plants is hampered by glandular trichomes [11,14,19–24]. Furthermore, toxic secondary metabolites (in plants and prey) are thought to be lethal to the phytoseiids [24,25]. The poor performance of phytoseiids on tomato was confirmed in a few greenhouse trials on tomato plants in Europe. In France, *N. cucumeris* and *N. californicus* only reduced TRM populations when high numbers of predators were released: 3000 *N. californicus* and over 12,000 *N. cucumeris* per plant [17]. Although a single preventative release rate of 100 *A. andersoni* mites per plant) resulted in in a low TRM density on stems after eight weeks in comparison with a curative or simultaneous release of the predator, it could not fully eradicate the pest [8]. Curative releases of 140 and 420 *A. swirskii* individuals per tomato plant did not reduce the pest [11], and *A. limonicus* was also hampered by tomato trichomes [15].

Alternative options to promote the biological control of TRM include adapting predatory mites to the tomato plant [26] or developing tomato cultivars with fewer harmful trichomes [27,28]. Some mite species of the Tydeoidae, including the families Tydeidae and Iolinidae, are about five times smaller than most phytoseiid predators [29]. They are not hindered by the tomato trichomes, allowing them to move under and between the trichomes [30]. This applies to the mite species *Homeopronematus anconai* (Baker) [31], *Pronematus ubiquitus* (McGregor), and *Tydeus kochi* Oudemans [32–35]. Some of these species have been reported to occur naturally on tomato. The feeding habits of tydeids and iolinids range from predators, phytophages, mycophages, and parasitism on insects to scavengers [36,37]. Some species are reported to be pollen-feeders [31,38–41] and predators of small arthropods [16,31,42–50]. Many Tydeoidea species have been reported to be associated with eriophyoids, such as *H. anconai*, *P. ubiquitus*, *Pronematus staerki* Schruft [51], *T. kochi*, *Tydeus californicus* (Banks), *Tydeus caudatus* Dugès [52], *Tydeus caryae* Kanjani and Ueckermann, and *Tydeus goetzi* Schruft [53]. *Homeopronematus anconai* and *P. ubiquitus* are common species that have been well-studied in relatively small-scale laboratory experiments [30]. In 1961, Rice reported predation of TRM by *P. ubiquitus* [32]. Carmona found remnants of TRM in the gut of *P. ubiquitus* [33]. Hessein and Perring [31] found *H. anconai* in their TRM rearing and collected the predator from tomato plants. *Homeopronematus anconai* was able to develop and reproduce on TRM and succeeded in reducing TRM populations on tomato plants. Adults and nymphs of *H. anconai* and *P. ubiquitus* have been reported to kill all stages of TRM [30]. *Homeopronematus anconai* adults showed daily predation of about 70 *A. lycopersici* deutonymphs in the laboratory [54,55] or 3 to 4 adults of TRM adults per day [16]. Haque and Kawai [54,55] observed more than 2000 individuals of a naturally occurring population of *H. anconai* per leaf on tomato plants infested by *A. lycopersici*.

In this study, we investigated the efficacy of different predatory mites against TRM. The search for suitable biological agents for TRM started in 2013, when we compared the efficacy on individual plants of diverse phytoseiid predatory mites, either commercially available or from experimental rearing. Subsequently, following an important survey on Solanaceae, our focus shifted to iolinids, including a demonstration trial in a semi-commercial setting.