

## Field diagnosis of insect pest of leafy vegetables: A comprehensive review

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### Abstract

Leaf vegetables, also called leafy greens, pot herbs, vegetable greens, or simply greens, are plant leaves eaten as a vegetable. Nearly one thousand species of plants with edible leaves are known. Leaf vegetables most often come from short-lived herbaceous plants, such as amaranth, lettuce, cabbage, spinach, mustard greens, celery, parsley etc. Leafy vegetables are exceptional source of essential vitamins, minerals, and phenolic compounds. These greens, particularly high in iron and calcium, surpass many staple food grains in nutritional content and designated as "protective foods" due to their health benefits. Insect pests are the major causes of crop yield losses around the world. Leafy vegetables are vulnerable to infestations by various insect pests. If left unmanaged, these infestations can significantly reduce their availability and quality. Insect pest infestations and damage can limit the production of vegetables in the farming systems. It is necessary to diagnose these insect pests in field at developing stages. Field diagnosis provides information relating to common symptoms expressed by crop plants and insect when under attack from a wide variety of insect pest.

**Keywords:** Leafy vegetables, Insect pests, Host plants, Infestation, Field diagnosis

### Introduction

Leafy vegetables, or greens, are cultivated primarily for their edible leaves. These vegetables include species like amaranth, lettuce, cabbage, spinach, mustard greens, celery, and parsley. Their versatility allows for various forms of consumption, such as fresh leaves, dried powders, juices, and snacks. Leafy vegetables are nutritionally rich, inexpensive, and an excellent source of dietary fiber, making them an integral part of a healthy diet.

### Nutritional value of leafy vegetables

Leafy vegetables play a vital role in ensuring food and nutritional security. They are an exceptional source of essential vitamins, minerals, and phenolic compounds. These greens, particularly high in iron and calcium, surpass many staple food grains in nutritional content. Notably, leafy vegetables are the only natural source of folic acid, a critical nutrient for human health.

Designated as "protective foods" due to their health benefits, these vegetables are rich in vitamins, essential fatty acids, minerals, amino acids, dietary fiber, and bioactive compounds (Shukla *et al.* 2018; Dias and Imai, 2017). Secondary metabolites, like antioxidants and phenolic compounds, contribute to their health-promoting properties. To meet the daily nutritional requirements, the World Health Organization (WHO) recommends consuming at least 400 grams of fruits and non-starchy vegetables per day, with green leafy vegetables constituting a key component. It is suggested that one of the every five servings of vegetables/food should be leafy vegetables. Studies have shown that diversifying vegetable intake is crucial as no single vegetable can provide all essential nutrients (Grusak and Penna, 1999) [2].

Green leafy vegetables are enough sources of polyphenols and carotenoids. These are also known for their property as secondary metabolites as well antioxidant capacity (Obboh, 2005; Subhasree *et al.*, 2009) [6, 9]. Research in

vegetables/food plant fields has drawn the great attention because polyphenols are good for human health. Green leafy vegetables are sufficient source of minerals as well vitamins and provide balanced diet (Caunii *et al.*, 2010) [1]. Carotenoids, abundant in leafy greens, have significant pro-vitamin A and antioxidant properties (Khanna *et al.*, 2002) [4]. Additionally, ethnobotanical studies have highlighted the medicinal properties of green leafy vegetables, including anti-carcinogenic, anti-diabetic, and anti-bacterial activities (Kesari *et al.*, 2005; Zeb and Hussain, 2020) [3, 5].

### Insect pest infestation

Like other crops, leafy vegetables are vulnerable to infestations by various insect pests. If left unmanaged, these infestations can significantly reduce their availability and quality. Pests such as beetles, caterpillars, aphids, and grasshoppers are among the common insects that attack leafy vegetables. Global estimates suggest that insect pests contribute to 8.7% of vegetable crop losses, highlighting the need for effective pest management strategies.

The Food and Agriculture Organization (FAO) estimates that 15-20% of global vegetable losses during field production are due to insect damage. The damage caused by pests can limit production, reduce crop quality, and affect economic returns.

### Field diagnosis of insect pests of leafy vegetables

#### 1. *Amaranthus* stem weevil: *Hypolixus truncatulus* (Curculionidae: Coleoptera)

**Host plant:** Amaranthus

#### Diagnostic Features

Adult weevils are ash-grey measuring 10-15 mm in length with brown elytra. They have long and elbow shaped antennae. Fully matured adult female make a round hole in the plant stem and lays single egg in each hole. The hole

was covered with adhesive secretion of black colour. Eggs can be identified with their smooth texture oval shape and pale colour. White, rounded and curved grubs are legless, and measuring about 14-17 mm. freshly emerged grubs make their irregular tunnel like path way into the stem. Grubs fill this zigzag tunnel with their faeces. The infested plant stems become weak and fragile due to excessive transpiration. The plants ultimately desiccate and dry up.

## 2. **Amaranthus leaf caterpillars: *Hymenia recurvalis* (Lepidoptera: Crambidae)**

**Host Plants:** Amaranthus, Spinach, chenopodium

### **Diagnostic Features:**

The dark black coloured adults moth have slender shape body measuring about 10 mm. Two pairs of wings are brownish grey in colour having white line in the center and outer regions are covered with short hairs. Wing expanse is about 15-20 mm. Eggs are recognized with spherical shape and white colour while caterpillars are greenish in colour measures 17-20 mm in length. Caterpillars can also be diagnosis with their white lines and black colour crescent shape structure on thorax present below the lateral line. Brown colour pupae are 10-14 mm in length. Caterpillars feed on tissues of leaves and fold them with a silvery secretion. These leaf lose their chlorophyll and become dry.

## 3. ***Eretmocera impactella* (Lepidoptera: Heliodinidae)**

**Host Plants:** Amaranthus, Beet greens

### **Diagnostic Features**

Adult moths have copper coloured head and thorax and yellow abdomen with second, third and terminal segments cuprous in colour. Forewings have similar cuprous colour and yellow spots on them. While hind wings are pale yellow in colour. Wing expanse is 13-18 mm. Fully grown caterpillars are 8-12 mm long, cylindrical in shape having brownish yellow to brownish grey in colour with longitudinal hairs. Pupa are also diagnosed with their brown colour measuring about 6 mm in length.

## 4. **Spinach blue beetle, *Altica caerulea* (Alticidae: Coleoptera)**

**Host Plants:** Spinach, Beets

### **Diagnostic Features**

Adult beetles are steel blue in colour measuring about 4-7 mm in length. Hind femoral leg of beetle is thick and strong which help in jumping. Adults beetle causes very little damage to leaves. Newly emerged grubs scrap and mine inside the plant leaves and feed on the mesophyll tissues. Grubs are 5-10 mm in length and have dark brown colouration. They pupate inside the leaf mines. Pupa are 11-15 mm long and brown in colour when newly formed and later on turns blackish brown.

## 5. **Beet armyworm: *Spodoptera exigua* (Lepidoptera: Noctuidae)**

**Host Plants:** Cabbage, Lettuce, Spinach Celery, Broccoli

### **Diagnostic Features:**

Beet armyworms diagnosed with their cottony eggs on surface of leaves and make a distinctive feature. Newly emerged armyworms are small in size, green in color and worms like. They often feed in groups. Older beet armyworms have many thin, wrinkled, light-colored stripes on the back and the broader stripes down on each side. While the body are without hairs.

## 6. **Western yellow striped armyworm: *Spodoptera praefica* (Lepidoptera: Noctuidae)**

**Host Plants:** Cabbage, Lettuce, Beet, Spinach

### **Diagnostic Features**

Adult pest is measured with 1-2 inches in length. Female lay eggs in groups which are covered with adhesive cottony substance. Larvae are completely black in colour, with two prominent and many fine, bright yellow stripes on the side, hence the name. This insect is an occasional pest of spinach; however, because it usually develops higher population levels than beet armyworm when it does occur, it can cause greater crop damage in a shorter period of time.

## 7. **Leafminers: *Liriomyza langei*, *Liriomyza sativae*, *Liriomyza trifolii* (Diptera: Agromyzidae)**

**Host Plants:** Lettuce, Celery, Spinach

### **Diagnostic Features**

Adults are diagnosed with small black colour flies. These flies puncture leaves to feed and lay eggs. Larvae mine between the upper and lower leaf surfaces, leaving winding white tunnels. Larvae emerge from the mines and pupate on the leaf surface or in cracks under the soil. The presence of these mines degrades the quality and quantity of leafy vegetables and makes them unmarketable (Rajna, 2022) [7].

## 8. **Cabbage Aphid: *Brevicoryne brassicae* (Hemiptera: Aphididae)**

**Host Plants:** Cabbage, Kale, Broccoli

### **Diagnostic Features:**

Adults are grey colored and measured about 2 mm in length. Female lays pale yellow colour eggs. Eggs hatch into yellow green and sometime grey nymphs which are 1-2 mm long. Aphids suck sap from leaves, causing stunted growth and poor head formation. Severe infestations may result in plant death.

## 9. **Cabbage butterfly: *Pieris brassicae* (Lepidoptera: Pieridae)**

**Host Plants:** Cabbage, Mustard

### **Diagnostic features**

The young caterpillars feed together on leaves, while the older ones disperse to nearby plants and fields, voraciously consuming the leaves and causing significant yield losses. The eggs, are diagnosed that they are yellow and cylindrical, are laid in clusters of 50-90 on the underside of the leaves. The larvae start off pale yellow and turn greenish yellow as they grow, with black markings on their heads and dorsal side. The adult butterflies are pale white with a smoky shade on their upper side, and have black patches on the apical angle of each hind wing. Females measure about 6.5 cm across the wings and have two prominent black spots on each fore-wing, while the males are smaller.

## 10. **Cabbage semilooper: *Thysanoplusia orichalcea* (Lepidoptera: Noctuidae)**

**Host Plant:** Cabbage, Broccoli

### **Diagnostic Features**

The larvae cause damage by creating circular holes in the leaves. They are chubby, pale green, and have three pairs of pro-legs, often found among *P. brassicae* caterpillars. The adults have light brown coloration with a golden patch on each fore-wing and have a wingspan of about 42 mm.

**11. Crucifer leaf webber: *Crocidolomia binotalis* (Lepidoptera: Crambidae)**

**Host Plants:** Cabbage, Mustard

**Diagnostic Features:**

The larvae cause damage as they feed on chlorophyll, with young larvae being gregarious while older larvae web leaves together and feed on the lower surface, potentially attacking up to 80% of the plants, capable of destroying premordia and preventing the establishment of young plants.

**12. Mustard sawfly: *Athalia lugens* (Hymenoptera: Tenthredinidae)**

**Host Plant:** Mustard

**Diagnostic Features**

The potential to cause defoliation in crop plants during the seedling stage is significant. Adult insects damage the plants by laying eggs using their saw-like ovipositor. The larvae then consume the edges of delicate leaves and subsequently create holes within the foliage. Typically, the larvae feed during the early morning and late evening hours.

**13. Cabbage flea beetle: *Phyllotreta cruciferae* (Coleoptera: Chrysomelidae)**

**Host Plants:** Mustard, Cabbage

**Diagnostic Features**

Larvae inhabit the soil and consume the roots of plants. The adult insects feed on the cotyledons and leaves of young plants, creating circular holes. Additionally, they may target the stems, flowers, and even pods. As a result of the infestation, older leaves become desiccated, while younger leaves are rendered unsuitable for consumption. The affected plants emit a decaying odor. The larvae are characterized by a dirty white coloration with a pale white head, measuring approximately 5 mm in length. The adults exhibit a color range from shiny black to black. All species possess robust femora, enabling them to jump similarly to fleas.

**14. Diamondback moth, *Plutella xylostella* (Lepidoptera: Yponomeutidae)**

**Host Plants:** Cabbage, Mustard, Broccoli

**Diagnostic Features**

Eggs are identified with a yellowish-white hue with a greenish tint. The fully developed larvae measure between 8 to 12 mm in length and are green in color. Pupation occurs within a silken cocoon, which is approximately 20 mm in size. The adult insects range from 8 to 10 mm in length, displaying a grayish-brown coloration with pale white narrow wings that have yellow inner margins. Each forewing features three pale white triangular markings along the hind margins, and when at rest, a distinct dorsal median patch consisting of three diamond-shaped spots is observable. The wingspan measures 15 mm. Young caterpillars feed by scraping the epidermal tissue of leaves, resulting in characteristic white transparent patches, while older larvae create holes in the leaves.

**15. Seed corn maggot: *Delia platura* (Diptera: Anthomyiidae)**

**Host Plant:** Lettuce

**Diagnostic Features**

Maggots infiltrate the germinating seeds, hindering their ability to sprout. Additionally, these immature forms can be lethal to lettuce seedlings. The initial noticeable indication

of pest damage is the inadequate establishment of the crop. These pests thrive in moist and cool conditions, with their population peaking in the spring season.

**16. Leaf beetles: *Diabrotica undecimpunctata* (Coleoptera: Chrysomelidae)**

**Host Plant:** Lettuce

**Diagnostic Features**

The foliage is harmed by both the larvae and adult forms of the beetle, resulting in irregular perforations. The adults are particularly destructive. They can be observed inflicting damage on the crops at all growth stages. The impact is especially detrimental when the leaves are compromised during the seedling phase.

**17. Black Bean Aphid: *Aphis fabae* (Hemiptera: Aphididae)**

**Host Plant:** Celery

**Diagnostic Features**

These pest appear nearly indistinguishable at first glance. The black bean aphid is characterized as a soft-bodied insect that ranges in color from dark green to black, featuring a similarly dark head, antennae, and cornicles. Its legs are black at both the base and the tips. Black bean aphids typically establish dense colonies on the undersides of celery leaflets. Under certain conditions, such as overcrowding and stress on the plants, winged black bean aphids emerge and migrate to other plants or fields. The population of black bean aphids can escalate in celery, reaching densities of several thousand per individual plant. This pest poses three primary threats to celery crops. Firstly, it can hinder plant growth and diminish yields by extracting substantial amounts of sap. Secondly, it is capable of transmitting viral diseases, including western celery mosaic, celery calico, cucumber mosaic, and celery yellow spot. Lastly, it can taint celery produce, especially in the fresh market segment, with aphid honeydew and debris, which can adversely affect the crop's market value. The feeding activity of black bean aphids may cause more significant distortion in plant growth and development compared to other aphid species.

**18. Willow-carrot aphid: *Cavariella aegopodii* (Hemiptera: Aphididae)**

**Host Plant:** Parsely, Celery

**Diagnostic Features**

Small, soft-bodied insects can be found on the undersides of leaves and stems of plants, typically exhibiting green or yellow coloration. In cases of severe aphid infestation, the leaves may exhibit yellowing, distortion, and necrotic spots, along with stunted growth in shoots. Aphids produce a sticky, sugary substance known as honeydew, which promotes the development of sooty mold on the plants. A notable characteristic of aphids is the presence of tubular structures that extend backward from their bodies. When disturbed, these insects tend to remain relatively immobile.

**19. Armyworm: *Pseudaletia unipuncta* (Lepidoptera: Noctuidae)**

**Host plants:** Cabbage, Celery, Lettuce, Parsley

**Diagnostic Features**

Circular to irregularly shaped holes in foliage, often singular or closely grouped, are diagnosis of significant feeding by young larvae, resulting in skeletonized leaves. Additionally,

shallow, dry wounds may be observed on the fruit. Egg clusters, consisting of 50 to 150 eggs, can be found on the leaves, typically covered in a whitish scale that imparts a cottony or fuzzy look. The young larvae exhibit a pale green to yellow coloration, while the older larvae are predominantly darker green, featuring a dark and light stripe along their sides and a pink or yellow underside.

## 20. Black cutworm: *Agrotis ipsilon* (Lepidoptera: Noctuidae)

**Host Plants:** Cabbage, Spinach, Lettuce

### Diagnostic Features

The smooth, ivory eggs are spherical with a textured outer layer and measure about 1/5 inch across. They are usually laid alone or in small groups, often on foliage, and take 2 to 9 days to hatch. These eggs are commonly seen on crops in areas that are prone to flooding or on plants in the lower regions of the field. The newly emerged caterpillars are about 1/25 inch in size, while the fully grown caterpillars can reach nearly 2 inches in length. These caterpillars are slender, cylindrical, and range from dark brown to a greasy gray with subtle lighter stripes running down each side of their bodies. Their heads are a dark brown color with two white spots. Once they have reached maturity, the caterpillars dig deep into the earth to create a cocoon, where they undergo metamorphosis. The cocoons are dark brown and measure about 3/4 inch in length. The adult moths have a wingspan of 1 to 5/8 to 2 inches. The front wings are gray with dark brown or black patterns. The back wings are nearly white, except for a dark edge at the tips, and are tucked under the front wings when the moth is not active. The body of the moth is gray in color.

### Conclusions

Leafy vegetables such as spinach, cabbage, lettuce, fenugreek, mustard greens, amaranth, and coriander are frequently attacked by various insect pests that reduce both yield and market quality. Field diagnosis is the process of identifying insect pests directly in the crop field by observing the type of damage, symptoms, and the insects present. Early and accurate diagnosis helps farmers adopt timely and effective pest management practices. The first step in field diagnosis is the regular inspection of crops. Plants should be examined for symptoms such as holes in leaves, leaf curling, yellowing, wilting, sticky honeydew. Both the upper and lower surfaces of leaves should be checked because many pests hide underneath. Accurate field diagnosis is essential for implementing Integrated Pest Management (IPM) strategies, including cultural, biological, mechanical, and chemical control methods. Regular monitoring, proper identification, and timely intervention help minimize crop losses, reduce unnecessary pesticide use, and promote sustainable vegetable production. Field diagnosis is a fundamental step in the management of insect pests in leafy vegetables. Correct identification based on visible symptoms and pest characteristics enables effective control measures, ensuring higher yield, better crop quality, and environmentally sustainable agriculture.

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