

**Insect-pests, diseases and weeds of pearl-millet and their management**

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**A) Insect-pests:**

**a) Soil insect-pests:**

**1. Termites or white ants, *Odontotermus obesus***

**Distribution:** All over the country and especially under rainfed conditions.

**Symptoms and extent of damage:**

Termite is highly polyphagous in nature. Worker termite damage the roots resulted yellowing of plant and finally dried. The pest is more severe under rainfed conditions. The pest remains active throughout the year on crop debris and stables.

**Management:**

- 1) Destruction and burning of plant debris in and around the fields.
- 2) Deep summer ploughing.
- 3) Use only well decomposed farm yard manure.
- 4) Frequent irrigation helps in reduction of termite infestation.
- 5) Application of Chlorpyrifos 20 EC @ 4 litre/ ha in 50 kg sand or quinalphos 1.5% dust @ 25 kg/ha during last ploughing and properly mixing in soil minimize the termite infestation.

**2. White grub, *Holotrichia consanguinea***

**Symptoms and extent of damage:**

White grub is highly polyphagous insect feed upon a number of host plants. Grubs damage the under ground root portion of the plants. Consequent to feeding, the plants show varying degrees of yellowing and wilting resulting in the death of plants. In young plants, attack by white grubs causes wilting which is characterized by an initial purpling of the leaves, followed by death of small plants and reduced vigour or lodging of larger ones. Sometimes affected plants produce dead hearts. Beetles are defoliating pests and damage a large number of fruit crops, plantation and forest trees as a result of feeding on apical buds and tender leaves.

**Economic threshold level of pest: 1 grub/m<sup>2</sup> area**

**Management:**

- 1) Deep ploughing in summer to expose hibernating stage of white grub.

- 2) Light traps can be used for collecting adult beetles during the night.
- 3) Collection and destruction of adult white grub beetles from jujuba, guava, ber, khejari, grapevine, almond and neem trees around the fields by shaking and jerking, immediately after the early rain. The fallen beetles are collected and destroyed by putting them in kerosinized water or by burning them.
- 4) Use of aggregating pheromone on the preferred host of white grub beetle.
- 5) Kill the adult beetle by spraying carbaryl 50 WP @ 2 g/litre of water on the above given preferred host just after the first rain.
- 6) Install 10-12 bird perches/ha.
- 7) Seed treatment with imidacloprid 70 WS @ 3.5 g a.i./kg or chlorpyrifos 20 EC @ 5 g a.i./kg was found effective.
- 8) In those areas where white grub is regular problem, apply phorate 10 G or carbofuran 3 G @ 1 kg a.i./ha into the soil at the time of sowing.

#### **b) Foliar insect-pests:**

##### **1. Shoot fly, *Atherigona approximata* (Muscidae: Diptera)**

**Distribution and status:** Throughout India

**Host range:** Pearl millet, sorghum, maize, finger millet etc.

##### **Symptoms and extent of damage:**

This is a serious pest of pearl millet all over the India. In Tamil Nadu the pest attacks the crop both in seedlings and boot leaf stage during cold weather season. The maggot on hatching migrates to the upper surface of leaf and enters between the leaf sheath and stem. After reaching the soil level, the maggot bores inside the stem and cuts the growing point resulting in wilting and drying of the central leaf known as “deadheart”. The infested plant produces side tillers which may also be attacked. The attack is more severe during summer than kharif season. It causes dead hearts in young plants and chaffy grains in the mature crop.

##### **Bionomics**

Adult is greyish white fly lays white, cigar-shaped eggs on the lower surface of leaf blades. The ovoposition period lasts for 37-48 hours and incubation period varies from 2-3 days. The Maggot is dirty white and apodous. Mature larvae are yellow and about 6 mm long. The larval period is 8-10 days and has four larval instars. It pupates at the base of the stem or in soil for 8-10 days. The life cycle is completed in 17-21 days.

**Economic threshold level of pest: 10% dead hearts or 1 egg / plant**

##### **Management**

- 1) Use resistant varieties like Co-1, CSH 15R, Maldandi and Hagari, M35-1, Swati, SPV 491, IS - 18551, 5566, 5285, 5613, ICSV 700, ICSV 705, Phule Yashoda, CSH 7, CSH 8
- 2) Sow sorghum immediately at the onset of monsoon rains to minimise shootfly damage.
- 3) Use higher seed rate (12.5 kg/ha) and remove the shoot fly damaged seedlings at the time of thinning or raise nursery and transplant only healthy seedlings.
- 4) Pull out and destroy plants showing dead hearts at the time of thinning.
- 5) Use hanging type of plastic fishmeal trap @ 12/ha till the crop is 30 days old.

- 6) Seed treatment with chlorpyrifos 20 EC or quinalphos 25 EC @ 4 ml/kg of seed.
- 7) Granular application of phorate 10 G or carbofuran 3 G to the furrow at the time of sowing @ 1 kg a.i./ha or spray

## **2. Stem borer: *Chilo partellus* (Crambidae: Lepidoptera)**

**Distribution and status:** Throughout India

**Host range:** Pearl millet, sorghum, maize, sugarcane, rice, finger millet, wild grasses etc.

### **Symptoms and extent of damage:**

Young larva crawls and feeds on the tender folded leaves causing typical “shot hole” symptom. Later the larvae bore into the stem near the nodes. The central shoot gets wither leading to “dead heart” formation especially in younger plants. This is the typical damage symptom. Older larvae of stem borer cause extensive stem tunneling resulting weakening the stems, which may break and lodge. They also tunnel the peduncle (the internode between the stem and the earhead) and moves up to the earhead. Infestation in crop starts a month after its sowing and the damage persists upto emergence of ear heads.

### **Bionomics**

Adult moth is medium size and straw coloured. The adult female moth lays the eggs on the underside of a leaf near the midrib in 3-5 rows and in a group of 50 to 100. Egg are scale-like flat oval shaped. Larva is yellowish brown body with a brown head and prothoracic shield. Incubation period is 7-10 days. The larval period takes 28-35 days. Pupation takes place in a small chamber in the stem and lasts upto 7 -10 days.

**Economic threshold level of pest: 10% dead heart or plants with damage symptoms**

### **Management**

1. Destruction of crop residues (stems and stubbles) through ploughing and burning and removal of volunteer crop plants and/or alternative hosts reduces carryover of diapausing larvae and active populations from one growing season to the next and will help to limit the most damaging attacks on young crops early in the growing season.
2. Grow resistant cultivars.
3. Dead hearts should be pulled out and destroyed.
4. Sow lab lab or Dolichos as an intercrop in the ratio of 4:1 to minimise the stem borer damage.
5. Use light trap till midnight to attract and kill the stem borer moths.
6. Bio-control agents viz., *Trichogramma chilonis* (egg parasitoids), *Bracon chinensis* and *Apanteles flavipes* (larval parasitoids) should be encouraged.
7. Use phorate 10 G or carbofuran 3 G @ 1 kg a.i./ha at the sowing time or spray carbaryl 50 WP @ 1 kg a.i./ha.

## **3. Earhead bug: *Calocoris angustatus* (Miridae: Hemiptera)**

**Distribution and status:** Throughout India

**Host range:** Pearl millet, sorghum, maize etc

**Symptoms and extent of damage:**

The adults and nymphs suck the sap from the developing grain when they are in the milky stage in the earheads. The damaged grains, shrink and turn black in colour and become ill filled (or) chaffy. Older grain shows distinct feeding punctures that reduce grain quality.

### **Bionomics**

Adult male is green in colour and female is green with a brown margin. Blue cigar shaped eggs are laid under the glumes or into the middle of the florets. Each insect lays between 150 and 200 eggs. The egg period is seven days. Nymphs are slender, green in colour. First instar is orange in colour. The nymphal period is 10 - 14 days. The life cycle from egg to adult occupies less than 3 weeks. At least 2 generations of the bug can feed on the same crop when the panicles do not ripen at the same time.

**Economic threshold level of pest: 10 nymphs or adults per ear head**

### **Management**

- 1) Synchronous and timely/early sowings of cultivars with similar maturity over large areas reduce damage by shoot fly, midge and head bugs.
- 2) Grow resistant cultivars like IS1760, IS 17645, CSM 388, Chencholam, BBR -1(ICS V239)
- 3) Dusting with quinalphos 1.5% @ 12 kg/ha synchronising during milky stage.
- 4) Spraying with carbaryl 50 WP @ 1.5 kg a.i./ha

### **4. Shoot bug: *Peregrinus maidis* (Delphacidae: Hemiptera)**

**Distribution:** Major pearl millet growing areas of country

**Host range:** Sorghum, maize, rice, millets

#### **Symptoms and extent of damage:**

Adults and nymphs suck sap from the leaf whorls. The attacked plants become unhealthy stunted and yellow. The leaves wither from top downwards. Panicle formation is inhibited and the plants die if attack is severe. Honeydew secreted by the bug causes growth of sooty mould on leaves. The midribs of the leaves turn red due to egg-laying and may dry up subsequently

### **Bionomics**

The adult is yellowish brown to dark brown with translucent wings. The brachypterous female is yellowish while macropterous female is yellowish brown and male dark brown. It lays eggs in groups of 1-4 inside the leaf tissue and covered with a white waxy substance. The fecundity of the bug is 97 eggs / female. The egg period lasts for seven days. The nymphal stage undergoes five instars in 16 days. The total life cycle is completed in 18-31 days

### **Management**

- 1) Conserve egg parasitoids viz., *Paranagrus optabilis*, *Octetrastichus indicus* and Predators - *Coccinella septumpunctatum*, *Menochilus sexmaculatus* and *Geocoris tricolor*
- 2) Spray dimethoate 30 EC or oxy demeton methyl @ 500 ml in 500 litre of water per ha.

### **5. Stink bug: *Nezara viridula* (Pentatomidae: Hemiptera)**

#### **Symptoms and extent of damage:**

Adult and nymph suck the sap from grains. Grains become chaffy or spotted black and get

shrivelled. A stinking smell emanates from the bug.

**Bionomics**

Adult is green in colour. Nymph is brownish red with multi colour spots.

**Management**

- 1) Spray with a systemic insecticide like dimethoate 30 EC or oxy- demeton methyl 25 EC @ 500 ml in 500 litre of water per ha.

**6. Aphid: *Rhopalosiphum maidis* and *Melanaphis sacchari* (Aphididae: Hemiptera)**

**Distribution:** All over India

**Host range:** Sorghum, maize, millets, sugarcane etc.

**Symptoms and extent of damage:**

Colonies of aphids are seen in central leaf whorl, stems, or in panicles. The young and adults suck the plant juice. This frequently causes yellowish mottling of the leaves and marginal leaf necrosis. The aphid produces an abundance of honeydew on which molds grow. In panicles, honeydew may hinder harvesting. The aphid also transmits maize dwarf mosaic virus.

**Bionomics**

***Rhopalosiphum maidis***

The aphid is dark bluish-green and somewhat ovate. It is 2 mm long, with black legs, cornicles, and antennae. Winged and wingless forms occur. Females give birth to living young without mating and a generation requires only a week or so. The adult is yellow coloured with dark green legs.

***Melanaphis sacchari***

The sugarcane aphid is yellow to buff. Numbers increase rapidly during dry spells or at the end of the rainy season. The female of the wingless form deposits 60-100 nymphs within its reproductive period of 13-20 days. The winged form produces slightly fewer nymphs. The life cycle is completed in 5.5-7.0 days during the dry season.

**Management**

- 1) Spray with a systemic insecticide like dimethoate 30 EC or oxy- demeton methyl 25 EC @ 500 ml in 500 litre of water per ha.

**7. Hairy caterpillar: *Spilosoma obliqua* and *Estigmene lactinea* (Arctiidae: Lepidoptera)**

**Symptoms and extent of damage:**

The pest is a highly polyphagous and sporadic in nature. Larva feeds on leaves voraciously and causes severe defoliation. Grown up larvae spread whole field or even adjoining fields. Larvae feed from the margin of leaves and defoliate the entire plant. Fourth and fifth instar larvae are voracious feeders. Consume much more food per day than their own body weight. Larvae have the habit of migration from one field to other.

**Management:**

- 1) Deep ploughing in summer to expose hibernating stage of insect.
- 2) Collection and destruction of egg masses and early stages of defoliator.
- 3) Spray nuclear polyhedrosis viruses (NPV) @ 250 LE/ha

- 4) Spray neem seed kernel extract @ 5%
- 5) In severe infestation spray quinalphos 25 EC or carbaryl 50 WP @ 0.05-0.1% or cypermethrin 10 EC @ 750 ml/ha

#### **8. Grasshoppers, *Hieroglyphus* spp. and *Chrotogonus* spp.**

**Distribution:** Throughout India

**Damage symptoms**

Both nymphs and adults feed on leaves and cause defoliation.

**Management:**

- 1) Spray chlorpyrifos 20EC @ 0.5 kg a.i./ha

#### **9. Semilooper: *Antoba* (= *Eublemma*) *silicula* (Noctuidae: Lepidoptera)**

**Distribution:** Throughout India

**Hosts:** Sorghum, pearl millet, finger millet etc.

**Damage symptoms**

Extensive webbing of grains and presence of broken grains on the ear head.

**Bionomics**

The adult moth is small with reddish buff coloured wings having wavy lines. Eggs are laid on spikelet and grain. The egg period is 4 days. Larva is a pale yellow semilooper. Larval period lasts for 12-13 days. It pupates within the gallery for about 12 days.

**Economic threshold level of pest: 2 caterpillars per ear head**

**Management:**

- 1) Spray cypermethrin 10 EC @ 750 ml/ha

#### **B) Important diseases of pearl millet and their management**

##### **1) Downy mildew, *Sclerospora graminicola***

**Distribution:** Throughout India

**Symptoms and extent of damage:**

Downy mildew of pearl millet may be referred as “green ear” is most destructive disease of this crop. Symptoms generally appear on the second leaf as a result of systemic infection. Under the severe condition, the disease may appear on the first leaf also. The symptoms on leaf start as chlorosis (yellowing) at the base of leaf lamina. Greater disease coverage may be seen on the successively top leaves. Severely infected plants are stunted and do not produce earheads. When earhead is infected, the floral parts are transformed into leaf like structure known as “green ear”.

**Economic threshold level of disease: 10% incidence at 30 days after transplanting**

**Management:**

- 1) Removal and destruction of infected plants reduce the spread of disease.
- 2) Early sowing may escape the infection.
- 3) Transplanted pearl millet crop suffers less from the disease than the direct sown crop.
- 4) Use of resistant cultivars is most cost-effective method to control the disease.
- 5) Seed treatment with metalaxyl 35% @ 6 g/kg seed was found effective.
- 6) Foliar spray of Ridomil MZ 72 @ 3g per litre of water or mancozeb 75 WP @ 2 Kg/ha may be done if disease is crossing ETL.

## **2) Ergot, *Claviceps fusiformis***

**Distribution:** Throughout India

### **Symptoms and extent of damage:**

Ergot is widespread fungal disease of pearl millet in India. Ergot disease can be identified when cream to pink mucilaginous droplets called 'honeydew' ooze out of the infected florets on pearl millet panicles. These droplets contain numerous asexual spores called conidia. Later on these droplets dry out and become hard, dark brown to black structures (larger than seed) and with a pointed apex develop which protrude from the florets in place of grain. These are called sclerotia. This disease causes direct grain yield losses by replacing grains with toxic alkaloid-containing sclerotia, making the produce unfit for consumption. Sclerotium contaminated grain when consumed induces nausea, vomiting, giddiness and in extreme cases may be fatal.

### **Management:**

- 1) Follow proper crop rotation.
- 2) Deep ploughing soon after harvest of the crop help in burying the sclerotia deep into the soil which reduce further spread of disease.
- 3) Balance use of nitrogenous fertilizers keep the disease under check.
- 4) Use disease free seed by removing of sclerotia from the seed using 10% salt solution.
- 5) Removal and destruction of alternate weed host like *Cenchrus ciliaris* and *Panicum antidotale*.
- 6) Use of resistant cultivars is most cost-effective method to control the disease.
- 7) Foliar spray of copper oxychloride @ 0.25% or ziram @ 0.2% at the time of flowering was found effective.

## **3) Smut, *Tolyposporium penicillariae***

**Distribution:** All pear millet growing zones of India

### **Symptoms and extent of damage:**

Smut is important seed and soil borne disease of pear millet in northern states of India. In the infected florets, ovaries are converted into structures called sori (sorus) containing black powder (smut spores). The sori are larger than the grain and appear as enlarged, oval to conical bodies projecting beyond the glumes in place of grains. Initially the sori are bright green but later they turn brown to black in colour.

### **Management**

- 1) Removal and destruction of affected earheads.
- 2) Use disease free seed.
- 3) Grow resistant varieties.
- 4) Seed treatment with Thiram or Captan @ 3g/kg seed.
- 5) Spray Carboxin or Zineb @ 0.2%.

### **4) Rust, *Puccinia penniseti***

**Distribution:** All pearl millet growing areas of India

### **Symptoms and extent of damage:**

Symptoms first appear mostly on lower leaves as minute, round raised reddish brown pustules. Uredosori occur in groups on both surfaces of leaf and leaf sheath. The pustules may also be formed on stem and peduncles. Dark brown to black teliospores are produced late in the season in the uredosori or teleutosori. In severe infections, whole leaf may wither completely presenting a scorched appearance to the field.

### **Management:**

- 1) Removal and destruction of alternate hosts.
- 2) Grow resistant varieties.
- 3) Spray with Wetable Sulphur 80 WP @ 0.3% or Mancozeb 75 WP @ 0.2%.

### **C) Important weeds and their management**

Following weeds were found to infest the pearl millet crop in India:

- 1) *Dactyloctenium aegyptium*
- 2) *Eleusine indica*
- 3) *Echinochloa* spp.
- 4) *Celosia argentea*
- 5) *Portulaca oleracea*
- 6) *Digera arvensis*
- 7) *Trianthema portulacastrum*

### **Management:**

- 1) Summer ploughing for destruction of stubbles and perennial weeds
- 2) Timely sowing of the crop to minimize crop weed competition
- 3) Proper spacing to facilitate interweeding operations
- 4) Two manual weeding after 3 and 6 weeks of sowing
- 5) Chemical management: Pre-emergence application of Atrazine 50 WP @ 0.5% followed by one hand weeding

## **Insect-pests of pearl millet in bulk storage and their management**

### **1. Rice Weevil (*Sitophilus oryzae*)**



**Nature of damage:**

The damage to the grains is mainly caused by the larvae and adults. Due to infestation, the grains are hollowed out and in some cases the kernels are reduced to mere powder. Rice weevil is also known to cause infestation right from the field. Adult insects cut circular holes in the grains. When the intensity of infestation increases it results in heating, referred to as dry heating.

**2. Khapra (*Trogoderma granarium*)**

This is another important pest that causes major damage in bulk storage conditions.

**Nature of damage:**

This pest damages the grain starting with the germ portion, surface scratching and devouring the grain. Actually, it reduces grain into frass. Excessive moulting creates public discrimination, loss of market value due to insanitation caused by the cast skins, frass and hair. Crowding of larvae leads to unhygienic conditions in warehouses. Damage is confined to peripheral layers of bags or 30–45 cms in bulk storage.

**3. Saw Toothed Grain Beetle (*Oryzaephilus surinamensis*)**

**Nature of damage:**

Adults and larvae cause roughening of grain surface and offensive odor. Grains with higher percentage of brokens, dockage and foreign matter sustain heavy infestation, which leads to heating.

**4. Grain Moth (*Sitotroga cerealella*)**

The grain moth is commonly known as Angoumois grain moth.

**Nature of damage:**

It is a primary pest. Only the larval stage is damaging while the adult stage is harmless. Grains are hollowed out. The infestation can occur in the field also. In stored bulk grain, infestation remains confined to upper 30 cms depth only. The hole made by the insect is circular in shape with characteristic ‘flap’ or ‘trap door’.

**5. Rice moth**

**Nature of damage:**

The larval stage of this insect is responsible for damage. It pollutes food grains with frass, moults and dense webbing. In the case of whole grains, kernels are bound into lumps.

**6. Flour Beetle (*Tribolium castaneum*)**

These are of two types: i) Rust red flour beetle and ii) Confused flour beetle

**Nature of damage:**

Adult as well as larval stages of this insect feed on milled products but can also attack broken grains if present in bulk storage. Flour beetles are secondary pests of all grains and primary pests of flour and other milled products. In grains, embryo or germ portion is preferred.

**Management of storage pests:**

**A) Preventive measures:**

1. Hygienic technology-clean storage structure, seal all cracks and crevices, store clean grain.
2. Hermetic technology-use air tight container.

3. Mechanical technology-sieving and separation of insect-pests from the infested lot.
4. Physical technology-drying the seed in hot sunlight to reduce the moisture or artificial heating, 10% grain moisture is suitable for storage of seed.
5. Chemical technology-
  - i) Use malathion 5% dust as grain protectant @ 100g/100 kg of seed. This should not be used as general treatment in the grain intended for consumption purpose.
  - ii) Disinfect the storage with malathion 50 EC or primiphosmethyl 50 EC @ 0.5% (1:100) @ 3 litre /100 sq.m or dip the gunny bags and dry in shade.

**B) Curative measures:**

- 1) Spray with Malathion 50 EC or Primiphosmethyl 50EC @ 0.5% on the gunny bags carrying infestation.
- 2) Fumigation with aluminium phosphide tab@ 3 tab/ton produce or 145 tab./1000cubic feet. The pest control operations with aluminium phosphide may be undertaken only by Govt./ Govt. undertakings/ Govt. Organizations / pest control operators under the strict supervision of Govt. Experts or experts whose expertise is approved by the Plant Protection Advisor to the Govt. of India except Aluminium phosphide 15 % 12 g tablet and Aluminum phosphide 6 % tablet. The production, marketing and use of Aluminium phosphide tube packs with a capacity of 10 and 20 tablets of 3 g each of Aluminium phosphide are banned completely. The tablet of Aluminium phosphide 3 gm each is 'open for sale' provided it is packed in cage packaging and Aluminium phosphide powder in pouch-in-pouch packing for its use in rat burrows.

**References (if any)**

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