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Downy Mildew Disease of Pearl Millet (Bajra) and Their Management

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Introduction

The downy mildew (DM) disease of pearl millet [*Pennisetum glaucum* (L) R. Br.] sometimes referred to as 'green ear' disease is caused by *Sclerospora graminicola*, which is the type species of the genus *Sclerospora*. It is the most widespread and destructive diseases of pearl millet in India and Western Africa (Rachie and Majmudar, 1980). This disease, first reported in India (Butler, 1907), is present in more than 20 countries (Safeeulla, 1976) and is a major factor limiting the full exploitation of the high yield potential of hybrids in India (Singh et al., 1993).

downy mildew of pearl millet **:** *Sclerospora graminicola*

Symptoms

Downy mildew disease causes reduction in the plant height, number of leaves and nodes in susceptible cultivars. As a result grain and fodder yields are reduced. Symptoms often vary according to host, time of expression and ambient conditions (Kenneth 1998). Both systemic and localized infection occurs. Infection is mainly systemic and symptoms appear on leaves and inflorescence. The downy mildew stage is prominent on the leaves (caused by sporangia) and the green ear stage affects the inflorescence/ear (caused by oospores). Green ear stage is more prominent, since the strain of the pathogen occurring in India produces more oospores than the sporangia. The initial symptoms appear in seedlings at three to four leaf stages of the plant. Symptoms can be observed in two phases, one is downy mildew phase that appears on the leaves and other is green ear phase appears on the ear head. Soil-borne spores cause systemic infection of the young seedlings. The affected leaves show patches of light green to light yellow colour on the upper surface and the corresponding lower surface bears white downy growth of the fungus consisting of sporangiophores and sporangia, infected leaves show greyish-white downy

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fungal growth on the lower leaf surface, white downy growth under high relative humidity (greater than 95%) and moderate temperature (20-22°C).

Initial symptoms of the systemic infection are expressed as chlorosis or yellowing of the lower leaves that progressively spread to the upper leaves and the whole plant. The infection is systemic and 7 to 10 day old seedlings show downy mildew symptoms as chlorosis on the upper and whitish sporangial growth on the lower surface of leaf. Subsequently, the leaves turn reddish brown due to oospore production and dry ultimately. The sporangia can cause further localised infection. Often the lower half of a leaf shows symptoms while its upper half remains symptomless. This is known as 'half leaf' symptom. Severely infected plants are generally stunted and do not produce panicles.

Epidemiology

The studies on epidemiological aspects of downy mildew of pearl millet reveals that the earliest symptom expression and the highest downy mildew were recorded when oosporic powder was placed below and above the seeds in furrows. Incorporation of oospores over the seed in furrow gave better results than the present practices of pre-sowing furrow application of oospores below the seed for field screening of pearl millet cultivars for downy mildew resistance. The amount of oosporic powder applied was correlated positively with disease incidence and negatively with the time taken to express disease symptoms. A high negative correlation between the age of seedlings at the time of sporangial inoculation and disease incidence was observed. The infection rate ('r') of the disease was highest in the unprotected plot. The magnitude of reduction in 'r' with Ridomil (metalaxyl) spray was greater than seed treatment with Apron (metalaxyl) (Gupta and Singh, 2000).

Disease Cycle

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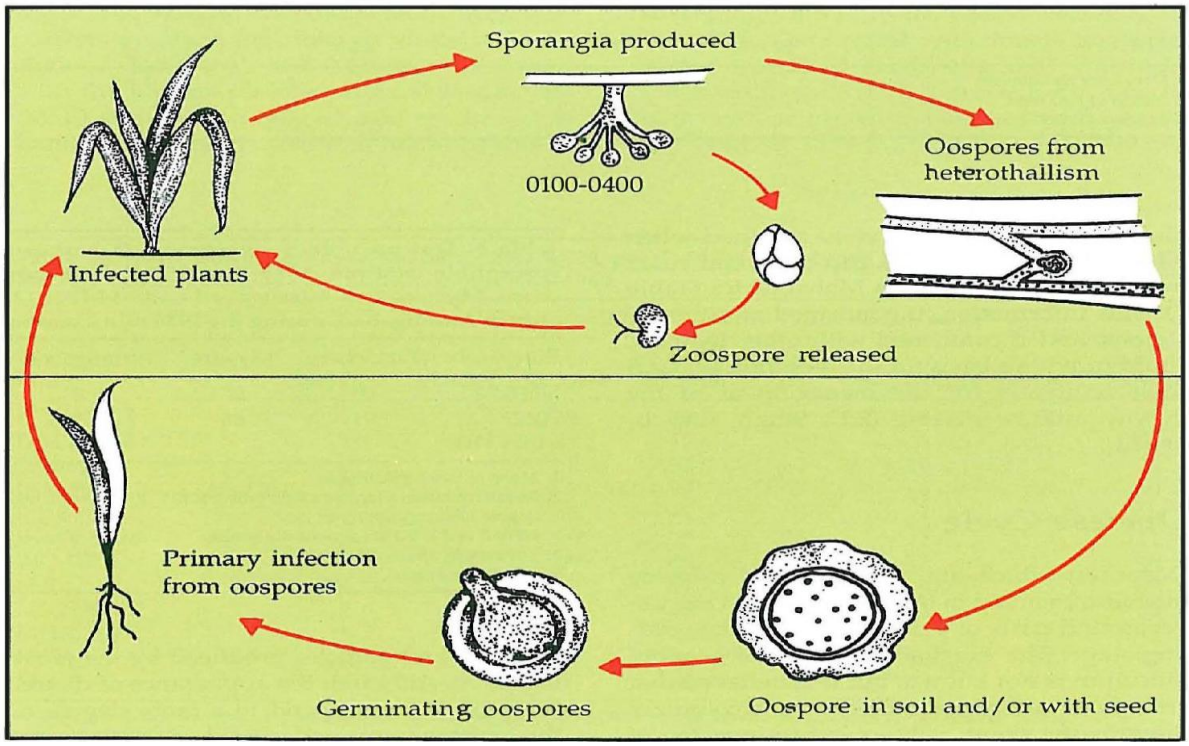
Oospores, which are the source of primary inoculum, remain in the soil and infect the underground parts of plants, mostly at the seedling stage. The exact site of entry of oospore inoculum is not known, but it is believed that after penetration, the pathogen soon colonizes the growing point. Subsequent to invasion of the growing point, systemic symptoms appearing leaves and panicles produced by the growing point. Although the appearance of disease symptoms may depend to a large degree on the environment, under field conditions, systemic infection has been observed within 6, 11 days after sowing. Infected plants produce oospores which are transmitted on the seed surface, in soil, by wind, or by water. Under humid conditions, systemically infected leaves produce abundant sporangia on the abaxial surface. Sporangia are important for the secondary spread of the disease within and among fields if environmental conditions are suitable (Singh and Williams 1980). These sporangia germinate and produce zoospores, which in turn, germinate and cause infection.



Germtubes generally penetrate the epidermis between cells but they can enter through the stomata also (Bhatnagar, 1988). Sporangial infectivity is limited by seedling age, with the greatest susceptiblity from the time of seed germination to the 1-2 leaf stage. Thereafter, the susceptibility decreases sharply (Singh and Gopinath 1985). Inoculation of plants at the coleoptile stage produces systemic symptoms in young leaves 4-7 days later. If the

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environment is suitable, infected leaves continue to produce sporangia until the tissues become necrotic or senesce. Oospores are produced in infected leaves when compatible mating types of *S. graminicola* are present in the same tissue, or when homothallism is operative. Oospores are not always found in systemically infected leaf tissue, presumably because only one mating type is present and homothallism is inoperative. Oospores remain in the soil along with infected leaf residue, and cause primary infection in the following years.

Yield losses

Downy mildew or green ear disease is associated with pearl millet since long (Butler, 1907). The disease was restricted only to the landraces and local cultivars. Epidemics were not reported till the introduction of F1 hybrids. In India, downy mildew epidemics caused substantial yield losses during 1970s and 1980s. Grain yield losses of 10% to 60% have been reported. The yield reducing potential of downy mildew is very high, and this was adequately demonstrated in HB 3, a popular hybrid, when pearl millet grain production in India was reduced from 8 million tons in 1970-71 to 5.3 million tons in 1971-72. This reduction was, to a large extent, due to a downy mildew epidemic, in which yields in some fields were reduced by 60 to 70%. The estimated annual grain yield loss due to downy mildew is approximately 20-40% (Singh, 1995; Hash et al., 1999; Hess et al., 2002). But, this could be much higher under favorable conditions of disease development (Singh, 1995; Thakur, 1998, 2008) and where a susceptible cultivar is repeatedly grown in the same field. Genetically uniform single-cross F1 hybrids become susceptible more rapidly than heterogeneous open-pollinated varieties (Thakur et al., 2006) leading to heavy production losses.

Management:

1. Rotation of crop, with non-host crop, removal of diseased plants and burning of plants within a month of disease detection may reduce the disease incidence to large area.
2. Deep ploughing to bury the oospores, rouging out infected plants, spraying with Dithane M-45 also helps in controlling the disease.)
3. Removal of diseased plants and their burning within a month of the disease detection checks the disease to a large extent.
4. Seed treatment with 0.4% thiram has been reported to control the disease to 50%. Spraying with Mancozeb 2 kg or Metalaxyl + Mancozeb at 1 kg/ha on 20 day after sowing in the field may prove effective.

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5. Use of disease resistant varieties like HB-15, PHB-10 and PHB-14 has been recommended. Seed treatment is recommended to prevent introduction of *Sclerospora graminicola* through seed. Mostly, asexual spores contribute to the air-borne inoculums.
6. Air-borne inoculums in the form of sporangia/zoospores can remain viable in the air for a few hours.
7. Hot water treatment of seeds at 55°C for 12 min and drying in shade has been found quite effective. Treat seed with metalaxyl-containing fungicide at 2 g a.i. per kg seed. Disease control through seed treatment with fungicide has also been found effective for downy mildew.

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