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Integrated Pest Management of Major Insect Pests of Millets

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Millets are a group of highly variable small-seeded grasses widely grown as cereal crops or grains for both human food and fodder. Major millets, such as pearl millet, sorghum, finger millets (ragi), proso millet and foxtail millet are the most widely grown millets in India. Minor millets such as Indian barnyard millet, little millet and kodo millet are grown in the pockets on marginal lands. Pearl millet is one of the most extensively cultivated cereals in the world, after rice, wheat, and maize, and particularly in arid to semi-arid regions. More than 100 insect-pests have been reported to be associated with pearl millet based cropping system, but only few of them are potential pests of significant economic importance. The insect-pests viz., shoot fly, stem borer, white grubs, ear head worms and grey weevil are the key pests of millets in India and need proper control measures. The description of major and minor insect-pests along with their scientific name, importance, status, nature of damage and their control measures are as under:

1. Shoot fly, *Atherigona approximate* (Malloch):

Host plants: Pearl millet, sorghum, maize, wheat, minor millets and fodder crops.
Nature of damage: The fly has assumed the status of a serious pest in a number of states, especially in Gujarat, Tamil Nadu and Rajasthan. The maggots feed on the seedlings and produce dead heart. Sometimes, the shoot is not killed due to quick plant growth. The fly also causes damage to ear heads in later stages of the crop and the ear head appears like cat's tail. It is reported that about 23.3 to 36.5 per cent grain losses are caused by shoot fly. The population fluctuation of shoot fly was studied at Jamnagar and revealed that the incidence ranged from 6.4-13.2 per cent during 15 to 50 days after germination of the crop.

2. Stem borer, *Chilo partellus* (Swinhoe):

Host plants: Pearl millet, sorghum, maize, sudan grass, baru and other grasses.
Nature of damage: This is a major pest and most destructive and cosmopolitan species. At seedling stage, borer larvae feed in plant whorls and thus parallel shot hole appears in the opening leaves followed by dead hearts at later stage. Whereas, at ear head stage the silver ear head/ empty ear head appears and losses up to 20-60 % have been reported. The study carried out for 10 years on population fluctuations of pearl millet stem borer revealed that its incidence is noticed 15 days after germination of the crop (4.4%) and gradually increased to its peak (15.1%) at 77 days after germination of the crop.

3. Ragi stem borer (*Sesamia inferens*): Noctuidae: Lepidoptera

The pink larva bores into the stem and damages the central shoot resulting in dead heart. Borer holes are visible on the stem near the nodes. The larvae cause dead hearts and stem tunnels. The female lays about 150 creamy white and hemispherical eggs that are arranged in

two or three rows between the leaf-sheath and the stem of the host plant. Egg period remains till seven days. The fully grown larvae measures about 25 mm and is pale yellow with a purple pink tinge and a reddish-brown head. The larval period is 25 days but in cold months it may be extended to 75 days. Pupation occurs in the larval tunnel in the stem and the adult emerges in 12 days. One generation may take 6- 7 weeks. The life cycle is completed in 45-75 days. There are 4-6 generations per year.

4. White grub, *Holotrichia consanguinea* Blanchard, *Holotrichia longipennis* and *Holotrichia serrata* L.

This is a serious pest of ground nut, sorghum and pearl millet in Gujarat. This insect is active from July to November. Its larva is in the shape of the English letter 'C', whose mouth is brown in color, which eats the roots of the plants, plants turn yellow and dry up slowly and are easily uprooted on drying. The pest is prevalent in its larval stage in the fields from March to October. The grubs feed on roots in the soil. The problem is more serious in lighter soils. The grub rapidly moves from one plant to another under the soil. The damaged plant starts drying up and ultimately dies. The seedlings are attacked by this pest. Larvae cause major devastation resulting in the failure of the crop. Both its beetles and larvae damage the plant.

5. Ear head worms, (a) *Helicoverpa armigera* Hubner:

Host plants: Pearl millet, sorghum, maize, wheat, minor millets

Nature of damage: The losses up to 10-15 per cent has been reported at Jamnagar and it is observed that egg laying by female moth is specifically done on the bajra ear heads at ear head emergence stage and freshly hatched larvae feed on stigma which ultimately leads to poor grain setting and it is sometimes misguided with sterility. Most of the larvae are dark greenish brown, but they can also be pink, cream or almost black. They do not hide in the soil during the day and are therefore, easier to find in the ear head. Pupation takes place in the soil.

(b) Hairy caterpillar, *Amsacta* spp.

These caterpillars have been reported as sporadic pests in semi-arid areas of the country. These caterpillars are difficult to kill when in advance stage, however, advantage can be taken of their habit of pupating gregariously in the soil of infested fields.

(c) *Eublemma silicula* (Swinh.)

Nature of damage: The caterpillars are observed feeding on the maturing grains, hidden under small dome-shaped or elongated structures formed from the dry anthers. The caterpillars feed mostly on the upper part of maturing grains. The excreta of insect leads to fungal attack thus quality of grain are deteriorated. The infestation by this pest is varied in different varieties and hybrids. The pest remains active from late August to early September. The attack is visible immediately with the commencement of grain formation.

6. Sorghum midge, *Contarinia sorghicola*: (Cecidomyidae: Diptera):

The maggot feeds on the developing grains and pupates there. White pupal cases protruding out from the grains and chaffy grains with holes are the damaging symptoms. Pupal cases can be seen attached to the glumes of damaged spikelet. The completion of one generation in a fortnight helps the pest to complete four to five generations in a season with overlapping generations especially when flowers are available. Some larvae pass the dry season by entering diapauses which may last 8-9 months and is terminated by warm and humid conditions in August/September. The adult fly is small, fragile with a bright orange abdomen and a pair of transparent wings. It lays eggs singly in developing florets resulting in pollen shedding. A female lays, about 30-35 eggs at the rate of 6-10 in each floret. The incubation period is 3-4 days, the maggot has four instars with duration of 8-10 days and total larval period is 9 - 11days.

7. Blister beetles: *Mylabris pustulata* Thunb., *Cylindrothorax tenucollis*

Host plants: Pearl millet, sorghum, maize

Nature of damage: Since the pest feeds on the flower petals and the pollen grain, seed setting in the pearl millet spike is affected. Different species of the beetles are present in nature. The beetle secrets an acidic substance, which on coming in contact with the human body, causes a "Blister" and hence the name is "Blister beetle".

8. Cotton grey weevil: (*Myllocerus subfasciatus*):

Host plants: Pearl millet, cotton, maize, sugarcane, ragi, lady's finger.

Nature of damage: This is an occasional serious pest of bajra. Adult causes severe damage to leaves leaving only the midribs. Beetle grubs feed on the roots. In some cases grub damage in seedling stage becomes very serious.

9. Ear head beetle/Blossom beetles (comman name: Chaffer beetle): *Anatona stillata* Newman, *Oxycetonia versiclor* Fab., *Chiloloba acuta* weed have been found on bajra crop. These insects are principally pollen feeders. These are seen on bajra ear heads. The larvae develop in organic matter in soil and few infest roots of plant also. These are medium sized to large beetles and are brilliantly coloured and dorsally flattened with a large scutellum.

Management: As an immediate remedy, chemicals have been used extensively, mainly on high yielding varieties and hybrids. It is emphasized that studies should be intensified on varietal resistance, mass rearing techniques, predators and parasites and manipulation of population by cultural practices leading to the possibility of using all available methods on an integrated basis for future pest management programmers' in sorghum and millets. The various management measures are as follows:

Cultural methods:

- Collect and burn stubbles and chafii ear heads and feed the stalks to cattle before the onset of monsoon rains. This will reduce the carryover of stem borers and midge.
- Deep plough one month before sowing will expose immature stages of insects and serve as a food for predators.
- Adopt synchronous and timely/early sowings of cultivars with similar maturity over large areas to reduce the damage by shoot-fly, midge, and head bugs.
- Rotate millets with cotton, groundnut, or sunflower, to reduce the damage by shoot fly, midge, and head bugs.
- Intercropping sorghum with pigeon pea, cowpea, or lablab also reduces the damage by stem borers.
- Treat seeds with thiamethoxam 35 FS @ 9.0 ml/kg or imidacloprid 600 FS @ 8.75 ml/kg to improve plant stand, seedling vigour, and reduce the damage by shoot fly and stem borer and sucking pest.
- Use higher seed rate of pearl millet at the time of sowing @ 5 kg/ha and delay thinning (to maintain optimum plant stand) to minimize shoot-fly damage.
- Initiate plant protection measures at 8 % and 5 % Economic Threshold Level (ETL) against shoot fly and stem borer, respectively in pearl millet crop.

Mechanical methods:

- Set up light traps till midnight to monitor, attract and kill adults of stem borer, grain midge and ear head caterpillars.
- Set up sex pheromone traps for monitoring of adult male moths of *Helicoverpa* sp. @ 5 traps/ha at 1 ft height above ear head formation from flowering to grain hardening.
- Set up the fishmeal traps @ l2/ha till the crop is 30 days old to reduce shoot fly damage.

Biological methods:

- Two foliar spray of *Beauveria bassiana* 1.15 WP (2 X 106 cfu/g) 5 g/l at 30 and 60 days after germination for management of shoot fly and stem borer in pearl millet.
- In case of small and marginal farmers who cannot afford the chemical pesticides can apply any one of the botanical materials available to them either neem seed kernel suspension or neem leaves suspension or mint leaves suspension @ 5% spray.
- Apply one spray of Ha-NPV 250 LE/ha at anthesis stage of pearl millet crop for effective and economical management of ear head worm *Helicoverpa* sp.

Biorational Methods:

- Apply balanced fertilizers having adequate NPK to promote better plant growth, that results in reduced damage by shoot fly and stem borers.

Chemical methods:

- When the shoot fly damage reaches 8% damage, the crop may be sprayed with quinalphos 25 EC 0.05%
- Granular formulation of insecticides may be applied as basal application for control of pearl millet shoot fly.
- Two sprays of profenophos 50 EC @ 0.05% or fenobucarb 50 EC @ 0.1% at 20 and 40 days after germination was found effective from the study at Jamnagar for the control of shoot fly.
- For stem borers, dust or granules can be applied in the whorl leaves of damaged plants or the entire field can be sprayed with fenvalerat at 0.01%.
- Whorl application of insecticides is also suggested for control of sorghum stem borer.
- For sorghum midge, the crop may be sprayed at 50 % flowering stage.
- For ear head bugs and head caterpillars, the crop may be sprayed at the completion of flowering and at the milk stage.

Looking to the status of the pests in changing climate, an integrated approach for management of these pests is need of the hour. A farmer friendly IPM package for the control and management of economically important insect pests, focused on pearl millet and finger millet is priority. Major pests in millets are shoot fly, stem-borer, white grubs while in finger millet, major pest is pink borer. The available evidence suggests that pearl millet and finger millet are relatively less subjected to many pests compared with other graminaceous crops such as sorghum. There is need to generate data on yield loss due to key pests of millet crops and effectiveness of natural enemies and their use in existing ecosystems. The traits responsible for resistance must be incorporated into agronomical suitable cultivars.