ON A LOTUS ANTHRACNOSE NEW TO JAPAN

By

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I. Introduction

Lotus rhizome is one of the important vegetables in the Orient, especially in Japan. It is a very profitable crop on the delta regions and in low fields where drainage is so poor that to make them into paddy is almost impossible. The culture of lotus, however, has been disturbed by the outbreak of the rhizome rot, which has become in recent very prevalent in many parts of lotus growing regions. During the course of studies on the control of this rot, the authors have found a new anthracnose disease on lotus as reported below.

In July 1954, a disease differing from that of the rhizome rot was observed by Mr. Chuichi Takemasa, one of the larger commercial growers, in his fields at Tsurushinden, Tsurajima-cho, Kurashiki, Pref. Okayama. This disease was revealed by the writers to be an anthracnose on lotus, not previously reported in Japan.

II. Symptoms

The anthracnose disease of lotus appears at about the time of the rainy or so-called "tsuyu" season of July. In 1954, however, it was found toward the end of May and became very prevalent during the rainy season. When the rain was over, it became less prevalent and almost disappeared in August.

The infection occurs on most of the above ground parts of the lotus, and not on the rhizomes as they occur in the field. The lesion first appears from the apical end of young, still folded leaf, and becomes larger after unfolding. It also starts from the basal portion of the roll. (Fig. 1). Therefore, the lesions starting from the leaf margin, spread toward the center along the veins, becoming violet to black in color. Petioles are also attacked by the disease; in which case, they sometimes break or cause the leaves to droop. The lesions are violet to dark gray and finally become black, with the boundary remaining indistinct. In the fields, the general appearance of the anthracnose resembles that of the rhizome rot, but is not as destructive.

When the aerial portion of the lotus plant is attacked, the development

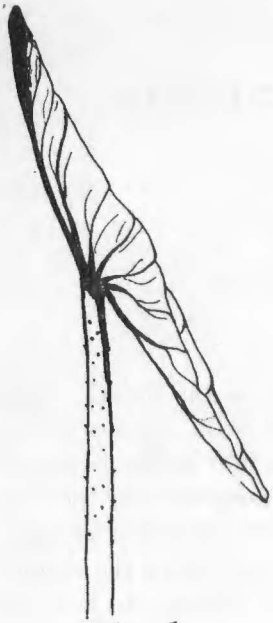
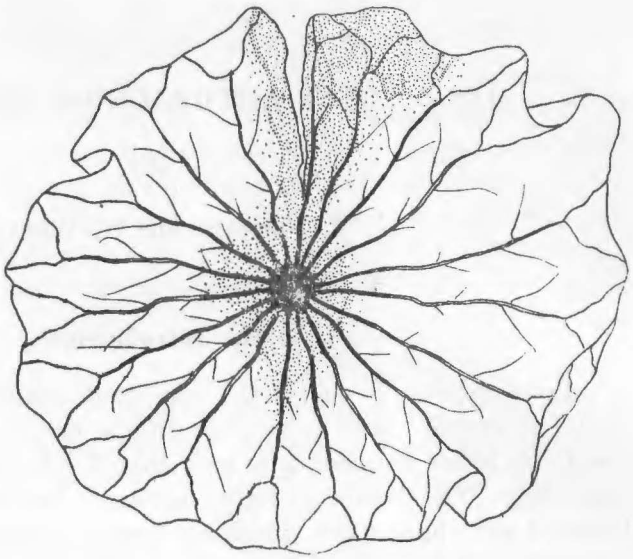


Fig. 1.



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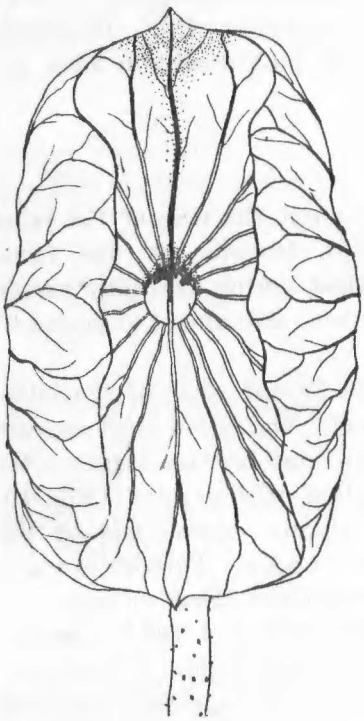

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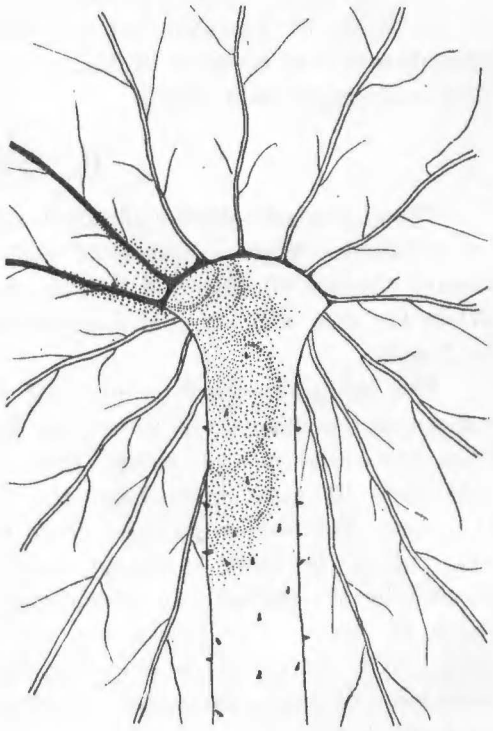

Fig. 4.

of the rhizome is greatly retarded. The writers' survey showed that the yield of rhizome in the diseased field was one third or even one fourth of the uninfected field.

The lesions bear, especially in moist weather, small, salmon-colored pustules or spore masses, concentrically arranged on the surface. These are formed chiefly on the upper side of the foliage, and rarely on the under side; but they may also occur on the leaf veins and the petioles.

III. Morphology of the Causal Fungus

The spore masses or acervuli formed on the lesions are salmon-colored, variable in size, 80—200μ in diameter (Fig. 5 and Plate II Fig. 9). They develop under the epidermis, but become exposed when ruptured. The conidiophores are hyaline, short rod-shaped with obtuse ends, and measuring

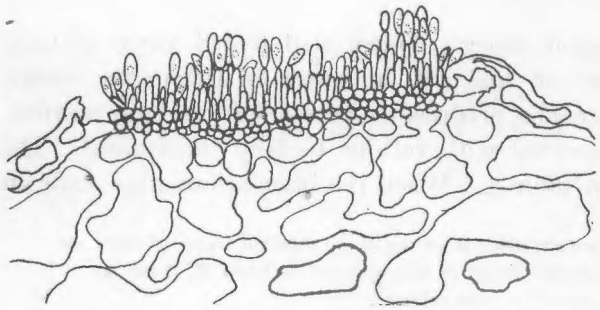

Fig. 5.

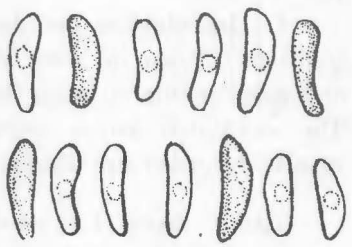

Fig. 6.

18—36μ in length and 2.5—4.5μ in width. There are no setae. The conidia are hyaline, continuous, cylindrical, fusoid or long ovoid, sometimes slightly curved to one side, ends rounded or somewhat pointed at one end. A clear vacuole-like body often occurs near the center. The conidia are 15.5—20.0μ (17.5μ average) in length and 3.25—4.8μ (3.75μ average) in width.

Explanation of Text Figures

Fig. 1. A young still folded leaf of lotus, affected by *Gloeosporium Nelumbii* F. Tassi. The infection takes place at the upper end of the leaf roll and spreads along the veins toward the center and then to the petiole.

Fig. 2. A young partly unfolded leaf of lotus, affected by *Gloeosporium Nelumbii*. In this leaf the disease lesions are shown at the margin of upper end and also at the center. Both lesions are connected by black discolored veins.

Fig. 3. Upper surface of a leaf, affected by *Gloeosporium Nelumbii* F. Tassi. Two large lesions are shown near the margin of the upper end and near the center of the leaf, both lesions being connected by discolored veins.

Fig. 4. Anthracnose lesions on the petiole and on the under surface of a leaf-blade of leaf, discolored veins being shown with heavy lines.

Fig. 5. An acervulus of the lotus anthracnose fungus, *Gloeosporium Nelumbii* F. Tassi, formed on a lotus leaf. (×300)

Fig. 6. Conidia of the lotus anthracnose fungus, *Gloeosporium Nelumbii* F. Tassi, showing various types of shape.

IV. Classification of the Causal Fungus

The morphological characteristics of the fungus in question classify it to the genus *Gloeosporium*. Among the *Gloeosporium* species, there is *Gloeosporium Nelumbii* Tassi, which was described on *Nelumbo nucifera* Gaertn., (*Nelumbium speciosum* Willd.) by F. Tassi in 1900 in Siena Botanical Garden, Italy. The description of the fungus coincides with the writers' fungus. Therefore, the fungus under consideration is here reported tentatively as *Gloeosporium Nelumbii* F. Tassi.

V. Pathogenicity

To ascertain the pathogenicity of *Gloeosporium Nelumbii* F. Tassi on lotus leaves, inoculation experiments were undertaken with the conidia produced in pure culture.

1. Inoculations on detached leaves: Young still folded leaves of lotus seedlings grown in pots were cut and put in water in Erlenmyer flasks, and were inoculated with the conidia produced on potato dextrose agar medium. The inoculated leaves were covered with bell-jar to keep them moist. The results recorded are shown in table 1. When the inoculations were made on

Table 1. *Results of the inoculation experiments on the young detached leaves of lotus set in bottles of tap water, with the conidia of Gloeosporium Nelumbii F. Tassi formed in pure culture.*

Incubation for		1 day	2 days	3〃	4〃	5〃	Formation of spore masses
Young still folded leaves (or roll of leaf)	Upper end	White mycelium was formed on the inoculum	±	+	||| |||	++
	Lower end	〃	±	+	++	|||	+
	Petiole	〃	±	+	++	++	+
Young unfolded leaves	Petiole	〃	±	+	++	|||	+
	Margin	?	—	—	±	|||	—
	Center	—	±	+	++	++	—

the upper or lower ends of the young rolls of leaves, traces of infection were observed after three days of incubation. After five days, more distinct lesions were observed. Some of the lesions bore characteristic salmon-colored spore masses. On the petioles, though it took somewhat longer, similar lesions were observed.

2. Inoculations on lotus seedling: Lotus seeds were treated with concentrated sulphuric acid for two days to soften and remove the hard outer walls. They were washed with water carefully and germinated in seed beds in sand. Young seedlings, grown in sand culture having 2 to 3 leaflets, were used for inoculations. The anthracnose conidia were smeared by a platinum loop to the upper and lower surfaces of the leaves and the petioles.

Table 2. *Results of the inoculation experiments to young leaves of lotus seedlings, with the conidia of Gloeosporium Nelumbii F. Tassi produced in pure culture.*

Incubation after				2 days	3 〃	4 〃	5 〃	Formation of stromata
Conidia was smeared	Young unfolded leaves	Upper surface	Margin	±	+	++	++	+
			Center	±	+	++	++	+
		Lower surface	Margin	+	+	++	++	+
			Center	+	+	++	++	+
	Young still folded leaves	Upper end		±	++	++	++	+
		Lower end		±	+	++	++	+
	Petioles			±	+	++	++	+
Conidia was sprayed	Unfolded leaves	Upper surface		−	−	−	±	−
		Lower surface		±	++	++	++	+
	Still folded leaves			±	+	++	++	+
	Petioles			±	++	++	++	+

Remarks: The formation of the spore masses was recorded after 5 days' incubation.

At the same time, a conidial suspension was also sprayed to the lotus seedlings. These results are shown in table 2.

From these results, the infection took place easily through the margins of young leaf and the petioles of lotus. But, the infection through the upper surface of the leaf seemed difficult, especially as with the case where conidia were sprayed on the upper surface. Waxy substance on the upper leaf surface seems to prevent the contact of the drops of conidial suspension with the leaf surface.

Summary

1. An anthracnose of lotus, *Nelumbo nucifera* Gaertn. caused by a species of *Gloeosporium* was found in the summer of 1954 at Tsurajima, Kurashiki, Pref. Okayama.

2. Up to the present, no *Gloeosporium* species have ever been reported on the lotus, not only in Japan but also in the Orient. In Italy, however, *Gloeosporium Nelumbii* F. Tassi was reported on lotus, *Nelumbo speciosum*, grown in the Siena Botanical Garden. As the writers' species of *Gloeosporium* is morphologically similar to the F. Tassi's description, it is reported with the name of *Gloeosporium Nelumbii* F. Tassi in this paper.

3. The lotus anthracnose infects mostly from the apical points of young, still folded leaf or the margin of a young unfolded leaf, and spreads to the central parts where it forms violet-brown lesions. On the lesion, many small, salmon-colored pustules of spore masses of *Gloeosporium* are formed concentrically.

4. Single spore cultures of the writers' *Gloeosporium* were isolated from the acervuli formed on lotus leaves. The conidia produced on the pure culture of potato decoction agar medium were inoculated to young, still folded

leaves, marginal parts of young unfolded leaves, their underside, and also the young petioles. After about a week's incubation, characteristic anthracnose lesions with salmon-colored spore masses were formed at the inoculated parts. Thus the pathogenicity of the present fungus in pure culture was established.

5. As to the physiological characters of this lotus *Gloeosporium* and the control measures, they will be reported in the future.

Explanation of Plates

Fig. 7. A lotus field attacked by the anthracnose disease. Diseased leaves are drooping and withering.

Fig. 8. A lotus leaf affected by the anthracnose. Yellow lesions towards the central part of the leaf.

Fig. 9. A part of a lotus leaf affected by the anthracnose. An advanced stage of the disease, one of the veins being distinctly discolored.

Fig. 10. A part of a lotus leaf affected by the anthracnose. A more advanced stage of the disease. The large lesion becomes dry and brittle.

Fig. 11. Conidia and conidiophores of the lotus anthracnose fungus, *Gloeosporium Nelumbii* F. Tassi, produced on potato dextrose agar medium in pure culture. (×450)

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Plate I

Fig. 7.

Fig. 8.

Plate II

Fig. 9.

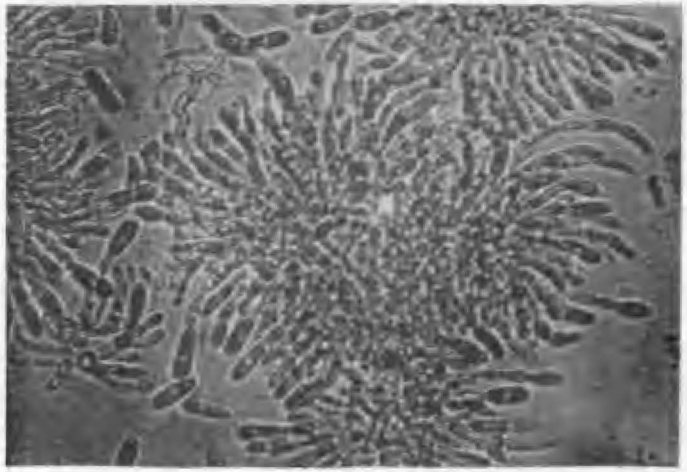

Fig. 11.

Fig. 10.