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REVIEW ARTICLE

REVIEW ON ECOLOGICAL WHITE FLY MANAGEMENT PRACTICES IN VEGETABLE CROPS

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ABSTRACT

White flies *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae) is a damaging sap-sucking insect pest of ornamental and vegetable crops. It causes yield reduction and crop damage by feeding on both immature and mature plants as well as spreading viral infections. Due to their widespread use throughout the world, synthetic chemical pesticides have a negative influence on human health, the environment, crop yield, and pollinator health. A few species have also evolved resistance to these pesticides. Sustainable and environmentally responsible management techniques are becoming more and more necessary to control whitefly populations as ecological concerns rise. The purpose of this review is to provide an overview and assessment of the effectiveness of various ecological management techniques used in vegetable crops to manage whiteflies. The review includes cultural, physical, and biological techniques as well as preventive and therapeutic treatments. Through altering their life cycle and habitat, cultural methods like crop rotation, intercropping, and trap cropping have showed promise in lowering whitefly populations. Physical controls like reflecting mulch, insect-proof screens, and sticky traps have proven successful in catching adult whiteflies and limiting their population. The employment of natural enemies like parasitoids, predators, and entomopathogenic fungi in biological control strategies has shown to be highly effective in reducing whitefly populations. These techniques reduce detrimental effects on the environment and human health in addition to providing long-term and sustainable management. These methods support environmentally sound and economically successful sustainable agriculture systems by fostering biodiversity, protecting natural enemies, and lowering the use of synthetic pesticides.

KEYWORDS

Bemisia tabaci Gennadius (Hemiptera: Aleyrodidae), insect pest, sustainable

1. INTRODUCTION

The whitefly is a polyphagous insect which have reduced the agricultural production especially in different families of the vegetable crops. Whitefly *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae) insect is destroying the agricultural production all over the world (Oliveira et al., 2001). Whiteflies are the small sap sucking which are more in number during the warm weather conditions (Flint, 2007). The whitefly abundance can be found worldwide (Brown, 1991) but absent Antarctica (Kanakala & Ghanim, 2019). The management of the whitefly once it is spread all over the plant is very much difficult (Flint, 2007). The whitefly has the capacity to produce number of the generation even in the short period of time in the controlled environmental warm conditions (Wintermantel, 2004). The losses of the whiteflies in the plant may varied significantly in the damage and weakened plants (Sani et al., 2020). Both the juvenile stage nymph and adult stage whitefly consume by sucking sap from the plants which stimulate sooty mould after the excretion of honeydew on the leaves and newly developed fruit which have a negative impact on the agriculture yield (Solanki & Jha, 2018). Due to injection of enzyme by the nymph at time of feeding, irregular ripening of fruits and diminished interior color are some of the symptoms occur in plants (Chintkuntla, 2015).

Various management practices are found to be effective in the controlling of whitefly(Yule et al., 2017). Pest control approach like the sticky traps, were effective in suppressing whiteflies in greenhouses, however they were ineffective against them in open fields because they were constantly migrating into nearby locations, thus changed the composition insect population, so they should be use along with other control methods (Lu et al., 2012). Many of the management options have been used for whitefly still there still should be very effective and strategies that reduced the number and spreading of the whitefly which is robust, effective and environment friendly should be needed for further research (Papnai et al., 2020).

2. METHODOLOGY

The paper is based on the review and research articles of national and international elaborating the damage that has been done by the whitefly in tomato and cucumber. Furthermore, sources from various reports, published text books, academic institutes and other reported international universities journals.

- Journal of Agricultural and Statistical Sciences.
- Journal of Asia-Pacific entomology.
- Journal of Insect Science.
- Environmental Entomology.
- Journal of Environmental and Zoology Studies.
- Agricultural and Environmental Sciences.
- Annual review of Entomology.
- Agriculture, Ecosystem and Environment.

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- European Journal of Plant Pathology.
- Trends in Plant Science.
- Transgenic Research.
- Journal of Entomology and Zoology Studies.
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- Journal of Invertebrate Pathology.
- Journal of Biotechnology and Bioinformation Research.
- Journal of Pharmacognsy and Phytochemistry.
- Entomol.
- International Journal of Agricultural Sciences
- Insects.
- Pure and Applied Biology.
- Crop Protection.
- Molecular Plant Microbe Interaction.
- Bulletin of Entomology Research.
- Journal of Economic Entomology.
- Plant defense: Biological Control.
- Post-Harvest Biology and Technology.
- Virus Research.
- Crop and Food Research.

3. Literature Review

3.1 Life Cycle

Whitefly is a small insect with most of the species having wings expansion up to 3mm and a body length ranging from 1mm to 2mm. Adults have very well-developed antennae which in most species in this family have seven segmented (Schuster et al., 2007).

Source: (Abubakar et al., 2022)

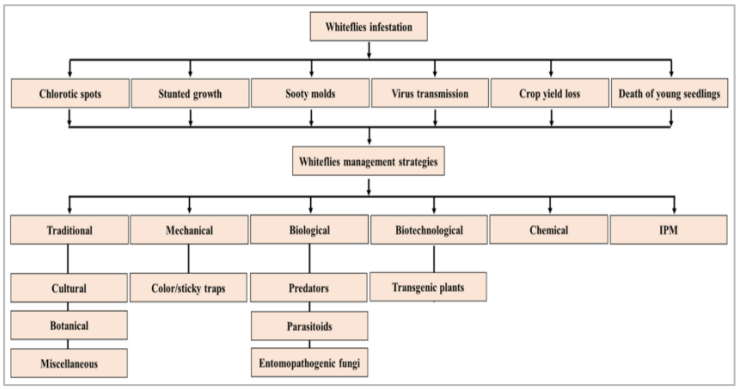
Figure 1: Whitefly life cycle. (A) Oval shaped eggs attached to the leaf stalk. (B) First instar nymph. (c)Second, Third and Fourth instar nymphs. (D) Fourth instar red eyed nymph. (E) Pupa stage. (F) Adult whitefly after the metamorphosis.

3.2 Damaging Nature

Firstly, it removal of sap from the phloem in the leaves and stems plant parts (Horowitz et al., 2020). Secondly, both the immature and mature stage secrete honeydew rendering the sticky leaves and forming of substrate which is medium for initiation of sooty mold (Naranjo et al., 2002). Thirdly, it act as an transmission of 100s of virus that infect the different vegetables family (Jones, 2003). Fourthly, both the immature and mature stage can feed by injecting salivary fluid resulting in the various type of plant disorder (McCollum et al., 2004).

Phloem feeding by whiteflies can cause direct damage, or they can spread viruses like the tomato yellow leaf curl virus that can cause damage indirectly (Ghosh, 2020). Cucurbits can contract at least 59 different plant viruses (Abrahamian & Abou-Jawdah, 2014). Numerous viruses belonging to the different genera are spread by whiteflies and infect cucurbits (Al-Saidi & Al-Obaidy, 2022). All vegetables species have been also attacked by the whitefly. Some of the research shows, in Texas loses of the whitefly recorded up to 29 million dollar and in the south Calorina it causes the leaves swell and change shape, crumpling and curling. The whitefly acquires the virus by ingesting and sucking sap from the phloem tissue of plants that are infected with it (Ghosh et al., 2021). To acquire the virus, the insect must feed on an infected plant for at least 15 minutes, and it must keep eating for an additional 15 to 30 minutes to transfer the virus to a different host plant. The disease Tomato leaf curl is brought on by the whitefly in tomatoes. Its signs are represented by: damaged zones, Leaf dryness, yellowing, and upward curling (Subramanian, 2022).The severity of the whitefly issue has prompted studies to create practical management strategies.

3.2 Management of The Whitefly



Source: (Abubakar et al., 2022)

Figure 2: Management of whitefly in vegetables.

3.2.1 Cultural Practices

1. Regulating the fertilizer and irrigation application so that the environment may be modified to have less impact of insect on the crops (Lapidot et al., 2014).

2. Drip irrigation was found to be effective for the reduction of whitefly density and to have less transmitted in several crops (Abd-Rabou & Simmons, 2012).

3. Adjusting the crop sowing season is beneficial for the reduction of high population level (Ellsworth & Martinez-Carrillo, 2001) also the sulfur containing fertilizer is also effective for reducing some number of population in various crops (Simmons & Abd-Rabou, 2009).

4. Both the synthetic and organic mulches found beneficial in reducing the infestation of whitefly on the vegetables (Simmons & Abd-Rabou, 2009). They help in the reduction of the number and the harmful pathogens they carry in different vegetable crops like tomato, bean, cucurbits species etc.

5. Intercropping practices reduced the whitefly number and its attacks like ginger as trap crops in okra field (Asawalam & Chukwu, 2012) and Zucchini intercropped okra have reported less number of populations of whiteflies (Manandhar et al., 2009). Lettuce intercropped in cucurbits reduced the whitefly up to 69.7% (Li et al., 2021).The uses of different techniques like barrior and trap crop are advantageous in controlling the virus with different crops (Schuster, 2004).

6. In reducing the infestation done by the whitefly, practices of using the UV-absorbing material are being used in the protected structure (Kumar & Poehling, 2006).

7. Use of the trap crop as a Nicotiana in the tomato cultivation process. The Nicotiana is a flowering tobacco plant variety that attracts the number of the whiteflies.

3.2.2 Host Plant Resistance

1) Multiple efforts have been carried out widely used in tomatoes breeding to develop B. tabaci resistance. In tomatoes cultivar that carry the Mi gene the host preference of the whitefly is lowered (Nombela et al., 2000).

   - For example, the Mi gene of the tomato have showed the resistance towards whitefly in causing infestation, egg laying and fourth instar nymphs number (Nombela et al., 2003).

   - The presence in number of the glandular trichomes in tomatoes have been associated with the reducing the number of the whitefly damaging the tomato plant (Setiawati et al., 2009).

2) Transgenic plant also have been used to show the resistance against the whitefly (Brunetti et al., 1997).

   - For example, the transgenic tomato have showed the resistance for TYLCV from the screening as no any visible symptoms of TYLCV are transferred to the progeny (Yang et al., 2004).

   - As whitefly are feed to the genetically modifying bean, the amount of BGMV DNA have been significantly decreased up to 84% (de Paula et al., 2015).

   - But in the feeding of the genetically modifying lettuce the death of whitefly have been recorded up to 98.1% (Ibrahim et al., 2017).

3.2.3 Monitoring and Sampling

1. The most efficient pest monitoring methods are scouting, pheromone traps, and light traps. Whitefly activity in a field can be found and tracked using yellow sticky traps (Schuster et al., 2007). These traps are an essential component in their management of whiteflies. The whiteflies management has been done by the use of yellow sticky traps on the large scale monitoring in the incidental time.

2. A lot of research has been done in figuring out how to track and sample for B. tabaci on vegetable crops like tomatoes (Arnó et al., 2006), the cucumber (Moura et. al., 2003) watermelons (Lima et al., n.d.), melons, common bean , muskmelons and eggplant (Shen et al.,2005), and pepper (Chung et al., 2014).

3.2.4 Traditional practices

1. Buttermilk mostly used by farmers has been beneficial in the controlling of the sucking pest. The casein protein present in the milk has been beneficial because it attach on the wings of whiteflies which restrict their movement and its transmission of pathogen (Mérillon & Ramawat, 2012).

For example: using of the fermented milk seems to have the reduction of 60% on whiteflies number in the okra crops (Tegene, 2020).

2. Foliar spraying of the cow urine not only beneficial in controlling of the diseases but also had been effective as a plant growth regulator.

3. The combination of the cattle urine and the extract from the chilly, neem and garlic was found to be beneficial for the reducing whiteflies population in okra and other pest populations (Singh et al., 2021).

4. Ash is also found to be beneficial in the controlling the wide range of whiteflies. Coating of thick layer of ash acts as a toxin and blocks the incoming nature of insects for finding their hosts.

5. The use of kerosene, soap and water formulation have been also beneficial for controlling the piercing-sucking insects (Celsia & Janarthanan, 2019). For example: use of the kerosene based treatment in the tomato crops not only reduce the whitefly infestation but also has been beneficial for increasing the yield.

3.2.5 Biological Control

The method of the management strategies in which there is use of organism for the reduction in population level of other. Some of the predators of the whitefly include ladybird beetle, lacewing, predaceous bugs and spiders (Xu et al., 2013). Some of the genera of parasitoids are known for the reduction of whitefly species number very effectively (Sani et al., 2020).

1. Tomato cultivation in the greenhouse condition have been reported to reduce the number of whiteflies by using lacewing (*Chrysoperla carnea* Stephens)(Rehman, 2020).

2. Use of the Mirid bug (*Macrolophous pygmaeus* Rambar) in cultivation of watermelon reduced the infestation by whitefly (Abubakar et al., 2022).

3. The use of the biological control agents like *Metarzhium anisopliae* in eggplants, the death rate of whitefly is recorded up to 84.3% (Isman & Grieneisen, 2014)

4. The use of (*Isaria fumosoroseus* Wize) as a bio-control agents, result was up to 83% death of whitefly second instar after a week of treatment (Tian et al., 2015).

5. In sweet potato, use of low density *Encarsia mundus* and *Encarsia formosa* had reduced the number of whiteflies by 77.9% and 62% respectively (Abubakar et al., 2022).

6. Use of parasitic wasp *E. eremicus* has been reduced whitefly population mainly immature stage of vegetables like tomato and sweet pepper under greenhouse conditions (Stansly et al., 2010).

7. By using *Amblyseius swirskii* Athias-Henriot in the cultivation of sweet pepper and tomato the whitefly population is lowered in high number (Calvo et al., 2009).

8. Over the course of seven days, mortality greater than 50% was seen as a result of *B. bassiana's* hostile interactions with other biological control agents (Sani et al., 2020).

4. Conclusion

Insect infestation is one of the key issues restricting vegetable production and quality. Therefore, for the crop to produce a quality and quantity of yield, accurate pest identification, knowledge of the insect's life cycle and dangerous stage, and prompt pest management are crucial. The vast majority of pest control techniques used today rely on chemical pesticides, which disturb the delicate balance between pests and their natural enemies, harm the ecosystem, promote pest rebirth, and boost pest

resistance. An integrated approach that includes pest monitoring, cultural practices like field rotation, the use of mulches and trap crops, shifting planting dates, resistant cultivars, mechanical practices like handpicking, biological control, and botanicals is very helpful in reducing insect pests in vegetables. In conclusion, ecological methods, integrated pest management techniques, and site-specific factors must all be used in conjunction for effective whitefly management. Farmers can effectively manage whiteflies while reducing negative environmental effects and maintaining crop health by putting these techniques into practice. To further develop and enhance whitefly management strategies, research and knowledge exchange are essential.

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