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Biological control of *Thrips tabaci* on tomato crop by their parasitoid "*Ceranisus menes*"

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Abstract

Tomatoes (*Solanum lycopersicum L.*) represent one of the leading vegetable crops grown around the globe. Among the insects with destructive impacts on tomato production, onion thrips (*Thrips tabaci Lindeman*) are among the most significant. While thrips damage tomatoes directly by feeding on plant tissues, they also damage tomato plants indirectly by introducing viruses into plants infected with the thrips, which can create considerable economic losses in tomato production. Currently, most pest management techniques used to control pest populations utilize chemical insecticides, which typically lead to pest resistance to pesticides, environmental degradation, and harm to beneficial organisms. Because of the growing concern about the use of pesticides for pest and disease management, biological control method to manage pest populations using their natural enemies has become very appealing as an environmentally friendly alternative method of pest control. One type of natural enemy for thrips are wasps in the genus Ceranisus (Hymenoptera: Eulophidae), which have received much attention because of their ability to effectively control thrips larvae through parasitization. *Ceranisus menes* (Walker) is a solitary larval endoparasitoid that parasitizes a number of different species of thrips, including T. tabaci. The female wasp lays her eggs within the early larval instars of thrips and then the wasp larvae develop in the thrips and eventually kill them. Research has demonstrated that *C. menes* can effectively decrease thrips populations in agricultural ecosystems, especially when used in conjunction with Integrated Pest Management (IPM) strategies. *C. menes* has been characterized as having a relatively fast life cycle and a high capacity for reproduction. Reproduction occurs primarily through the laying of approximately 80 eggs, and larvae of the first instar are the preferred hosts for *C. menes* . Field studies have also shown that T. tabaci is naturally parasitized by Ceranisus species in agricultural fields, suggesting that *C. menes* may assist in controlling the proliferation of thrips in certain IPM systems. This current review examines the potential of *C. menes* for the biological control of T. tabaci in tomato production systems by providing a synthesis of the currently available literature on the biology, ecology, host's relationship to *Ceranisus menes* and other information regarding the effectiveness of *Ceranisus menes* within IPM systems. Furthermore, the future directions for research into improved biological control strategies for sustainable crop production are discussed.

Keywords: Biological control, *Thrips tabaci*, *Ceranisus menes*, tomato pest management, integrated pest management.

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Introduction

Sources indicate that tomato (*Solanum lycopersicum L.*) is one of the world's most commonly grown vegetable crops, as well as an important economic crop because it is nutrient-rich and used in many food products. Many crops like tomatoes are heavily affected by insect pests, and produce significant economic loss to the agricultural system (Kumar *et al*., 2014). One highly destructive group of insect pests that attack tomato crops are thrips and it is especially damaging due to their feeding habits and ability to transmit plant viruses. The onion thrip, *Thrips tabaci* (Lindeman) is an extremely polyphagous pest, with a wide host range of crops including tomato, onion, garlic, cabbage and many ornamental plants (Nault & Shelton, 2015). Thrips feed by piercing plant tissues and sucking the contents of cells from the plant. As a result, the plant will exhibit leaf yellowing, silvering due to rapid loss of cellular parts, and have less active photosynthesis (Reitz *et al*., 2011). The T. tabaci life cycle is made up of eggs, larvae, pupae, and adults (Kirk & Terry 2003). The ability of this insect to reproduce rapidly under optimum environmental conditions can lead to rapid population growth in agricultural settings. In addition to the direct injury inflicted on plants by the T. tabaci, thrips serve as a vector for many plant viruses, thereby increasing the total injury and economical loss of vulnerable crops (Reitz *et al*., 2011). Using chemical insecticides is a common method for controlling thrips population; however, the overuse of these has contributed to pesticide resistance, destroying our ecosystems with pollution, and negatively affecting beneficial organisms (Gill & Garg 2014). As a result, there needs to be development of alternative pest management methods that can sustainably control thrips pest populations. Biological control methods utilizing natural predators of insect pests are a viable and effective method for managing agricultural pests. The natural enemies of thrips are comprised of predators such as acarine (mites) or hemipteran (bugs) predators and Eulophidae family parasitic insects (Loomans 2003). One of the most significant parasitic thrips parasitoid is *Ceranisus menes*, which is known to parasitize thrips larvae (Loomans & van Lenteren 2005).

Ceranisus menes is a solitary larval endoparasitoid and can target early instar thrips larvae. The parasitoid enters into the host thrips larva to deposit its eggs inside the larval body, and as the parasitoid develops, it consumes its thrips host body internally until the host thrips dies (Loomans 2003). Due to the ability of *Ceranisus menes* to parasitize various species of thrips, it has been evaluated as a possible biological control agent of agricultural pests (Mouden *et al*., 2017). This study will evaluate the potential for *C. menes* to provide biological control of *Thrips tabaci* in tomato cultivation, and will help assess the role of these natural enemies as a component of more sustainable pest management systems. Research on biological control of thrips has become an increasingly important area in the field of agricultural entomology. Many different types of natural enemies have been examined for the ability to control populations of thrips in crop production systems (Reitz *et al*. 2011), and no fewer than 40 species of parasitic wasps that attack thrips have been identified as potential biological control agents. In particular, Loomans (2003) conducted very comprehensive research on potential parasitic wasps of thrips, and he identified many species of the genus Ceranisus as possible biological control agents. The members of the genus Ceranisus are solitary larval endoparasitoid that develop within the larvae of thrips and ultimately kill their hosts. Previous studies also have reported that *C. menes* has been observed in various agricultural ecosystems aiding to naturally regulating populations of thrips by parasitizing a number of thrips species (e.g., T. tabaci and F. occidentalis) (Loomans & van Lenteren, 2005). The life cycle of *C. menes* is influenced by temperature and the availability of hosts according to laboratory studies conducted (Reitz *et al*. 2011). They showed that the rate of development of parasitoids was higher at moderate temperatures and that high host density would increase the efficiency of parasitism. Field studies of parasitoids have also shown they are effective at reducing thrips population. (Mouden *et al*. 2017) found that parasitoids can help suppress thrip populations when used alongside other pest management methods. New studies (Wolde-Melak, 2020) indicate that parasitoids may provide a more stable way of controlling thrip populations over the long term compared to using chemical insecticides, as they help maintain ecological balance in agricultural ecosystems.

Materials and Methods

This study is based on a systematic review of scientific literature related to biological control of thrips using parasitoid wasps. Studies focusing on thrips biology, parasitoid ecology, and biological control strategies were included.

Data Analysis

Information was compiled regarding:

- Thrips life cycle
- Parasitoid biology
- Parasitism rate

• Pest suppression efficiency
According to various prior research studies, *Ceranisus menes* has a major impact at lowering the number of thrips occurring in farms/fields. Early larvae of thrips (the first stage of development) are at greatest risk due to their young age when attacked by *Ceranisus menes* (Loomans 2003).

Table 1. Biology of *Thrips tabaci*

Parameter	Description
Order	Thysanoptera
Host range	Tomato, onion, garlic
Feeding habit	Sap sucking
Damage symptoms	Leaf silvering

The pest feeds on plant tissues and causes damage by reducing photosynthetic efficiency (Nault & Shelton, 2015).

Table 2. Biological characteristics of *Ceranisus menes*

Parameter	Description
Family	Eulophidae
Host stage attacked	Thrips larvae
Parasitism type	Endoparasitoid

Parasitoids develop inside the host and eventually kill the host larva (Loomans & van Lenteren, 2005). By the mechanism of lays eggs inside larvae, wasps develops internally and killing the host before pupation. Optimum condition required for parasitism, temprature 20-30 degree Celsius, self sustaining once established in the field.

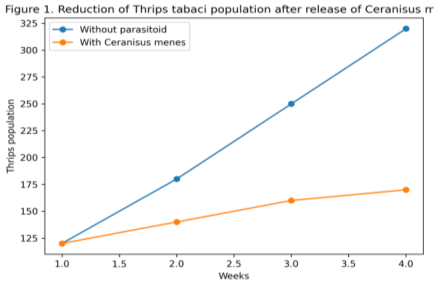

Figure 1 – Thrips population reduction after parasitoid release
Figure 1. Reduction of *Thrips tabaci* population in tomato crop after release of the parasitoid (*Ceranisus menes*).

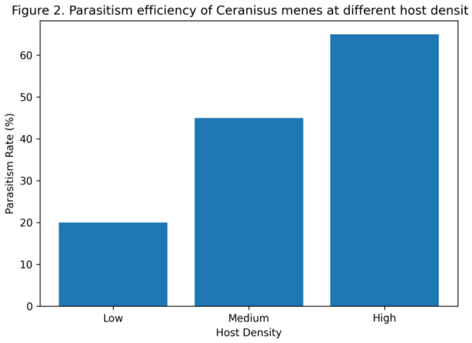

Figure 2 – Parasitism efficiency of *Ceranisus menes*
Figure 2. Parasitism rate of *Ceranisus menes* under different host density conditions.

Result and Discussion

The results of this literature review show that parasitoids are essential for controlling thrips populations in agricultural crops. There can be a lot of economic loss from thrips infestations due to feeding sites caused by thrips and/or the transmission of viruses (Reitz *et al*., 2011). Biological control through parasitoids such as *Ceranisus menes* has many advantages over chemical control (Loomans, 2003). Parasitoids tend to be very host specific and this reduces the chance of damaging beneficial insects. In addition, environmental factors such as host density and temperature have a strong effect on the efficacy of parasitoids. Parasitism rates tend to increase with higher host populations when using parasitoids (Mouden *et al*., 2017). The integration of parasitoids into an integrated pest management program will greatly reduce the need for pesticides and increase sustainability in agricultural systems (Wolde-Melak, 2020).

Conclusion

Using parasitoids as biological control against thrips in tomato plants is an environmentally friendly way to manage these pests. One specific parasitoid, *Ceranisus menes*, contributes to the control of *Thrips tabaci* populations by parasitizing them while they are still in the larval stage of development. Future studies should concentrate on creating better ways to rear these parasitoids in large numbers as well as field testing their effectiveness and how they can be combined with other biological control for improved pest management method.

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