

Diseases and Pests of Millet in Taitung, Taiwan

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Millets (*Setaria italica* (L.)) are small grained cereals, contain a variety of vitamins, vegetables fats, dietary fiber and carbohydrates, which are one of staple foods of Taiwan's aborigines, also the important point in aboriginal celebration. Rust disease, downy mildew, shoot fly (*Atherigona orientalis* Schiner), Asian corn borer (*Ostrinia furnacalis* (Guenée)), cut worm and armyworm (*Mythimna loreyi* (Duponchel), *Mythimna separata* (Walker), *Spodoptera frugiperda* (Smith and Abbot)), and Corn leaf aphid (*Rhopalosiphum maidis* (Fitch)), might threat millets to decrease quantity and quality. We introduced the key pests, and how to perform integrate pest management (IPM), as the reference of field pest control for farmers

Disease

1. Rust

Scientific name: *Puccinia sorghi* Schwein, *P. polysora* Underw

Host range: Millet, Sorghum, maize, Pearl millet

Spread: Spread by air-borne spores

Symptoms: Rust appears on the leaf as round to elliptical reddish-orange pustule. Mature pustules break and release rusty spores linearly arranged on the upper surface of the top leaves. The symptoms may appear on stem and other plant parts. Severely rusted plants look reddish-brown. Rust disease happen severely when high temperature (28-32 °C) , high humidity, especially planted in low-lying and densely planted field.



Fig.1. Severely rusty plant look reddish-brown



Fig.2. The spores of rust

2. Downy mildew (crazy top, green ear disease)


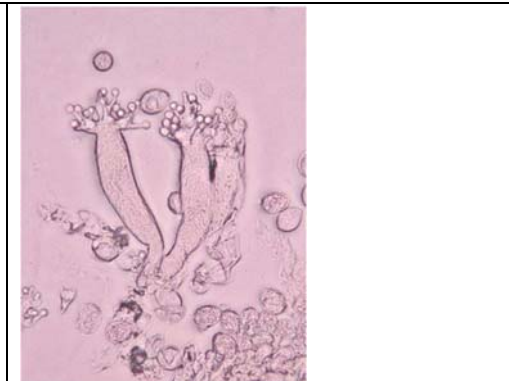

Scientific name: *Sclerospora graminicola* (Sacc.) J. Schröt.

Host range: Millet, Sorghum, maize, Pearl millet

Spread: Survive as oospores in host tissues (e.g. seeds) and soil; Primary infection in soil, secondary infection through conidia

Symptoms: Downy mildew is developed both on the leaves and earhead. Initial symptoms of the systemic infection are expressed as chlorosis or yellowing of the lower leaves that progressive spread to the upper leaves and the whole plant. Numerous sporangia are produced on the lower surface of an infected leaf. When infected plant produces symptom only on the earhead in the form of the leafy structures called ‘green ear’ disease. Spikelet tissues are transformed into thead-like leafy structure, and do not produce grain. Leafy growth dries up giving the panicle a dark brown to black appearance. In Taiwan, downy mildew is always happen in

spring cropping millet, while low-temperature (16-22°C) and high humidity, dense planting will be severely.

	
<p>Fig.3. Downy mildew infection showed chlorosis or yellowing of the leaves.</p>	<p>Fig.4. Sporangia of <i>Sclerospora graminicola</i>.</p>
	
<p>Fig.5. Downy mildew infect the earhead, spikelet tissues are transformed into thead-like leafy structure.</p>	

Pests

1. Shoot flies (Pepper fly)



Scientific name: *Atherigona orientalis* Schiner

Host range: Millet, Sorghum, maize, Solanaceae, Fabaceae, Cucurbitaceae

Damage symptoms: It is a major seedling pest normally occurring in the 1st -6th week after germination. Female adults always laid eggs on shoot surface or leaf back,

maggots hatch out and feed on the growing tip, and causing wilting of leaf and drying of central leaf.

Identification: Adult body length is 3.2-4.0 mm, with yellow-gray color housefly like. A female lays whitish cigar shaped, and length 721 -886.8 nm eggs on lower leaf surface of leaf. After hatched the maggot enters the seedling and destroys the growing point causing dead-heart formation. Mature larvae is yellowish, and pupation takes place either at the plant base. In Taitung, flies population tends to increase after sowing in spring cropping, and reaches the peak one month later.

 A composite image. The top-left corner shows a close-up of a pepper fly, which is yellowish-brown with transparent wings. The rest of the image shows a young millet seedling in a field. The central part of the seedling's leaves is dead and brown, forming a 'dead heart' shape, while the surrounding leaves are green.	 A close-up photograph of a pepper fly on the lower surface of a green leaf. The fly is positioned over a cluster of whitish, cigar-shaped eggs that are laid in a small, circular area.
<p>Fig. 6. Pepper fly (left up) causes dead hearts in young millet seedling.</p>	<p>Fig. 7. Pepper fly lays whitish cigar shaped eggs on lower leaf surface.</p>



2. Stem borer (Asian corn borer)

Scientific name: *Ostrinia furnacalis* (Guenée)

Host range: Millet, sorghum, maize, wheat, ginger, Solanaceae, Fabaceae,

Damage symptoms: This is an important pest for millet, the damage is caused by caterpillars feeding. Newly hatch larva feed in the whirl of leaves, and they bore holes into the stems. The mature caterpillars commonly feed on the stalks. Frass is seen around the holes. The leaves may wilt above the entry holes.

Identification: The female moth lays up to 1500 eggs. The female is pale yellow brown whit irregular bands across the wing, the male is darker. The body length is 15-20 mm, females are slightly larger than males. Eggs were laid on underside of leaves at the base. The caterpillars are pink-brown with spots on the back. The late stages bore into the stalks for feeding. After 3-4 weeks of the last larva stage, the caterpillars form pupae within the stems; this stage lasts 7-9 days before the moth emerged.

	
<p>Fig.8. Asian corn borer (right up) caterpillars feed on the stalks and frass around the hole.</p>	<p>Fig.9. Caterpillars (red arrow) are pink-brown with spots on the back, and bore into the stalks to feed.</p>

3. Cutworms and Armyworms

Scientific name: *Mythimna loreyi* (Duponchel)
Mythimna separata (Walker)
Spodoptera frugiperda (Smith and Abbot)

Host range: Millet, sorghum, maize, wheat and members of Poaceae.

Damage symptoms: Caterpillars are defoliators feeding on foliage. The larva feed on leaves, and scrap the green matter of the leaf tissue and show as skeletonized appearance. Young larva of *S. frugiperda* are feed on leaf tissue from one side, latter formed holes in leaves, and eat from the edge of the leaves inward. Feeding in the whorl of millet often causes characteristic row of perforations in the leaves. Heading stage caterpillars may feed into young ears, effect the quantity directly.

Identification: Larva cut tender stems of young and growing stem. They hide in the soil during day time and become active at dusk. Sometimes the entire leaf is eaten. *M. separata* adults are brownish in colour, there are black spots in the middle of fore wing. Egg of *S. frugiperda* are laid in groups of 100-200 and covered by grey scales from the female moth. Larvae are greenish with a black dorsal surface of the body. The face of the mature larva are also marked with a white inverted “Y” and the epidermis of the larva is rough or granular in texture when examined closely. The moths have wingspan of 32-40 mm, females are slightly larger than males.



Fig.10. Typical adult female (left) and male (right) of *Mythimna loreyi*.



Fig.11. Typical adult female (left) and male (right) of *Mythimna separata*.



Fig.12. Larvae of *Mythimna separata*



Fig.13. Mature larva of the fall armyworm, *Spodoptera frugiperda* (left up adult)

4. Aphids

Scientific name: *Rhopalosiphum maidis* (Fitch)

Host range: Millet, sorghum, maize, wheat, and members of Poaceae.

Damage symptoms: The colonies are typically found deep inside the plant whorl of the middle leaf on the ventral surface of the leaves, stem and panicle. The nymph and adults feed directly on phloem sap. They always cause yellowish mottling of the leaves and marginal leaf necrosis. The aphids produce lots of honeydew on which

molds grow. In pencils, honeydew may hinder harvesting.

Identification: Aphid is dark bluish-green and 2 -2.3 mm long, with black legs, cornicles, and antennae. Winged and wingless forms occur. Female can born new ones without mating (Parthenogenesis), and a generation takes 7 days.



Fig.14. Adult corn leaf aphid,
Rhopalosiphum maidis.



Fig.15. Corn leaf aphid colonies hind
in the ventral surface of leaf.

Management

1. Cultural method

- (1) Crop rotation with non-host plant help reducing inoculums of pest and soil-borne disease.
- (2) Replacement of alternate hosts.
- (3) Crop residue destruction, clean field borders and weed control.
- (4) Regulation the amount of nitrogenous fertilizers reduce incidence of aphids, blast, downy mildew.

2. Mechanical method

- (1) Set up net fence higher than 90 cm to prevent pest invasion.
 - (2) Set up yellow sticky paper to rape stem fly and aphid.
 - (3) Remove the insect pest directly.
3. Biological method
- (1) Release parasitoid wasps, *Trichogramma chilonis* for noctuids.
 - (2) Spray Bt to control stem borer, cutworms and armyworms.
 - (3) Set up sex pheromone trap to attract male moths *Spodoptera frugiperda*.
 - (4) Seed treatment with *Trichoderma* sp. reduce soil-borne disease of millet (e. g. downy mildew.)
4. Non-pesticide material method
- (1) Spray neem oil, extract of soapberry to control leafhoppers, aphids, or mix with Bt control lepidopteran pest.
5. Chemical methods
- (1) Select etofenprox, spinetoram or methomyl to control lepidopteran pests, aphids.
 - (2) Seed treatment with metalaxyl reduces downy mildew incidence or foliar spray of flutriafol to control the rust.
 - (3) Other pesticides refer to “Plant Protection Information System (<https://otserv2.acri.gov.tw/ppm/>)”.