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Stem rot (*Sclerotium oryzae*) in rice crops on the southern region of Paraguay

Pudrición del tallo (*Sclerotium oryzae*) en cultivos de arroz en la región sur de Paraguay

Podridão do caule do arroz (*Sclerotium oryzae*) em lavouras de arroz no Paraguai

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Abstract

The expansion of rice cultivation in Paraguay observed in the last five agricultural seasons, together with the new technologies applied, has been accompanied by an increase in the presence of diseases affecting rice leaf sheaths and stems. In view of the scarcity of information in the country on some of these diseases, this study was carried out to characterise rice stem rot. Samples of symptomatic plants were collected from commercial lots located in the southern region of the country, and routine techniques in plant pathology for the study of mycoses were applied, such as macro and microscopic observations, *in vitro* sowings, and the study of morphological and cultural characteristics of the fungus. The pathogenicity of the fungus was determined by inoculations on healthy 50-day-old rice plants. Associated with the symptoms observed on rice pods and stems, the fungus *Sclerotium oryzae* Catt was identified as causing irregular black lesions on the leaf sheaths at the water line. As the disease progressed, it caused lesions on the sheaths and leaf blades, and finally stem rot with the formation of sclerotia inside the affected stems. The symptomatology observed in the rice plants and the cultural and morphometric characteristics of the pathogen *Sclerotium oryzae* were consistent with those reported in the bibliographical references analysed.

Keywords: *Oryza sativa*, Mycosis, Soil fungus.

Resumen

La expansión del cultivo de arroz en Paraguay observada en las 5 últimas campañas agrícolas, junto a las nuevas tecnologías aplicadas, ha sido acompañada por un aumento en la presencia de enfermedades que afectan vainas foliares y tallos de arroz. Ante la escasez de información en el país sobre algunas de ellas, se realizó este trabajo a fin de caracterizar a la pudrición del tallo de arroz. Se colectaron muestras de plantas sintomáticas de lotes comerciales localizados en la región sur del país, y se aplicaron técnicas de rutina en fitopatología para el estudio de micosis como observaciones macro y microscópicas, siembras *in vitro*, y estudio de características morfológicas y culturales del hongo. La patogenicidad del hongo se determinó mediante inoculaciones en plantas sanas de arroz de 50 días de edad. Asociado a los síntomas observados en vainas y tallos de arroz, se identificó al hongo *Sclerotium oryzae* Catt causando lesiones irregulares de color negro, en las vainas foliares a la altura de la línea de agua. Con el avance de la enfermedad, se produjo la lesión de las vainas y láminas foliares, y finalmente la pudrición del tallo con formación de esclerocios en el interior de los tallos afectados. La sintomatología observada en las plantas de arroz y las características culturales y morfométricas del patógeno *Sclerotium oryzae*, fueron coincidentes con los reportados por las referencias bibliográficas analizadas.

Palabras clave: *Oryza sativa*, Micosis, Hongo de suelo.

Resumo

A expansão da cultura do arroz no Paraguai tem sido acompanhada por um aumento na presença de doenças que afetam as vagens das folhas e os colmos do arroz. Dada a escassez de informações no país sobre alguns deles, este trabalho foi realizado para caracterizar a podridão do colmo do arroz. Foram coletadas amostras sintomáticas de plantas nas principais regiões produtoras do país e aplicadas técnicas de rotina em fitopatologia para o estudo da micose, como observações macro e microscópicas, sementeiras *in vitro* e estudo das características morfológicas e culturais do fungo. A patogenicidade do fungo foi determinada por inoculações em plantas de arroz saudáveis com 50 dias de idade. Associado aos sintomas observados nas panículas e caules do arroz, o fungo *Sclerotium oryzae* Catt foi identificado causando lesões pretas irregulares nas bainhas das folhas na linha de água, morte gradual das vagens com suas lâminas foliares e finalmente a apodrecimento do caule com formação de esclerócio preto e superfície lisa nos tecidos afetados. Os sintomas observados e as características culturais e morfométricas do patógeno *Sclerotium oryzae* foram consistentes com os relatados nas referências bibliográficas analisadas.

Palavras-chave: *Oryza sativa*, Micose, Fungo do solo.

Introduction

In recent years, the rice (*Oryza sativa* L.) production area of Paraguay has experienced a large growth in the sowing of the crop, due to the expansion of productive areas and increased yields (Enciso, 2020). This situation was also accompanied by the inclusion of crop management technologies such as fertilisation, planting dates, new rice varieties, etc. However, an increase in the presence of different fungal diseases that cause diverse symptomatology in different organs of the rice plant was also observed (Quintana et al. 2016, 2017). Among these pathologies, those caused by soil fungi were the ones that have given rise to numerous consultations from producers and technicians, due to the incidence values of these diseases in the different growing regions.

During the 2015-2018 cropping seasons, symptoms were observed on leaf sheaths and stems of rice plants associated with a fungus of the genus *Sclerotium*. The literature refers to *Sclerotium oryzae* Catt. as the causal agent of the disease called stem rot, first described by Cattaneo in 1876 in Italy (present as sclerotia on rice plants, and named *Sclerotium oryzae* Catt. and in its teleomorphic form on rice stubble as *Magnaporthe salvinii* (Catt.) Krause and Webster (= *Lepthosphaeria salvinii* Catt.). In 1889, Cavara identified the anamorphic stage in Italy, named *Nakataea sigmoidea* (Cav) Hara (= *Helminthosporium sigmoideum* Cav.) (Ou, 1985). This disease was detected in several rice production regions worldwide, including Japan, India, Vietnam and the Philippines in Asia; Italy in Europe; Kenya, Madagascar and Mozambique in Africa; Cuba in the West Indies; and Argentina, Brazil, Colombia, Guyana and Peru in Latin America (Ou, 1985; Martinez de la Parte et al., 2014; Pramesh et al., 2017; Aguilar-Ancota et al., 2017; Chethana and Kumar, 2019). The disease causes significant crop damage, with yield losses of up to 22% in California, 75% in Arkansas (Webster and Gunnell, 1992) and 5 to 80% in India (Kumar et al. 2003).

As far as Argentina is concerned, there are no studies related to yield losses. However, it has 100% prevalence and incidence values varying from 5 to 80% in the growing region (Gutiérrez et al. 2017).

Studies carried out by different authors worldwide affirm that the damage caused by this disease varies depending on climatic factors, crop management, susceptibility of the varieties, virulence of the isolates and time of infection (Kumar et al. 2003; Gopika et al. 2016b; Aguilar-Ancota, 2017).

Considering the regional and economic importance of rice cultivation in Paraguay, and the scarcity of information on this pathology, the aim of this study was to characterise the symptomatology and aetiology of rice stem rot.

Materials and methods

During the 2015-2018 agricultural seasons, samples of diseased rice plants of Irga 424, Irga 417, Irga 428 and Taim varieties were collected from different districts of the departments of Itapúa, Caazapá and Misiones. *In vitro* isolations were made with pieces of symptomatic rice leaf sheaths, previously disinfected with 1% sodium hypochlorite, on potato dextrose agar medium (1.5%, pH 6) and incubated in an oven at 25°C for 10-12 days (Alfenas and Gonçalves Maffia, 2007). Subsequently, the cultural characteristics of the colonies were analysed and the size of the sclerotia was determined by measuring 100 sclerotia with an optical microscope (400x).

The pathogenicity of the causal agent was determined by inoculations on healthy 50-day-old rice plants, raised in pots in greenhouses, using 15-day-old discs of culture medium containing inoculum (mycelium and sclerotia) which were placed on the leaf sheaths and incubated at 25°C.

Results and discussion

In samples of leaf sheaths from rice plants of Irga 424, Irga 417, Irga 428 and Taim varieties, symptoms characteristic of rice stem rot were observed in association with diseased tissues (Figure 1). Symptoms on the rice plants appear towards the middle of the tillering stage as irregular, black lesions on the leaf sheaths at the water line. As the disease progresses, lesions occur on the sheaths and leaf blades, with sclerotia forming inside the affected stems (Figure 2); at the end of the harvest, the sclerotia survive in the crop debris and in the soil, constituting the source of inoculum for the next crop cycle, mainly for no-tillage systems.

The fungus *Sclerotium oryzae* Catt. was isolated and identified by means of its cultural and morphometric characteristics, as well as the corresponding specific literature. In culture medium, the pathogen presents colonies with cottony aerial mycelium, greyish in colour (Figure 3; sclerotia develop around 7-9 days. Initially greyish-white, smooth, globose, or sub-globose, sometimes covered with hyphae; finally, when they completely cover the plate, they acquire their glossy black colour (Figure 4). Their measurements ranged from 150 to 260 μm . These cultural and morphometric characteristics were consistent with those observed in the corresponding specific literature, allowing the identification of the causal agent (Ou, 1985; Webster and Gunnell 1992; Beldarrain and Avila, 2009; Gopika et al. 2016a; Gopika et al. 2016b).

The inoculations reproduced the disease symptoms on leaf sheaths and stems of rice plants, which appeared about 10 days after the start of the tests. Re-isolation of the causal agent was achieved.

The symptomatology observed in rice plants and the cultural and morphological characteristics of the pathogen were consistent with those reported in the literature (Ou, 1985; Webster and Gunnell, 1992; Gopika et al. 2016a; Gopika et al. 2016b, Aguilar-Ancocota et al. 2017).



Fig. 1: Stem rot symptoms.



Fig. 2: Sclerotia formation in infected tissues.

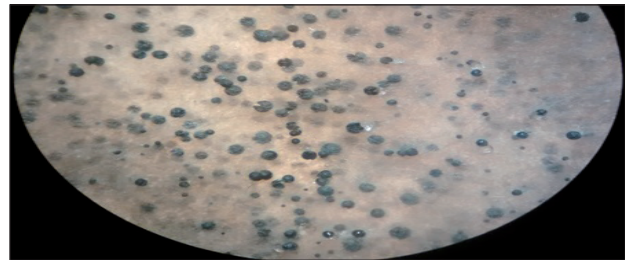


Fig. 3: Development of sclerotia on APG culture medium.

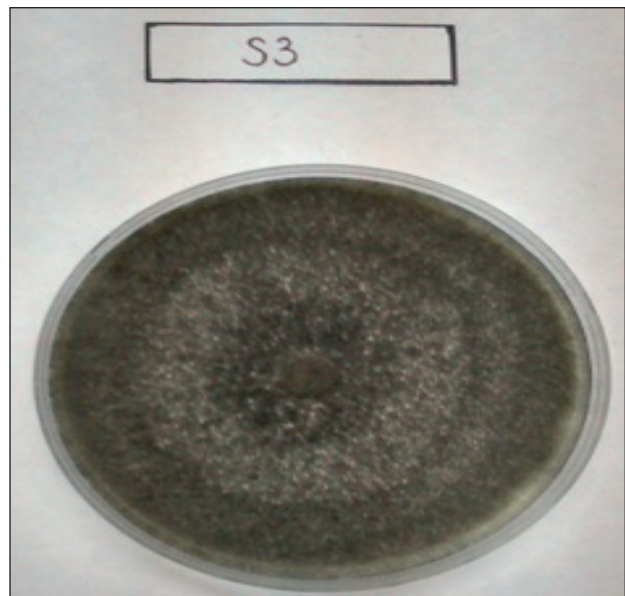


Fig. 4: Colony of *Sclerotium oryzae* on PDA.

Conclusions

It was possible to confirm that the symptomatology observed in rice plants and the cultural and morphometric characteristics of the pathogen correspond to the fungus *Sclerotium oryzae* Catt. The information generated in the present work will be useful for the control of the disease, considering that it is a fungus that survives in the soil and crop residues; it should also be complemented with an evaluation of the susceptibility of the varieties planted in the country.

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