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Production of Disease-free Seed for the Management of Downy Mildew (*Sclerospora graminicola*) in Pearl Millet

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Summary

Frequent occurrences of downy mildew (*Sclerospora graminicola*) of pearl millet (*Pennisetum glaucum*) cause substantial losses in grain yield. Since the disease is seed transmissible, diseased seed is considered as one of the factors contributing to these epidemics. Production of disease-free seed, therefore, requires special attention. Seed production should be carried out in fields with little or no oospores. Seed of a cultivar should not be multiplied in a given field for more than two consecutive years. This can best be achieved by multiplying seed in rotation of selected cultivars. This practice will reduce the development of host-specific populations of the pathogen. Seed should be treated with metalaxyl to control infection by externally seed-carried oospores. A seed crop should be planted with pre sowing irrigation and the field should not be irrigated for 12-15 days after planting. This will control development of an early epidemic in the seed crops. Effective roguing of infected plants should be practiced from seedling to heading stage. Cultivars with fast seedling growth should be developed. This trait will help in producing seed free from internal mycelium which could reach the seed from the infected plant. A combination of all these operations will help to produce disease-free seed.

Introduction

Downy mildew caused by *Sclerospora graminicola* (Sacc.) Schroet. is the most widespread and destructive disease of pearl millet [*Pennisetum glaucum* (L.) R. Br.] in India and Africa. The crop is grown for grain and fodder throughout the tropical and snbtrophical areas of Africa and the Indian subcontinent on about 26 m ha (FAO, 1983). The disease is a major limiting factor to the full exploitation of the high yield potential of improved cultivars in India. A reduction of 10-60% in grain yield has been reported (Singh *et al.*, 1987). The disease caused substantial reduction in grain yield in the epidemic years 1970-76 (Safeeulla, 1977) and 1983-84 (Singh *et al.*, 1987). On an average, downy mildew epidemics occur once in every three years on some cultivar in one or other part of the country (S. D. Singh, unpublished).

Cultivation of susceptible cultivars and seed-carried inoculum are being considered as major contributory factors to these epidemics. The purpose of this paper is to evaluate the various modes of disease spread and to suggest ways of preventing them for the production of disease-free seed.

Modes of disease spread

1. Spread through seed

(*a*) **Seed carried mycelium :** Presence of mycelium inside the embryos has been reported by several workers (Singh and Pushpavathi, 1965; Singh, 1974; Sundaram *et al.*, 1973; Shetty *et al.*, 1977). However, the role of this mycelium in transmitting the disease has been in controversy. Some workers have reported that the mycelium does not cause systemic disease in the plants (Suryanarayana, 1962; Williams and Singh, unpublished). On the other hand, others have presented evidence that the embryo-borne mycelium gave rise to the disease (Sundaram *et al.*, 1973; Thakur and Kanwar *et al.*, 1977; Shetty *et al.*, 1977, 1980).

(*b*) **Seed-carried oospores :** Presence of oospores on seed has been reported (Shetty *et al.*, 1978). They stick to seed surfaces in the field or on the threshing floors. Although all the seeds do not carry oospores, a seed may carry as many as seven. (S. D. Singh, unpublished).

2. Spread by air

(*a*) **Oospore dispersal :** Oospores are produced inside infected leaves. During harvesting and/or chopping the standing crop, oospores are separated and some become wind-borne. These wind-borne oospores transmit the disease.

(*b*) **Sporangial dispersal :** Under field conditions, sporangia are produced on infected plants at night, generally after midnight at about 20°C and 95%RH. Soon after maturity, sporangia become wind-borne (Reddy, 1973), causing disease in susceptible crops up to 300 m from the source during rainy season. During the postrainy season sporangial infection has also been recorded up to 80 m from the source (Singh and Williams, 1980).

3. Cultural practices

Oospores can be easily transported from one field to another through implements and to some extent by irrigation water. However, long distance dissemination through cultural operations does not appear likely.

Obviously, there are several ways by which the pathogen can be spread and cause the disease. For the production of disease-free seed, we must aim to produce disease-free crops. To achieve this, the following measures should be carried out.

1. *Prevention of crop infection by oospores*

(a) Disinfecting seed-carried oospores with seed treatment : Seed-carried oospores can be effectively disinfected by treating seed with fungicides,

Although Agrosan G. N. has been used routinely in the past, metalaxyl is the most effective fungicide Seed treatment with metalaxyl at 2 g a. i./kg seed effectively controls infection by oospores (Dang *et al.*, 1983 ; Singh, 1983).

(b) **Disinfecting soil-borne oospores :**

Selection of Field : It is advisable to confine seed production to areas/fields with no downy mildew history. Even if such fields are not totally free from soil-borne oospores, these would certainly have less oospore load than fields which had diseased crop in the previous years.

Produce seed crop in rotation : Strong evidence exists that *S. graminicola* is highly host-specific (S. D. Singh, unpublished). When a pearl millet cultivar is grown for several years in succession, the oospores of host-specific pathotype starts increasing. Due to the gradual build-up of the oospore population of the specific pathotype, the host begins to show increased levels of susceptibility, and in due course, a situation arises when the cultivar can no longer be grown. This explains the reason for withdrawal of several pearl millet cultivars in the past.

However, the useful aspect of this host-specificity is that such specific populations cannot exist in the absence of the host for long. Once a cultivar is withdrawn, the host-specific oospore population dies out within a period of three years (Singh and Singh, 1987). Therefore, if the same cultivar is grown after three years, it will be free from soil-borne oospore infection. This way the disease-free seed crop can be grown. Infact, this practice could effectively be used to control downy mildew in commercial crops in farmers fields (S. D. Singh, unpublished).

2. *Prevention of crop infection from sporangia*

(a) **Sowing with presowing irrigation :** Pearl millet is highly susceptible to infection by sporangia at the early seedling stage (Singh and Williams, 1989 ; Singh and Gopinath, 1985). If during this stage the humidity level is reduced to 70% or less, the crop can escape infection even if the sporangial inoculum is available. This should be achieved by stopping irrigation 12-15 days after sowing. The crop can grow without irrigation for about 15 days if it is irrigated prior to sowing.

(b) **Roguing of infected plants :** Sporangia play a major role in the epidemiology of the disease, particularly in the build-up of the disease within the field (Singh and Williams, 1980). Although younger seedlings are most susceptible, some susceptibility in the crop continues until heading due to the production of basal and nodal tillers. Thus the presence of a few infected plants within the crop can continue to provide sporangial inoculum and spread the disease. This inoculum source must be removed by roguing and destroying the early-infected plants. This operation should begin soon after the first detection of infection in the field and continue two to three times a week until heading.

(c) **Spraying with metalaxyl :** Metalaxyl spray can effectively be used to

control the spread of the disease in the field (Dang *et al.*, 1983; Singh *et al.*, 1984). If the crop has not been grown from seed treated with metalaxyl and the disease has appeared, metalaxyl should be sprayed twice. The first spray should be done prior to panicle initiation to prevent the panicle from developing into green earhead, and the second spray 30-35 days after sowing to prevent the expression of hidden infection and secondary spread. Roguing coupled with metalaxyl spray is the most effective way of controlling the build up of the disease in the field.

(d) **Prevention from exodemic:** As mentioned above, sporangia can travel 80-300 m from the source depending upon season. Infection from sporangia could be avoided provided proper isolation from other millet crop is followed In rainy season, a seed crop should be planted 300-500 m from other millet crops. In the dry season, however, a seed crop can be planted at a distance of 200 m. Although this isolation distance is generally maintained to exclude pollen contamination, sometimes the same cultivar is planted several times during the same season in adjacent fields. In such a case, proper isolation is not considered necessary. If the earlier planted crop becomes diseased, it serves as on inoculum source for the later planted crop.

(e) **Seed production during dry season:** Dry season is an ideal time for the production of pearl millet seed. During this season, the chances of disease build-up are quite low due to low humidity levels. In India, most of the seed production is undertaken during the dry season. However, considerable amount of seed is produced in Maharashtra during the rainy season also.

3. *Use resistant cultivars*

The easiest way to produce disease-free seed is to grow disease resistant cultivars. One should always insist on the seed of those cultivars showing high levels of resistance to the disease. However, the steps listed above should always be followed. This is necessary because no cultivar is 100% resistant; each cultivar always has a small proportion of susceptible plants.

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