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OBSERVATIONS AND EXPERIMENTS ON DISEASES OF PLANTS IN HYDERABAD STATE, INDIA

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Hyderabad State, which is also known as the Dominions of the Nizam, occupies a large part of the Deccan Plateau. The principal crops of the State are rice, cotton, castor bean, sugar cane, and sorghum. In its seedling stage rice is attacked by *Sclerotium rolfsii* and *Rhizoctonia solani* which cause stunting, yellowing, and withering of leaves. These diseases can be prevented by proper cultural practices. In later stages of its development rice is attacked by *Sclerotium oryzae,* causing stem rot. The panicles of the attacked plants are light and poorly filled, and there is a browning and darkening of the stem. The disease is observed to be more severe in fields where there is stagnant water. Warm moist weather seems favorable for the development of the disease. Various control measures have been tried, and the best seems to be to prevent standing water in the fields for a period of three to four weeks prior to maturity. Other preventive measures tried have been burning of the stubble after harvest, frequent ploughing, and the use of resistant varieties.

Rice blast, caused by *Piricularia oryzae,* causes the grains to become completely empty, with dark grayish spots on the surface. On the leaf blades and leaf sheaths small, pale, and somewhat watery spots, whose central part assumes a smoky or grayish color, extend through the tissues of the leaf. The infected stem in most cases collapses and breaks, and the heads hang downward. Preventive measures tried are (1) burning of infected plants, (2) seed treatment either with hot water or formalin, and (3) use of resistant varieties.

Cotton in its seedling stage is attacked by *Rhizoctonia* spp., causing root rot. Cotton wilt due to *Fusarium vasinfectum* is similar in nature to many other true wilt diseases. The parasite enters the roots and makes its way into the fibro-vascular bundles where it grows rapidly and spreads into the stem. Control of this disease lies in the use of resistant varieties. Some of the varieties now grown in the State are fairly resistant.

Castor is affected by leaf spot *(Cercosporina ricinella)* and rust *(Melampsorella ricini).* The leaf spots are visible on both surfaces, at first as minute black or brown points, which soon become surrounded by a pale green ring. As they enlarge, the center turns pale brown and then grayish white, and the margin forms a deep brown band. The spots occur in great numbers, scattered all over the leaf.

They are roundish when young, becoming angular at maturity. Castor leaves are used as a food for the Eri-silkworm, and as such the leaf spot and rust are more harmful, as the worms do not thrive when fed with diseased leaves. Control of these diseases consists in removing and burning the first-attacked leaves in order to check secondary infection.

On sugar cane, red rot *(Colletotrichum falcatum)* is the most destructive disease. Upper leaves of shoots approaching maturity begin to lose color and droop slightly. The leaves wither at the tips and margins, leaving the centers green. Later, the whole crown withers and droops. As the disease progresses, large patches can be seen with every stool destroyed. On splitting open a cane in the early stages of the disease, a rather sour smell may be noticed, and the tissues are found to be reddened in one or a few internodes, usually towards the base. This discoloration appears first in the vascular bundles but ultimately extends to much of the cane pith. Often definite red blotches, with a white center, transversely elongated, are found, which are characteristic of the disease. Cavities in the pith contain a cobweb-like growth of mycelium. In dry cane spore acervuli are produced on the rind surface. Infection spreads (1) by spores or mycelium from the outside, (2) through the soil, (3) air, or (4) irrigation water. Spores infect sound cane through wounds, exposing the pith, leaf scars, injured shoots, roots, eyes, and cut ends of sets. This disease is controlled by (1) using healthy sets for planting, (2) removing and burning of all withering clumps during the growing and ripening season, (3) rotation of crops from 5 to 9 years (5 years in light soils, and 9 years in heavy soils), and (4) using resistant varieties. Usually thin canes are more resistant than the thick canes.

On sorghum, the covered kernel smut *(Sphacelotheca sorghi)* is by far the most destructive disease. The loose kernel smut *(Sphacelotheca cruenta)* is also common, although it is not so destructive as the covered kernel smut. The life histories of both these smuts are alike, i.e., individual grains are attacked and transformed into a spore sac, usually conical in shape and measuring $\frac{1}{6}$ to $\frac{1}{2}$ inch in length and $\frac{1}{12}$ to $\frac{1}{6}$ inch or more in breadth. This is surrounded at the base by the unaltered glumes. The wall of the spore sac is composed of fungus tissue in the form of parenchyma of small cells, and only at the base is the wall composed partly of the tissues of the host plant. The wall in covered kernel smut is tough, rigid, and usually remains unbroken until after harvest, whereas in loose kernel smut it is much more transient and ruptures, exposing the spores before the head emerges from its sheath. The interior of the sac is completely filled with the spore powder, excepting a slender central column of hard tissues, the columella. Infection can only occur between the time of germination of the seed and the appearance of the seedling above ground. Spores are carried to the healthy seeds during threshing, and therefore these smuts are controlled by

seed treatment with sulphur dusts and copper carbonate at the rate of two ounces per bushel.

Head smut of sorghum *(Sorosporium reilianum)* occurs sporadically in every part of the State. The whole inflorescence is infected, and a large sorus normally occurs in place of each ear. The membrane, which consists of fungal cells, is transient and usually ruptures before the bud has emerged from its sheathing leaves, exposing the black spore masses. Seed treatment fails to prevent this disease, because the spores shed on the soil in large numbers remain alive and capable of germination when the next crop is sown. Early removal of attacked ears, before they shed their spores, and rotation have given fairly satisfactory control.

In some localities the three smuts mentioned above occur at the same time, and therefore the question of their hybridization is of importance both from a scientific and practical point of view. It is known from the work of Rodenhiser[1] that covered kernel smut *(Sphacelotheca sorghi)* and loose kernel smut *(Sphacelotheca cruenta)* can hybridize readily. The F_1 and F_2 sori resemble the sori of loose kernel smut. It is also known from the work of Tyler and Shumway[2] that covered kernel smut *(Sphacelotheca sorghi)* and head smut *(Sorosporium reilianum)* can hybridize, and the F_1 sori and chlamydospores are intermediate between those of the parents. The writer's experiments[3] have shown that different combinations of monosporidial lines of *Sphacelotheca sorghi* and *Sorosporium reilianum* produce smutted panicles in the sorghum plants, differing in size and shape. The length of the promycelia and sporidia of the hybrid are significantly greater than those of either of the parents, and this may be due to heterosis.

In order to determine whether loose kernel smut *(Sphacelotheca cruenta)* and the head smut *(Sorosporium reilianum)* can hybridize, experiments were made by the writer[4] at University Farm, St. Paul. Sporidia were isolated from the promycelia of germinating chlamydospores of *Sphacelotheca cruenta* and *Sorosporium reilianum*. Each monosporidial line was cultured in potato dextrose broth for about a week and injected hypodermically into five-week old sorghum seedlings. Five monosporidial lines of *Sphacelotheca cruenta* and seven of *Sorosporium reilianum* were injected singly and in paired combinations. None of the single lines caused infection, but 11 out of 18 paired combinations produced chlorosis on leaves in 8 to 12 days. Long sori developed in the inflorescences of the chlorotic

[1] Rodenhiser, H. A. Heterothallism and hybridization in *Sphacelotheca sorghi* and *S. cruenta*. Jour. Agr. Res. *45*:287–296. 1932.

[2] Tyler, L. J., and C. P. Shumway. Hybridization between *Sphacelotheca sorghi* and *Sorosporium reilianum*. (Abs.) Phytopath. *25*:375–376. 1935.

[3] Vaheeduddin, Syed. Hybridization and segregation in crosses between *Sphacelotheca sorghi* and *Sorosporium reilianum*. Unpublished Master's Thesis. University of Minnesota. 1935.

[4] Vaheeduddin, Syed. Hybridization between *Sphacelotheca cruenta* and *Sorosporium reilianum*. (Abs.) Phytopath. *26*:*111*. 1936.

TABLE 1. DIAMETERS OF CHLAMYDOSPORES AND LENGTHS OF SPORIDIA AND PROMYCELIA OF *Sphacelotheca cruenta, sorosporium reilianum,* AND THE HYBRID *(Sphacelotheca cruenta* × *Sorosporium reilianum), in microns.*

	Sphacelotheca cruenta	*Sorosporium reilianum*	Hybrid
Diameters of chlamydospores	5.9	11.5	8.8*
Lengths of sporidia	11.3	5.6	12.7*
Lengths of promycelia	25.2	27.3	79.0*

* Statistically significant.

plants. Different monosporidial combinations of the two species produced sori differing in shape and length. The hybrid chlamydospores are echinulate like those of *Sorosporium reilianum* and intermediate in size between both the parents. The chlamydospores germinate readily and produce promycelia bearing sporidia or numerous hyphal branches with few or no sporidia. The promycelia and sporidia are significantly larger than those of the parents (Table 1, Fig. 1), possibly due to heterosis.

Monosporidial lines isolated from the hybrid chlamydospores and inoculated singly and in different paired combinations produced chlorosis on the sorghum leaves and later sori in the inflorescences.

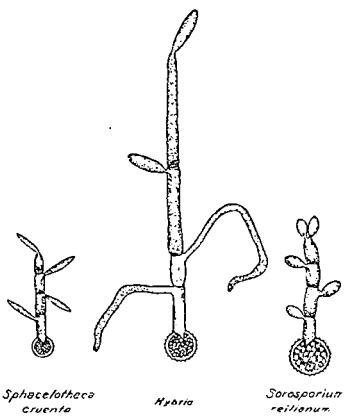

Fig. 1. Chlamydospores, promycelia, and sporidia of *Sphacelotheca cruenta, Sorosporium reilianum,* and the hybrid between *Sphacelotheca cruenta* and *Sorosporium reilianum.*

Monosporidial lines alone caused no infection. This shows that the hybrid is heterothallic and can cause normal infection.

Back cross trials of the hybrid with both of the parental lines indicate that the hybrid is interfertile and can unite with either of the parents and infect the host.

In conclusion it can be said that hybrid vigor, like that in higher plants, is evident in this intergeneric hybrid. It seems likely that many intergeneric crosses take place in nature, which may account to a considerable extent for the origin of new smut types and physiologic races.