

## DOWNY MILDEW DISEASE OF CORN IN VENEZUELA

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Downy mildew (DM) diseases of corn and sorghum in Venezuela were called to the attention of farmers and plant pathologists only 2 years ago in 1974. Some diseased plants were observed in 1973 although its etiology was uncertain. In effect, symptoms in corn (deformed or phyllodied tassels, elongated ear shoots and yellow stripped leaves) suggested to the first observers that the disease was "crazy top" (Punta loca). At that time, as the plants were old, no conidiospores were observed and occasionally oospore like bodies (probably oogonial structures) were found.

In sorghum, the disease was first confused with a bacterial one due to the brown leaf stripping. There were no phyllody symptoms, but chlorotic, brownish streaks and later, leaf shredding occurred. Affected leaves soon become necrotic and dried from the tip downwards to the base of the leaf. The affected plants remain stunted and produced many tillers. The etiology of the disease in sorghum, caused by *Sclerospora sorghi*, was easily established as oospores are extremely abundant in shredded leaves. They are located in the mesophyll cells parallel to the vascular bundles and conidia are also abundant on young diseased leaves.

In corn, the relation between the plants showing chlorotic, narrow, erect leaves and the other ones with the phyllody symptoms was established later (1975) when conidia could be observed in diseased young leaves of both types of plants. Also, inoculated corn seedlings, transplanted in the field, could be followed throughout their life.

At the same time, B. L. Renfro and R. A. Frederiksen visited Venezuela and confirmed the etiology of the disease and the similarity of the

causal agent in both sorghum and corn. A further confirmation of this identification has been done by C. G. Shaw, studying corn and sorghum samples sent to him from Venezuela.

It may be worth mentioning that in 1973, 1974 and 1975 the rains were very poor at the beginning (May-June), when the corn plants were young. Perhaps the dry conditions made the plants more susceptible to systemic infection from soil borne inoculum. Oospores were not observed in corn. In 1976 the rains were very heavy from the beginning to the end of the corn life cycle making sowing and cultural operations difficult, and oospores were easily found throughout the period.

**Distribution and importance of the disease.** — Corn is the most important and traditional cereal crop in Venezuela. It is planted in an area of more than one-half million hectares and averages about 1,300 kgs/ha. It is used for human as well as animal consumption and is commonly sown at the beginning of the rainy season in May to take advantage of the rain fall (1,200-1,800 mm.) that lasts until September. The corn area is located mostly in the Central and Central-Western states of the country at an altitude of about 150-500 meters A.S.L., with a temperature average of 26-33°C during the day and 12-22°C at night.

A limited diseased area of sorghum and corn was first seen in the state of Yaracuy in 1973, subsequently observed in three additional states in 1974 and, in 1975, it was found to be present in nine states; covering at least one-third of the national cultivated corn area. The percent of diseased plants in the total affected area is calculated to be about 1.6%; but, in many particular fields they have reached 60%. The disease

has been observed in equal intensities and incidence during the rainy and dry seasons; the later grown under irrigation. It is quite possible that the disease will spread over the total corn area within a few years and increase in incidence, considering its rapid spread from the central point. It is thought that the fungus was introduced into the country with either experimental or commercial sorghum seeds.

**Research work done or what we know about the disease.** --- Etiology: inoculation tests.

a) Using conidia: The seedlings were inoculated using the Petri dish method described by R. A. Frederiksen, *et al.* (Monograph 2, Texas A&M University) or by spraying young corn plants at the three leaf stage with a conidial suspension in water (as described by different authors) and kept in a moist chamber for 24 hours.

Actually, we are using a 3 cubic meter plastic moist chamber, kept humid with constantly moistened paper on the floor and two humidifiers. The young plants are located in pots on the floor in it and the inoculum comes from infected leaves located at the upper part of the chamber.

b) Using oospores: The seeds were sown in sterilized soil in pots and inoculated by putting milled (powder) dry leaves of diseased sorghum or Johnson-grass along side the seed, as described by K. M. Safeeulla and Thirumalachar. (Phytopathol.45:128-131). In all cases the inoculation tests were conducted in a laboratory room conditioned at 18-20° C. The results obtained prove that: the disease is caused by the fungus *Sclerospora sorghi*, which can infect plants in both its asexual and sexual stage, the same fungus causes the disease in corn as well as in many species of *Sorghum* (*S. bicolor*, *S. vulgare*, *S. halepense*, *S. verticilliflorum*, *S. arundinaceum*, *S. sudanense* and many natural hybrids of them); and, inoculations with conidia seem to be more effective than with oospores. In nature it is sure that conidia are the most quick and feasible way of spreading the disease, while oospores assure its perpetuation.

**Development of the disease and symptoms.** ---

This was studied in one case by marking young diseased plants in a corn field and following the development of the disease throughout the plant life. In another case a lot of corn seedlings were inoculated with conidia from different hosts, transplanted in the field and later the disease development was observed as in the first case.

The results of these observations are summarized as follows. The final symptoms in diseased corn plants are very variable (Phyllody, sterility, stunting, etc.), but these symptoms are not strictly related with the early ones. Of the diseased young plants, about 21 % were stunted and died prematurely; 36% had deformed, phyllodied tassels, and the other plants had chlorotic, narrow, erect, stripped leaves, without tassels and/or cobs. The disease development does not appear to be related to the source of inoculum (conidia or oospores). Conidial infection first produces a local lesion that turns systemic when the fungus reaches the central bud. The "half-leaf lesion" is a very common symptom in corn in the early stage of the disease (in about 80% of diseased plants). It commonly begins in the third leaf and increases in the successive 6-7 leaves, while the remaining ones (9-10 to 15-16) become systematically infected. The corn plants with phyllody frequently developed from ones which displayed the "half-leaf symptoms" when young.

**Fungus perpetuation and reservoirs of inoculum.** ---

The most peculiar matter in Venezuela is the susceptibility of the types of wild sorghums which are very common everywhere, including inside the cultivated fields as well as along the drainage or irrigation ditches. They are perennial rhizomatous weeds that ensure fungus perpetuation and survival from one season to the other, and from 1 year to another by providing constant inoculum, both as conidia (disseminated by wind) and oospores which fall to the soil or are carried in the irrigation or rain water.

The same situation is found in grain sorghum -- that commonly produces two crops -- and in forage sorghum, which is more susceptible to the

disease and can be cut several times a year. As said before, conidia production is constant in all mentioned hosts throughout the year whenever night temperatures are below 20° C for several (6-8) hours. This happens very frequently in the rainy season, especially after a rainy period; or, in the dry season when the temperature is lower and nocturnal dew is abundant to assure a great condensation of moisture on leaf surfaces.

Oospores form abundantly in all *Sorghum* species affected as soon as leaf necrosis or striping is observed. It seems that their production is constant without special requirement of humidity and low temperature. In corn, oospores were observed only in 1976 after a period of heavy constant rains and relatively low (18-20° C) temperature. It seems that, in corn, special environmental factors (very high moisture and low temperature) along with corn susceptibility are required for oospore production. Corn oospores are the same size as sorghums, but the oogonial wall is more persistent and sometimes polyhedral shaped with ridged prominences. They are easily visible in old tissues that have been exposed for 24-48 hours in a NaOH solution. The infected tissue is commonly mixed with *Helminthosporium*, *Curvularia* or *Fusarium* mycelium and conidial structures. Corn oospores are pale in color, in contrast with the yellow-brownish ones of sorghums, and the oospore wall seems to be thinner.

We do not believe two races of *S. sorghi* exist in Venezuela (corn race and sorghum race) as suggested by M. M. Payak in India. Susceptible corn cultivars (Arichuna hybrid and L. Antigua Gr. 2), inoculated at the seedling stage with conidia from different hosts (corn, sorghum, Johnson and False Johnsongrass), have produced diseased plants with equal formation of oospores.

**Varietal reaction.** — All our commercial cultivars – varieties and hybrids – are susceptible to the disease but severities differ. Among the commercial hybrids (double hybrids), Arichuna was the most susceptible, followed by Obregon, Proseca 74, Tamanaco Baraure and Proseca 68. Among varieties, the most susceptible were Venezuela, Sicarigua, Tunapuy and Minita.

In the experiment station at Yaritagua (state Yaracuy) a field test was conducted in 1975 using 68 cultivars of corn grown in a soil where the corn plantings had been heavily diseased the year before, and where the infestation of “Johnsongrass” weeds secured a constant inoculum. Of the tested cultivars, only L 30 DMR from Philippines was disease free. Of the other, the least susceptible (1-10% infection) were V. H. Semicristalino, L Llera III-53, L 48-S-74, L 48-S-38, and L Desc. 2 29-6. The most susceptible (more than 40% infection) were V Proseca 75, I. Eto b2053, Antigua Gr. 2, Raza Puya Grande Orig., Compuesto semidentado and Raza canilla, Venez. Orig. The Phil. DMRs 1, 2, 3, 4, 5 and 6, obtained from Thailand (Dr. Renfro), Philippines (Dr. Exconde) or from CIMMYT (Mexico), planted in different location of the country, were almost disease free.

The 1975 International Corn Downy Mildew Nursery from Thailand has been only partially sown in a field in Maracay. Of the original list four entries had diseased plants while 14 were disease free. Of two corn inbred lines received from Texas, Tx 441 was not infected while Tx 601 was heavily diseased.

#### **Control methods practiced at present.** --

- Avoid planting corn and sorghum in fields that had been seriously affected in previous years.

- Rouge diseased plants in fields when very young. This is possible and useful when the percentage of diseased plants is low and it is required regulatory practice when the corn field is to be used for seed production.

- Destroy corn plants after harvest and before plowing in order to reduce the risk of incorporating more inoculum (mycelium and oospores) in the soil.

- Destroy *Sorghum* weeds as much as possible (specially false Johnsongrass) inside fields and along ditches and roads. In this case they can be controlled by herbicides.

- Realize the best cultural practices (good soil preparation, good and healthy seeds, etc.)

to promote quick germination and growth of seedlings in order to escape the disease.

- Use of the corn variety or hybrids that has shown less susceptibility. Our hybrid Arichuna has been discarded, giving preference to Baraure or Obregon, or Proseca 68.

- We are also advising farmers to treat their seeds with a seed protectant. This could possibly protect the germinating seed from germinating oospores though we have not real data on this.

**Work in progress.** — Beside the use of less susceptible hybrids, we have been producing seed of Philippine DMR 2 and DMR 6. These two cultivars have shown good adaptability and are distributed freely to farmers in the most affected areas.

In the Venezuelan corn breeding and improvement program the corn lines commonly used are Eto b2053, Eto bc244, 48-S-38 and 48-S-74. The last two lines (sicarigua and tuxpeno) are somewhat tolerant to the disease. The program is to cross the Phil. DMRs with the mentioned inbred lines, using the Venezuelan lines

as mothers, and then use the back-crossing method. We are at the second back-cross stage and, from there, we will plant an advanced generation to observe genotypic segregations. In  $F_1$  materials that we now have in the field, many cultivars (more than 200) are less affected than the mother Venezuelan lines or varieties.

Another program now in progress is the selection of more adapted lines from the DMR materials we have received from Thailand, Philippines, Taiwan, and CIMMYT, before crossing with our lines or varieties. This work has been done by different Institutions collaborating—Maracay and other locations—in Venezuela. Proseca, as gap solution, has made a cross using a normal simple hybrid as the mother and Phil. DMR 6 as the father parent. Foremaiz is using, for the same gap solution, Phil. DMR 2. The Genetic Department is also interested in studying the type of heredity, using resistant and susceptible lines. For the first ones, lines from DMRs 1 and 6 or Composite 1 and 2 have to be selected; as susceptible parents they will use Antigua Gr.2 and Eto b2053; and, as intermediate the Sicarigua lines 48-S-38 and 48-S-74.