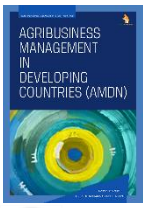
ZIBELINE INTERNATIONAL PUBLISHING

Agribusiness Management In Developing Nations (AMDN)

DOI: http://doi.org/10.26480/amdn.01.2023.13.15

E-ISSN: 2990-9309 (Online)
CODEN: AMDND7



CrossMark

REVIEW ARTICLE

A REVIEW ON THE INVASIVE VEGETABLE LEAF MINER (*Diptera: Agromyzidae*): LIFE CYCLE, DAMAGE SYMPTOMS, AND MANAGEMENT

Prava Paudel[a*], Pragya Paudel[a], Richa Timilsina[b], Pratibha Basnet[c]

[a]Girija Prasad Koirala College of Agriculture and Research Center (GPCAR), Purbanchal University, Gothgaun, Morang, Nepal
[b]Nepal Polytechnic Institute, College of Agriculture, Engineering, Medical & Veterinary Science, Purbanchal University, Bharatpur, Chitwan
[c]Mahendra Ratna Multiple Campus, Tribhuvan University, Illam
[*]Corresponding Author Email: paudelprava6@gmail.com

ARTICLE DETAILS

Article History:

Received 03 February 2023
Revised 06 March 2023
Accepted 09 April 2023
Available online 19 April 2023

ABSTRACT

The leaf miner is a juvenile stage of insects that dwell within the leaves of vegetables and feed on their tissues. It belongs to the family of dipteran flies and has a polyphagous feeding habit, meaning it can consume a wide range of plants. This comprehensive review paper provides an in-depth analysis of the invasive vegetable leaf miner, covering topics such as its life cycle, damage symptoms, and management strategies. The vegetable leaf miner is an invasive pest that causes significant damage to vegetable crops, particularly solanaceous crops. The paper explores the biology and ecology of the vegetable leaf miner, including its life cycle and host range. It also describes the damaging symptoms caused by the pest, which include the formation of distinctive tube patterns on the leaves. The paper further investigates the various management strategies that have been developed to control the spread of the vegetable leaf miner, including chemical, cultural, and biological control measures. The aim of this paper is to provide a comprehensive overview of the invasive vegetable leaf miner and to highlight the most effective management strategies for controlling its spread and minimizing its impact on crop yields.

KEYWORDS

Vegetable leaf miner; Dipteran fly; Crop damage; Life cycle; Control measures

1. INTRODUCTION

Liriomyza sativae Blanchard, commonly known as the vegetable leafminer, is a widespread pest found in the southern United States, as well as Central and South America (Capinera, 2001a). While it is a prevalent vegetable pest in tropical and subtropical regions, outbreaks of this polyphagous leafminer are often secondary and occur when insecticides used to control other pests reduce their suite of parasitoids in cropping systems or in the absence of naturally occurring parasitoids in greenhouses (Ridland & Umina, 2020). Greenhouses, in particular, are easily infested by *Liriomyza trifolii* (Burgess), also known as the American serpentine leafminer, which is one of the three most destructive polyphagous leafminers of horticultural crops (Capinera, 2001b). *Liriomyza trifolii*, *Liriomyza huidobrensis* (Blanchard), and *Liriomyza sativae* Blanchard are the three major species of polyphagous leafminers that can cause reduced crop value or yield due to their feeding on leaf mesophyll tissue (Minkenberg & van Lenteren, 1986). The adverse effects of *Liriomyza sativae* Blanchard can also be seen in several types of bedding plants, such as chrysanthemum and gerbera (Sher, Parrella, & Kaya, 2000). The aim of the paper is to provide a comprehensive review of the vegetable leafminer, *Liriomyza sativae* Blanchard, including its life cycle, damaging symptoms, and management strategies. The paper also aims to explore the occurrence of this pest in various regions and highlight the importance of integrated pest management for effective control.

2. LIFE CYCLE OF VEGETABLE LEAF MINER

The temperature range of 9°C to 12°C is considered to be the developmental limit for eggs, larvae, and pupae of the vegetable leaf miner. On the other hand, warm conditions of 25°C to 30°C are found to be optimal for the combined development of egg and larval stages, taking approximately 7-9 days. Pupal development at these temperatures requires an additional 7-9 days (Capinera, 2001a). This indicates that temperature plays a crucial role in the developmental stages of the vegetable leaf miner. The life cycle of the vegetable leaf miner consists of the egg, larva, pupa, and adult stages, which undergo development and metamorphosis in the appropriate environmental conditions.

2.1 Egg

The eggs of the vegetable leaf miner are approximately 0.23 mm in length and 0.13 mm in width, and they are oval and white in color. The eggs are laid by the female on the lower leaf surface, usually one at a time, and sometimes in close proximity (Capinera, 2001a). Mugala et al. (2022) reported that female vegetable leaf miners typically lay 8 to 14 eggs per day. The eggs are placed just below the surface of the leaf tissue and take three days to hatch. Capinera (2001a) further notes that the fly feeds on both naturally occurring exudates and the plant secretions produced by oviposition.

2.2 Larva

The larvae of this insect do not have legs, and they start off colorless but turn yellow as they develop. The mouthparts of the larvae are different in size for each of the three feeding stages, with average lengths ranging from 0.09 to 0.23 mm (Capinera, 2001a). Unlike many other fly larvae, the vegetable leaf miner's larvae do not sharply taper towards the head and have two spiracles at the rear end. These larvae cause harm to their hosts in two ways by stinging the leaves for either oviposition or feeding and by mining the mesophyll of the leaves, leading to a loss in photosynthetic capacity and an unattractive appearance that renders flowers unusable for commercial use (Sher et al., 2000). The vegetable leaf miner feeds on several economically important plants, including vegetables, ornamentals,

Quick Response Code	Access this article online	
	Website: www.amdn.com.my	**DOI:** 10.26480/amdn.01.2023.13.15

and weeds, and lives inside and feeds on plant leaves (Jovicich, 2009).

2.3 Pupa

According to Weintraub and Horowitz (1995), the larva of the vegetable leaf miner creates an opening in the leaf's surface before emerging to pupate. The puparium gradually changes color from yellowish to golden brown and then to a darker brown. Its shape is round with a slight ventral flattening, and it has dimensions of 0.5 to 0.75 mm in width and 1.3 to 2.3 mm in length, as noted by Capinera (2001a). Pupae usually pupate in the soil, where they are not easily destroyed by chemicals and sunlight, as reported by Zekeya and Chacha (2016).

2.4 Adult

Adult leafminers are small, measuring less than 2 mm in length, with transparent wings ranging from 1.25 to 1.9 mm in length. They have crimson eyes and a golden head, and the majority of their body is gray and black, with yellow legs and ventral surface of the thorax (Capinera, 2001a). The feeding behavior of adult leafminers results in a significant decrease in photosynthetic rates, stomatal conductance, and mesophyll conductance in greenhouses (Sher, Parrella, & Kaya, 2000). Adults are most active at dawn and in the morning, and they mate one to two days after emerging from the pupa. Females can lay eggs after one mating, and they pierce the leaves to lay their eggs and feed on plant sap. Adult males eat the punctures that females make on leaves (Jovicich, 2009). To protect their eggs from predators and unfavorable environmental conditions, adults hide themselves and lay their eggs on the undersides of leaves (Zekeya & Chacha, 2016). The lifespan of adults ranges from 13 to 18 days (Capinera, 2001a).

3. Damaging Symptoms

The vegetable leaf miner is known to cause significant damage to a wide range of crops, including vegetables and ornamental plants. The symptoms of infestation include tunneling, leaf deformation, and reduced yield. Below are the symptoms caused by vegetable leaf miner that led to damage.

1. Females puncturing leaves during oviposition or feeding can cause stippled appearance on leaves, but it causes little damage compared to larvae's leaf-mining activity (Capinera, 2001a).
2. As the larva grows, the irregular mine widens from approximately 0.25 mm to about 1.5 mm, resembling L. trifolii's mines in both appearance and effect (Capinera, 2001a).
3. An increase in leaf cell multiplication rates pushes eggs and young larvae out of actively growing leaves, increasing the risk of desiccation and exposing them to predators (Mugala, T., Visser, D., Malan, & Addison, 2022).
4. Larval feeding is the most significant cause of damage, reducing plant's ability to photosynthesize and causing desiccation and early leaf fall. Severe infestation may cause fruits to become sunburned in subtropical areas (Minkenberg, & van Lenteren, 1986).
5. Adult leafminer feeding in greenhouses can significantly decrease photosynthetic rates, stomatal conductance, and mesophyll conductance (Sher, Parrella, & Kaya, 2000).
6. Larval mining reduces photosynthetic capacity and damages leaves, leading to the production of unusable products (Sher, Parrella, & Kaya, 2000).
7. Leafminers can attack plants at every stage of growth, from seedling to fruiting (Jovicich, 2009).
8. Larvae can create leaf mines on cotyledons, leaves, petioles, and pea pods, preferentially mining the mesophyll that contains chloroplasts. Loss of chlorophyll-containing cells reduces photosynthesis in leaves (Jovicich, 2009).
9. Mature females can puncture both leaf surfaces for egg production and sap feeding (Jovicich, 2009).

4. Host Plants

Liriomyza sps. is known for attacking a variety of plants, but it is especially known for causing damage to celery and chrysanthemums. In Florida, Stegmaier (1966) found that L. trifolii attacked at least 55 plant species, including bean, beet, carrot, cucumber, eggplant, lettuce, melon, onion, pea, pepper, potato, squash, and tomato (Capinera, 2001b).

5. Control Measures of Vegetable Leaf Miner

There are various control measures available for managing the vegetable leaf miner. The approaches include cultural control, biological control, chemical control, botanical control, and Integrated pest management (IPM).

5.1 Cultural Method

To monitor adult and larval population levels, leaf samples and yellow sticky traps were utilized, respectively (Monica et al., 2021). Cultural control measures aim to reduce the prevalence and spread of the pest by altering the cropping system and the environment in which the crop is grown. Some of the cultural control measures that can be implemented include crop rotation, sanitation, and the use of reflective mulches. Crop rotation involves planting different crops in rotation with one another to disrupt the life cycle of the pest. Sanitation involves removing infected plant material and debris, while reflective mulches act as a deterrent by disrupting the insect's visual orientation (Yadav et al., 2022a).

5.2 Biological Control

The primary goal of biocontrol is to reduce agricultural pest populations while minimizing harm to the environment and other organisms. Natural enemies, including parasites, predators, diseases, and viruses, are often utilized in biological control techniques (Yadav et al., 2022b). Agromyzid leafminers have abundant natural enemy communities, making augmentative biological control in greenhouses and traditional biological control in the field using insect parasitoids a popular focus (Abd-Rabou, 2006). The most effective biological control methods involve using parasitoids, nematodes, entomopathogenic fungi and bacteria, and pheromone traps for population monitoring and detection (Zekeya & Chacha, 2016). Releasing parasitoids into crops has been found to be a successful method for suppressing leafminers in the field, particularly in greenhouse cultivation (Capinera, 2001a). In order to avoid using toxic chemicals, entomopathogenic fungus and entomopathogenic nematodes are used in biocontrol, and there is ongoing interest in developing fungus as biocontrol agents for various pests and illnesses (Mugala et al., 2022).

5.3 Chemical Control

To control leafminer infestations, systemic or translaminar insecticides are necessary since contact insecticides are ineffective against the larvae inside the leaf (Mugala et al., 2022). However, frequent use of chemical insecticides can lead to insecticide resistance in leafminer populations, which varies depending on the population's pesticide susceptibility and the frequency of insecticide application. To prevent resistance, it is recommended to alternate between insecticide classes and reduce the dose and frequency of application in some untreated areas (Capinera, 2001b). Early pesticides like nicotine were used to control leaf miners, and other systemic insecticides like Di-syston, phorate, and abamectin have shown successful control in crops like cucumbers and southern peas (Monica et al., 2021; Musgrave et al., 1975). The use of abamectin and plant oil in combination has also been shown to have a synergistic impact on leafminer control, allowing for lower concentrations of the insecticide to be used and lowering treatment costs (Monica et al., 2021).

5.4 Botanical Control

The bioinsecticides offer different mechanism of action, with which the recipient range of insecticides induces and wide spectrum of pests are controlled (Yadav et al., 2022c). To test the efficacy of Margosan-O TM, a neem seed extract product sold commercially, against L. trifoli leaf miners, different concentrations of the product were applied on foliage, and the adult population levels were measured. The study found that Margosan-O significantly reduced the number of leaf miners at foliar concentrations of 0.41%, 0.84%, and 1.25% (Monica et al., 2021). Similarly, neem leaves have been utilized to lower leafminer populations in onion plantations by steam distillation (Monica et al., 2021).

5.5 Integrated Pest Management

Integrated Pest Management (IPM) is an effective and sustainable approach to manage the vegetable leaf miner, *Liriomyza sativae* Blanchard. IPM involves the use of a combination of control tactics, including cultural, physical, and biological methods, in addition to chemical control measures. In conclusion, IPM is an effective and sustainable approach to manage the vegetable leaf miner. It involves a combination of control tactics that work together to reduce the prevalence and spread of the pest. By implementing IPM, growers can effectively manage the pest population and reduce the risk of economic losses due to damage caused by the vegetable leaf miner. Additionally, according to Yadav et al. (2022d), the use of the sterile insect technique (SIT) could become a fundamental element of area-wide integrated pest management (AW-IPM) programs, particularly for controlling a variety of significant agricultural pests and disease carriers.

6. Conclusion

Vegetable leaf miner is a notorious pest that can cause significant economic losses for farmers in the vegetable production industry. The use of Integrated Pest Management (IPM) strategies can help manage this pest and reduce its impact on crop yields. IPM strategies such as cultural control, biological control, and chemical control when used judiciously can help reduce the pest population, minimize damage to crops, and reduce the reliance on chemical pesticides. However, there is still much to learn about the vegetable leaf miner and the efficacy of various control methods. Continued research on this pest and its control methods is necessary to develop more effective and sustainable pest management strategies. With proper management practices, the vegetable production industry can mitigate the impact of the vegetable leaf miner and continue to provide high-quality produce to consumers.

Author Declaration

The authors declare no irreconcilable circumstances. All authors contributed equally in all phases of preparation of this manuscript. Likewise, the final version of the manuscript was approved by all authors.

References

Abd-Rabou, S. 2006. Biological control of the leafminer, Liriomyza trifolii by introduction, releasing, evaluation of the parasitoids Diglyphus isaea and Dacnusa sibirica on vegetables crops in greenhouses in Egypt. Archives of Phytopathology and Plant Protection, 39(6), 439-443.

Capinera, J. L. 2001a. Vegetable Leafminer, Liriomyza sativae Blanchard (Insecta: Diptera: Agromyzidae). University of Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, EDIS.

Capinera, J. L. 2001b. American Serpentine Leafminer, Liriomyza trifolii (Burgess)(Insecta: Diptera: Agromyzidae). IFAS Extension. Institute of Food and Agricultural Sciences, University of Florida, 1-5.

Jovicich, E. 2009. Leafminer pest-generic incursion management plan for the Australian vegetable industry.

Minkenberg, O. P., & van Lenteren, J. C. 1986. The leafminers, Liriomyza bryoniae and L. trifolii (Diptera: Agromyzidae), their parasites and host plants: a review (No. 86-2). Agricultural University.

Monica, S. S., Sathishkumar, J. K., Vinothkumar, B., Krishnamoorthy, S. V., & Rajendran, L. 2021. A review on management of leafminer in horticultural crops. Journal of Entomology and Zoology Studies, 9(2), 1204-1213.

Mugala, T., Visser, D., Malan, A. P., & Addison, P. 2022. Review of Liriomyza huidobrensis (Blanchard, 1926)(Diptera: Agromyzidae) on potatoes in South Africa, with special reference to biological control using entomopathogens and parasitoids. African Entomology, 30, 1-10.

Musgrave, C. A., Poe, S. L., & Bennett, D. R. 1975. Leaf miner population estimation in polycultured vegetables. In Proceedings of the Florida State Horticultural Society (Vol. 88, pp. 156-159).

Ridland, P. M., Umina, P. A., Pirtle, E. I., & Hoffmann, A. A. 2020. Potential for biological control of the vegetable leafminer, Liriomyza sativae (Diptera: Agromyzidae), in Australia with parasitoid wasps. Austral Entomology, 59(1), 16-36.

Sher, R. B., Parrella, M. P., & Kaya, H. K. 2000. Biological control of the leafminer Liriomyza trifolii (Burgess): implications for intraguild predation between Diglyphus begini Ashmead and Steinernema carpocapsae (Weiser). Biological Control, 17(2), 155-163.

Weintraub, P. G., & Horowitz, A. R. 1995. The newest leafminer pest in Israel, Liriomyza huidobrensis. Phytoparasitica, 23(2), 177-184.

Yadav, S. P. S., Bhattarai, S., Ghimire, N. P., & Yadav, B. 2022a. A review on ecology, biology, and management of a detrimental pest, Tuta absoluta (Lepidoptera: Gelechiidae). Journal of agriculture and applied biology, 3(2), 77-96. http://dx.doi.org/10.11594/jaab.03.02.02

Yadav, S. P. S., Lahutiya, V., & Paudel, P. 2022b. A Review on the Biology, Ecology, and Management Tactics of Helicoverpa armigera (Lepidoptera: Noctuidae). Turkish Journal of Agriculture-Food Science and Technology, 10(12), 2467-2476. https://doi.org/10.24925/turjaf.v10i12.2467-2476.5211

Yadav, S. P. S., Sharma, R., Ghimire, N., & Yadav, B. 2022c. History, Presence and Perspective of Botanical Insecticides against Insect Pests. In K. Ghoneim (Ed.), Advances in Agricultural Entomology. Pp. 49–69. AkiNik Publications.

Yadav, S. P. S., Sharma, R., Ghimire, N., & Yadav, B. 2022d. Sterile Insect Technology (SIT) in New World Screwworm. In K. Ghoneim (Ed.), Advances in Agricultural Entomology. Pp. 15–33. AkiNik Publications.

Zekeya, N., Chacha, M., Ndakidemi, P. A., Materu, C., Chidege, M., & Mbega, E. 2016. Tomato leafminer (Tuta absoluta Meyrick 1917): A threat to tomato production in Africa.