Pearl Millet Production Technologies for Andhra Pradesh and Maharastra

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Global Theme on Crop Improvement

Pearl Millet Production Technologies for Andhra Pradesh and Maharastra

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Contents

Introduction

Pearl millet is traditionally major food crop grown in arid and semi-arid tropical environment of Indian subcontinent and Africa.

Pearl millet is grown under the environmental conditions which are too harsh for growing other cereals to produce grains. These regions are characterized by erratic distribution of annual rainfall, high mean temperature and depleted soil fertility. Limited use of improved cultivator, inadequate plant population, low level of fertilizer application, weed control measures, and water conservation practices mainly contribute to low yield levels in this crop.

How ever pearl millet possesses greater abilities to produce grain under hot, dry conditions on infertile soils of low water-holding capacity, where other crops generally fail completely to perform. Correspondingly, it is produced mainly in outlaying areas peripheral to the major production and population centers of the developing world.

Yields are low; averaging only three quarters of sorghum yields. Most farmers who rely on pearl millet crop are quite poor and frequently experience food shortfalls. Little of the millet production enters the commercial market; most never leaves the farm on which it is grown. Rather, many millet farmers are more likely to be food buyers than sellers. One of the important reasons for the low farm gate prices is the several layers of traders between the farmers and consumers. The crop is also becoming less important in the economies of SAT countries and the demand for these grains as human food has been declining in the past 30 years.

The combination of poverty and severe environmental conditions makes it difficult to improve productivity in pearl millet. While yields are growing in Asia, many African producers are unable to raise yields because of the continuing expansion into even drier and harsher agroecologies and poor adoptions of 'improved' technologies in these environments. A major reason for poor adoption is that some of these technologies are expensive or otherwise inappropriate for these harsh environments.

The growth of pearl millet yields in Asia is due to the adoption of improved cultivars (both hybrid and open-pollinated) and at least limited investments in fertility management. Farmers are also expanding investments in water conservation technologies as land constraints become more severe. Yield improvement would be greater if the move to more remunerative oilseed crops (e.g., groundnut, sesame and castor) were not so prevalent in the more favorable pearl millet production areas in Asia.

Prospects for the adoption of improved management technologies in Asia are limited for several reasons. Firstly, high variability in the amount and distribution of annual rainfall. Secondly, labor constraints that restrict the adoption of improved soil and water conservation systems. And thirdly, farmers judge the returns to cash investment in inputs, such as fertilizer, against the gains obtained by saving to but food or livestock. The experts need to understand and assume that the farmers decisions will change depending on rainfall levels over the course of the season, and target narrow opportunities for even marginal improvements in water-use efficiency and soil fertility. These may include aiming for a small investment in chemical fertilizer to complement the use of manure, or a legume rotation rather than a short-run profit- maximizing investment entailing higher production risk.

However, it will still be difficult for millet to compete with other cereals grown on substantially more productive land in regions with higher rainfall. In areas where millet is competitive in terms of price and feed value, demand for millet grain for fish and poultry feed may grow. Pearl millet has

the advantage of superior adaptation to high temperatures and infertile soils with low water-holding capacity. In specific areas where these constraints are important, millet grain will compete effectively as a livestock feed against other cereals that must be transported across long distances at considerable expense.

Pearl millet is a traditional crop in Asia comprising mainly India and Pakistan and along the southern coast of the Arabian Peninsula and in Western Africa, particularly in the Sahel; in Central, Eastern and South Africa. Estimated world area of this crop is 24.2 million ha. India is major pearl millet producing country with 43.4 per cent of the world area. In western Africa it is cultivated nearly on 45 per cent in 17 countries and on 8.7 per cent of the world area in nine countries of the southern and western Africa (Harinaryana et al. 1999).

It is one of the important crops grown in the project areas of CFC-FAO-ICRISAT project in Andhra Pradesh and Maharashtra state clusters. (Fig. 1.)

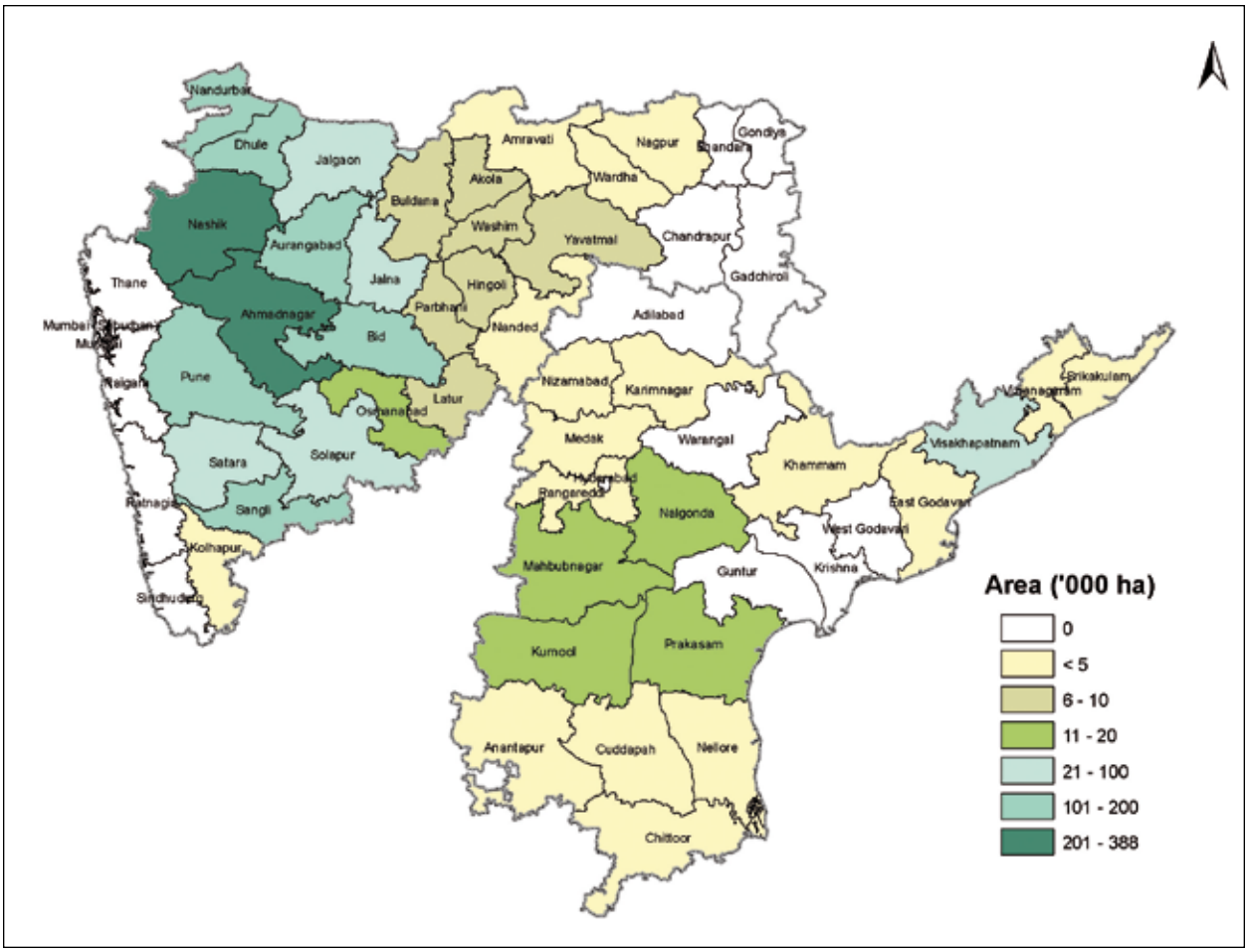

Fig 1. Pearl millet distribution in Andhra Pradesh & Maharashtra, 1998.

Different names of pearl millet:

Pearl millet (Pennisetum glaucum, P. typhoides, P. tyhpideum, P. americanum) is the most widely grown of all millets. It is called by different names such as bulrush millet, babala, bajra, cumbu, dukhn, gero, sajje, sajji, sanio, or souna.

Production constraints

Pearl millet production suffers from a number of constraints such as,

(1) poor soil fertility
(2) low and erratic rainfall
(3) high temperatures
(4) widespread *Striga* infestation
(5) downy mildew disease
(6) loss of grain to bird damage.

In addition, millets are cultivated on small, fragmented production units and are often intercropped with legumes and sometimes with sorghum.

Unreliable precipitation tends to keep the use of inputs such as chemical fertilizer, pesticides and hired labor to a minimum and limited commercial demand depresses the incentive to use purchased inputs.

Utilization

Although millet represents less than 2 per cent of world cereal utilization, it is an important staple in a large number of countries in the semi-arid tropics, where low precipitation and poor soils limit the cultivation of other major food crops.

Millet is high-energy, nutritious food, especially recommended for children, convalescents and the elderly. Several food preparations are made from millet, which differ between countries and even between different parts of a country. These consist primarily of porridge or pancake-like flat bread. However, because whole meal quickly goes rancid, millet flour (prepared by pounding or milling) can be stored only for short periods.

Millet is traditionally pounded in a mortar, but mechanical dehulling and milling are increasingly used since they eliminate a considerable amount of hard labor and generally improve the quality of the flour.

World wide, millet food consumption has grown only marginally over the past 30 years, while total food use of all cereals has almost doubles. Millet is nutritionally equivalent or superior to other cereals. However, consumer demand has fallen because of a number of factors, including changing preferences in favor of wheat and rice (cheap imports are available in several countries), irregular supplies of millet, rising incomes and rapid urbanization. Particularly in urban environments, the opportunity cost of women's time has encourages the shift from millet to readily available processed foods (milled rice, wheat flour, etc.,) that are far quicker and more convenient to prepare.

Animal feed

Utilization of millet grains as animal feed is not significant. It is estimated that less than 2 million tons, (about 7 percent of total utilization), is fed to animals, compared with about 30 million tons of

sorghum (almost half of total output). In the developing countries, use of millet grain for animal feed is concentrated in Asia; very little is fed in Africa. However, millet fodder and stover are a valuable and critical resource in the crop/ livestock systems where millet is grown.

Feed use estimates are heavily influenced by assumptions made for China, the world's third largest producer. In fact, little reliable information is available on feed use in this country. Based on very rough calculations of feed use in the CIS, it is estimated that about 1.0 million tons per annum are currently used as animal feed in the developed countries. Feeding trials have shown that pearl millet grain compares favorably with maize and sorghum as a high-energy, high-protein ingredient in feed for poultry, pigs cattle and sheep. Nevertheless, very little millet is used as feed.

Other uses

There are few other uses of millet. Small quantities of finger millet are used for commercial brewing and opaque beer. Food technologies have experimented with the incorporation of pearl millet into composite flour, but the commercial application of this technology is limited.

Improved cultivation practices

Soil requirements

- Pearl millet can be grown on different kind of soils in different parts of the country:

-Sandy soils : Northwestern India and in parts of Andhra Pradesh
-Heavy (deep) soils : Karnataka and Maharasthra
-Light red and black soils : South India/parts of Andhra Pradesh

- Well drained sandy loam to loamy soils, free from salinity or alkalinity are best suited.
- Pearl millet should not be grown on acidic soils and highly saline soils.

Climatic requirements

- The crop is cultivated on wide range of climate with rainfall ranging from 200–900 mm, but grows well under warm climatic conditions with 500–600 mm rainfall during entire growing period. Light to medium rainfall is quite beneficial in vegetative growth, but the rains at flowering and at grain formation adversely affect the grain setting.
- The crop should not be grown in low lying areas, as waterlogged conditions are not congenial to plant growth.
- A temperature range of 28–32°c is optimum for normal crop growth. High humidity and low temperature at grain maturity period induces infection of diseases like ergot.

Planting time

Sowing of pearl millet as a rainfed crop should be taken up after sufficient rainfall that has wet the soil profile 15-18 inches deep. Sowing usually spreads over a period of 1-2 weeks starting the second week of June. In case irrigation facilities are available, sowing can be taken up in the first week of June even with the first rain, which may barely be enough.

- Onset of monsoon (June–July) is optimum time of sowing in rainfed areas. Sowings should be completed by first fortnight of July.
- Avoid delayed sowings. Such crops have more chance of poor seed setting and incidence of diseases.

Seed requirement

The seed requirement varies with soil types. The recommended seed rate is ranges between 2.5–3 kg ha^{-1} in clayey and black cotton soils and is 4–5 kg ha^{-1} for sandy and sandy loam soils.

Planting space requirement

The planting space requirement also varies with different climate regions.

Region	Spacing	
	Plant-to-plant	Row-to-row
Areas with rainfall <450 mm	12–16 cm	10–12 cm
Areas with rainfall >450 mm	50–60 cm	45 cm

The depth of sowing also varies depending on the type of the soil and the and the climatic conditions prevailing in the region.

Optimum sowing depth – 2.50–3.00 cm
Heavier soils – 1.25–2.50 cm
Red soils – 2.50–5.00 cm
Desert sandy soils – 5.00–7.00 cm

Plant population:

Maintaining optimum plant population is a prerequisite in getting desired levels of crop yields.

- The optimum plant population ranging from 175,000 to 133,000/ha need to be maintained which can be achieved by thinning during weeding after 3 weeks of sowing..
- In drier areas where the rainfall is too erratic, plant population be reduced to 100,000 to 133,000/ ha in place of recommended practice

Cultivars:

A large number of hybrids and a few open-pollinated varieties with resistance to downy mildew (green ear disease) and appropriate maturity are available for Andhra Pradesh and Maharashtra.

Some of these are given below:

State	Hybrids	Variety	Area of adaption
Andhra Pradesh	Research Hybrids of Private Companies	ICTP 8203 ICMV 221 AIMP 92901	Mahaboobnagar (Andhra Pradesh)
Maharashtra	Saburi, Research Hybrids of Private Companies	ICTP 8203 ICMV 221 AIMP 92901	Beed (Maharashtra)

Sowing Method:

The spacing between rows should be 45 cm, and that between plants within the rows it should be 10 cm. Seed should be placed 4-5 cm deep with good moisture contact and covered with the soil. Seeds can be sown in dry soil in case of availability of irrigation soon after sowing.

Nutrient management (application of manures and fertilizers)

At the time of last ploughing, application of 4 t/acre of farmyard manure is desirable. Alternatively, fertilizer dose of 25 kg nitrogen and 12 kg phosphorus /acre is recommended and 50 per cent nitrogen and total phosphorus (i.e. 60 kg of 20:20 /acre) should be applied as basal dose and remaining 50 per cent of nitrogen (25 kg of urea/acre) should be applied as top dressing at about 18-20 days after sowing based on the availability of moisture.

Nitrogen

Of the three major nutrients (N, P, K), response of nitrogen has been almost universal, as most of the soils where pearl millet is grown are deficient in nitrogen. Response of nitrogen application mainly depends upon many factors such as:

- Type of soils
- Inherent soil fertility
- Climate
- Type of cultivar (hybrid/variety)
- Growing conditions(rain fed/irrigated)

In rain fed areas, response to nitrogen application in most of the varieties/hybrids depends on soil condition and rainfall pattern of the region

- In low rainfall areas (<450 mm), response of nitrogen is up to 60 kg ha^{-1}. However optimum dose is 40 kg nitrogen ha^{-1}.
- In good/assured rainfall areas, response of nitrogen is up to 120 kg ha^{-1} but, the optimum dose varies from 60 kg to 80 kg nitrogen ha^{-1} depending on type of soil (sandy, loam, heavier soils) and available soil nitrogen.
- Desired dose of nitrogen should be applied in two splits, half at sowing and half at three weeks after sowing subject to the availability of soil moisture.
- In drier region farmers normally skip basic dose of nitrogen, whereas basal dose of 20 kg nitrogen would always be beneficial for better initial root growth and establishment of the crop.

Phosphorous and potash

Most of the Indian soils respond to phosphorus (P) but few of them require potash (K). Application of phosphorus and potash fertilizers, therefore, needs to be based on soil test recommendations. Significance of phosphorus application is next to nitrogen. It has been observed that nitrogen may not be utilized without phosphorus.

- Recommended level of phosphorus for pearl millet crop is 20–40 kg ha^{-1}, which should be applied at sowing along with basal dose of nitrogen.
- Application of 15 kg K in the presence 60 kg nitrogen along with 30 kg of phosphorus increases seed yield significantly.

Organic manuring

Organic manure supply not only macronutrients and micronutrients, but also improves water holding capacity of soils.

- Application of inorganic fertilizers in combination with organic manures produces higher grain and straw yield than only organic manure/inorganic fertilizers.

- Application of 2.5 t of farmyard manure (FYM) in low rainfall sandy region and 5.0 t FYM ha^{-1} every year in combination with 40 kg N ha^{-1} is more economical and conducive for yield stability in pearl millet.

Bio-fertilization

Inoculation of pearl millet seed with local strains of the bacterium Azospirillum brasilence increases yield markedly. The effectiveness of the bacterium increases considerably when it is applied in addition to low rates of N at 10–40 kg ha^{-1}

Thinning and weeding

Seedlings should be thinned at 10 cm spacing when they have reached five-leaf stage, which makes them strong enough for easy pulling without any damage. Careful thinning of weak and diseased seedlings is desirable for better crop stand. Normally one hand weeding is required within 15 days after sowing and one inter-cultivation 10-15 days thereafter.

- Another weeding and inter-cultivation might be essential if the weed infestation is more before flowering.

Competition with weeds, reduces grain yield by 25–50%. For effective weed control, following two alternative measures are recommended:

Intercropping

Growing 1 or 2 legumes with pearl millet as mixed without any specific row arrangement has been a traditional practice, which leads to low yield in both of the mixed components. Through researches on this aspect, technique and pattern of planting of crop grown in association has been perfected to obtain additional yield of short duration legumes with out reducing the yield potential of pearl millet. For this purpose recommended practice is:

- Adopt paired row planting in place of uniform rows in spacing of 30/70 cm. Pearl millet is sown in paired row at a distance of 30 cm and the spacing of 70 cm is kept between the two paired rows for sowing of intercrop (Fig. 2.) (Gautam 1995).
- Grow suitable intercrops as per agro climatic conditions of the region such as Sandy arid : Moth bean or cluster bean
  Sandy semi-arid : Mung bean or Cowpea Heavier semi-arid : Pigeon pea, groundnut

Fig. 2. Pearl millet intercropping with pigeonpea.

Crop rotation

- In low rainfall areas, where monocropping is practiced, legume–pearl millet rotation is beneficial. Pearl millet crop should be grown in alternate years and legumes (moth bean, cowpea, cluster bean) in between.
- In assured rainfall areas, pearl millet grown as rainfed crop is followed by a post rainy season (*rabi*) crop on conserved moisture. One or two irrigations are recommended to rabi crops, if conserved moisture is not sufficient. Suitable crop rotations are: pearl millet–wheat, pearl millet–barley, pearl millet–toria and pearl millet–mustard.

Harvesting:

Harvesting the heads by hand when crop attains physiological maturity or within a week thereafter. Dry the panicles and thresh them for grains.

Major Diseases and their management

Downy mildew

Symptoms and damage:

- The disease cause substantial losses of grain and fodder yield under sever infection conditions.

The most obvious symptom of downy mildew is the transformation of the panicle into proliferated, leafy protuberances replacing the grains, hence it is called 'green ear disease'. Other symptoms of the disease are presence of only leafy mass in place of peduncle or panicle (Fig. 5, 6.). The disease also occurs in the early crop growth stages even, wherein the leaves become light green and chlorotic, with light colored streak, (Fig. 3.) and white powder on the lower surface of the leaves (Fig. 4.) (especially clearly visible on the older leaves). Some times entire plant is affected; in other cases, only secondary tillers seem to be affected.

High humidity favors the fast spread of the disease during the growth of the crop.

Fig 3. Young leavs showing light green chlorotic leaf symptm.

Fig4. White powdery growth under side of leaf.

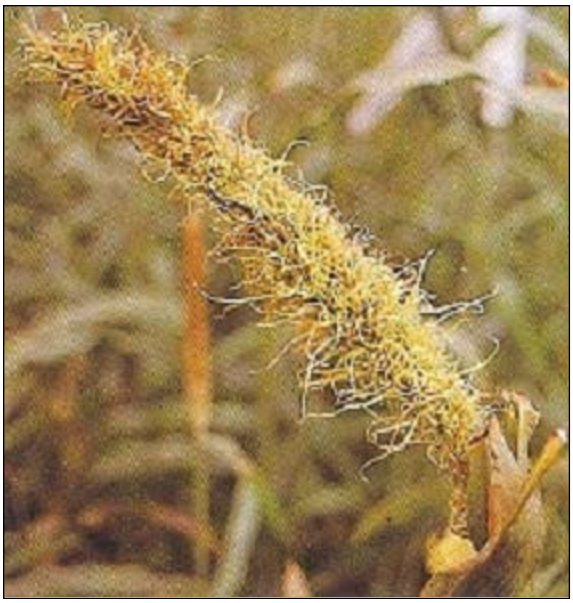

Fig 5. Thread like leaf in place of seed "green ear" style.

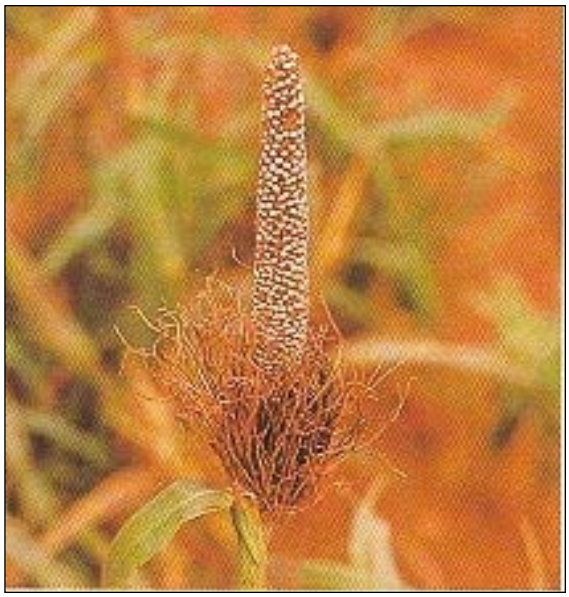

Fig 6. Partial ear head transformed into leafy structure.

Disease Management

Choose downy mildew resistant hybrids for cultivation. Use seed treated with metalaxyl at 2 g a.i. per kg seed (Apron 6g/kg). This is effective only up to 30-35 days after the seedling emergence in susceptible cultivars (hence choice of resistant cultivars is very important).plus one foliar spray of Metalaxyl 25% WP (63 g a.i. to 125 g a.i./ha) before panicle initiation. Uproot and burn the diseased plants to prevent further spread of the disease.

- Use resistant cultivars.
- Seed treatment with Apron S.D. 35 @ 6 gms kg^{-1} seed.
- Foliar spray-Ridomil 25 WP (100 ppm) after 21 days of sowing if infection exceeds 2–5%.
- Infected plants should never be allowed to remain in field. Such plants should be uprooted and burnt.
- Avoid monoculture of particular cultivar.

Smut:

The smut fungus *Tolyposporium penicillatiae*, infects the florets; ovaries are converted into structures called sori. (Fig. 7.) The sori are larger than grains and appears on enlarged oval to conical bodies projecting somewhat beyond the glumes in place of grains. During threshing the panicles, the grain gets contaminated with smut spores, a black powdery spores may spread over seed and soil.

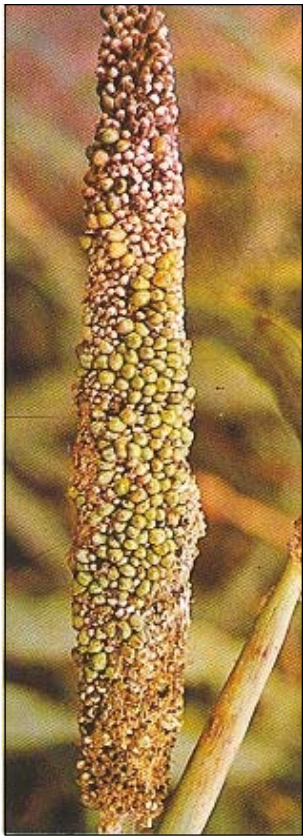

Fig 7. Smut sori in place of seed.

Disease Management:

No effective, economical and practical cultural or chemical control measures are available, seed treatment and panicle spray having varying success rates in control of disease. Seed treatment with Benlate @3 gm/kg may have some effect on the disease.

Ergot (*Claviceps fusiformis*)

The pathogen infects the florets at the protogyny stage and develops in the ovaries, producing initially copious creamy, pink, or red colored sweet sticky liquid called honeydew, (Fig. 8.) which contains conidia of the causal fungus. The honeydew can drip down the inflorescences onto the upper leaves making them sticky, and often pollen and shed anther sacs adhere to the honeydew. Subsequently, long dark-colored hard structures, sclerotia develop from infected florets, (Fig. 9.) first dark at the tip and then becoming completely black.

Sclerotia can be as large as 6 mm by 2 mm, may appear somewhat creamy during the early stages of their formation, but generally turn black as they mature. Infection can be so severe that all florets are infected and the head appears like a bottlebrush with large black sclerotia sticking out over the entire surface.

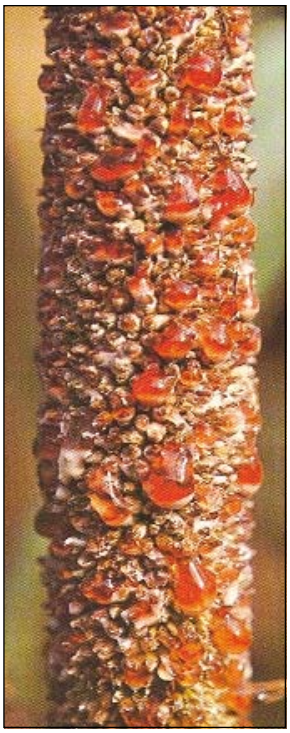

Fig 8. Honeydew stage.

Fig 9. Ergot sclerotia formation stage.

Disease management:

As there are no effective, economical and practical cultural or chemical control measures are available for the above disease.

- There is no effective control measure through fungicides, therefore genetic resistance is the best option.
- Precautionary measures.

1. Dip seeds in 20% brine water solution, stir and remove floating seeds and sclerotia. Seeds lying in bottom be dried and sown.
2. Adjust sowing dates so that ear emergence do not coincide with more rainy days.
3. Plow the field soon after harvest so that ergot is buried deep.

Major Pests

Bird damage:

Birds are most serious problem in cultivation of pearl millet, which substantially reduce the yield levels if not controlled. Generally field sparrows are major bird pest in the project area (fig. 10). Bird damage is severe if the crop is grown in isolated areas, off-season seed production plots, or if grown on small area in a village.

Fig. 10. Field sparrows feeding on pearl millet crop during seed setting stage.

Management:

a. Bird scares needed from sunrise to sunset from 10 days after flowering until grain harvesting is completed for the control of bird damage. Usually farmers protect the crop by shouting and moving around in the field or making noise/sounds by beating a metal plate/box or by using automatic phosphate gun to scare away the birds (usually done in seed production plots).

b. Use cultivars, which have long panicle bristles that restrict the bird damage to some extent.

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The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a nonprofit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 600 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Future Harvest Centers of the Consultative Group on International Agricultural Research (CGIAR).

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