



Microdochium albescens may affect the physiological quality of irrigated rice cultivar seeds

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ABSTRACT: Knowledge of the effect of the seedborne inoculum is important for knowing the level of tolerance of the pathogen by the seed. This research evaluated the effect of the incidence of the fungus *Microdochium albescens* on the physiological quality of the seeds of different cultivars of irrigated rice. The study was carried out in the seed testing laboratory (STL), phytopathology laboratory and in greenhouse, located at the Center of Agroveterinary Sciences of the Santa Catarina State University, Lages, SC, Brazil. Seeds from six irrigated rice cultivars produced in the Alto Vale do Itajaí Region in the 2016/17 harvest, were used. The lots were submitted to the seed health test, identifying four lots per cultivar with a natural incidence of *M. albescens*, with two lots of each cultivar with an incidence greater than 40% and two lots equal or less than 40%, totaling 24 seed lots. The following evaluations were carried out on the lots: germination, accelerated aging test, emergence in a greenhouse at 14 days, emergence speed index (ESI), emergence speed (ES), shoot length, root length and fresh and dry mass. There was a significant interaction between cultivar and level of incidence only in the variables germination, vigor and root length. Fresh mass, shoot length and ESI were not affected, regardless of cultivar and incidence of fungus in the seed. The irrigated rice cultivars SCS118 Marquês and SCSBRS Tio Taka are susceptible to a high incidence (> 40%) of the fungus *M. albescens*.

Key words: germination, *Oryza sativa*, seed pathology, vigor.

Microdochium albescens pode afetar a qualidade fisiológica de sementes de cultivares de arroz irrigado

RESUMO: O conhecimento do efeito do inóculo na semente é importante para conhecimento do nível de tolerância do patógeno pela semente. Objetivo deste trabalho foi avaliar o efeito da incidência do fungo *Microdochium albescens* sobre a qualidade fisiológica das sementes de diferentes cultivares de arroz irrigado. O estudo foi realizado nos laboratórios de análises de sementes (LAS), fitopatologia e na casa de vegetação, localizados no Centro de Ciências Agroveterinárias da Universidade do Estado de Santa Catarina, Lages, SC. Utilizaram-se sementes de seis cultivares de arroz irrigado produzidas na Região do Alto Vale do Itajaí na safra 2016/17. Os lotes foram submetidos ao teste de sanidade de sementes, identificando-se quatro lotes por cultivar com incidência natural de *M. albescens*, sendo designados dois lotes de cada cultivar com incidência superior a 40% e dois lotes igual ou inferior a 40%, totalizando 24 lotes de sementes. Foram realizadas as seguintes avaliações nos lotes: germinação, teste de envelhecimento acelerado, emergência em casa de vegetação aos 14 dias, índice de velocidade de emergência (IVE), velocidade de emergência (VE), comprimento de parte aérea, comprimento de raiz e massa seca. Houve interação significativa entre cultivar e nível de incidência apenas nas variáveis germinação, vigor e comprimento de raiz. A massa fresca, comprimento da parte aérea e IVE não foram afetados, independente do cultivar e incidência do fungo na semente. Os cultivares de arroz irrigado SCS118 Marquês e SCSBRS Tio Taka são suscetíveis à alta incidência (> 40%) do fungo *M. albescens*.

Palavras-chave: germinação, *Oryza sativa*, patologia de sementes, vigor.

Despite the productivity levels of irrigated rice in the state of Santa Catarina being among the highest in Brazil, in some years there is a decrease in yield due to adverse climatic and meteorological conditions that favor the occurrence of diseases (SOSBAI, 2018).

In southern Brazil, diseases known as brown spot (*Bipolaris oryzae* (Breda de Haan) Shoem) and scald (*Microdochium albescens* Thüm (Syn. *Microdochium oryzae* Hashioka & Yokogi; *Gerlachia oryzae* Hashioka & Yokogi) it has occurred with greater frequency (CELMER et al., 2007; LUDWIG et al., 2009).

The seeds are considered a source of primary inoculum (WEBSTER & GUNNELL, 1992), and are responsible for the dissemination of innumerable pathogens that cause important diseases in the rice culture (SILVA et al., 2014). *Microdochium albescens* is transmitted from seed to irrigated rice seedling (SCHEIDT et al., 2020) causing discoloration in the seedlings (GUTIERREZ et al., 2009).

Despite that, currently the importance of the health quality of rice seeds is underestimated due to the scarcity of studies that prove the real impact on the physiological quality and the performance of seedlings.

Health tests for irrigated rice seeds from Santa Catarina crops in the 2015 to 2018 harvests, carried out at the Phytopathology Laboratory of the Santa Catarina State University (CAV / UDESC) revealed a prevalence of 100% and an average incidence greater than 50% of *M. albescens* (data in press).

Therefore, the knowledge of the effect of the inoculum on the seed is important to know the level of tolerance of the pathogen by the seed and how much it compromises the performance of the seedlings. Therefore, this research evaluated the effect of the incidence of the fungus *M. albescens* on the physiological quality of seeds of different cultivars of irrigated rice.

The study was carried out in the seed testing laboratory (STL) and in the greenhouse, located at the Center of Agroveterinary Sciences of the Santa Catarina State University, Lages, SC, Brazil. Seeds of cultivars SCSBRS Tio Taka, Epagri 109, SCS116 Satoru, SCS118 Marquês, SCS121 CL and SCS122 Miura were used, produced in the Alto Vale do Itajaí in the 2016/17 harvest and supplied by the cooperative CRAVIL.

Several lots were submitted to the seed health test at the phytopathology laboratory, where the seeds were sown in BSA + A culture medium (Potato-Sucrose-AGAR + Antibiotic = 200 mg L⁻¹ of streptomycin sulfate). Seeds were disinfected with sodium hypochlorite solution (1%) for two minutes, with a subsequent rinse with distilled and sterile water. For each batch, four replicates of 100 seeds were analyzed. The seeds were placed in acrylic Petri dishes and kept in growth chambers for seven to ten days at 25°C and 12 hours photoperiod. Subsequently, four plots per cultivar with a natural incidence of *M. albescens* were identified, with two lots of each cultivar having an incidence greater than 40% and two lots equal to or less than 40%.

The general average incidence of lots below and above 40% were 30.5 and 84.0% (SCSBRS Tio Taka), 27.0 and 85.5% (Epagri 109), 30.5 and 84.5% (SCS116 Satoru), 14.0 and 70.0% (SCS118 Marquês), 16.0% and 73.0% (SCS121CL), 23.0% and 42.5% (SCS122 Miura).

For physiological quality tests carried out in STL, the seeds were initially disinfected in 1.5% sodium hypochlorite solution for 3 minutes, followed by washing with sterile water. Germination was performed with four replications of 100 seeds for each cultivar and incidence lower and higher than 40% of the fungus in the seed, on germitest paper moistened three times the weight of the dry paper, and taken to the germinator at 25°C (BRASIL, 2009).

The first count occurred at seven days and the final count at the fourteenth day, after sowing. At the end of the test, the number of normal seedlings, abnormal seedlings and dead seeds was recorded.

The accelerated aging test was conducted in germination boxes, using four replicates of 100 seeds for each cultivar, these separated into lots with an incidence above and below 40% of the fungus *M. albescens*. The seeds were arranged on a stainless steel grid over 40 mL of distilled and deionized water inside the gerbox boxes and kept in an accelerated aging chamber at 41°C for 120 hours (ZUCHI & BEVILAQUA, 2012). After that period, the seeds were disinfected and distributed in rolls of germitest paper, moistened with water three times its dry weight, and kept in a germinator at 25°C (KRZYZANOWSKI et al., 1991). Next, these same seeds were submitted to germination testing as described above.

The greenhouse emergence consisted of sowing four repetitions of 50 pre-germinated seeds of each cultivar and incidence in trays containing 5 cm of water. Pre-germination was performed by imbibing the seeds in water for 36 hours, followed by another 36 hours in the shade until growth stage "S2" (SOSBAI, 2018). The emergence index (EI), emergence speed (ES), emergence percentage at 14 days (E), shoot and root length and fresh and dry mass were evaluated.

The emergence index (EI) was determined by counting the number of emerged seedlings at the same time every day. At the end of the test, EI was calculated using Maguire's formula (1962).

$$EI = \frac{G_1}{N_1} + \frac{G_2}{N_2} + \frac{G_n}{N_n}$$

where: EI = emergence index; G = number of seedlings observed at each count; N = number of days from planting to counting.

The formula was applied for each repetition and the arithmetic mean was calculated after all the tests to obtain the EI of the seed lot. The evaluation of seed emergence can follow a dimension less proportionality

The emergence speed (ES) was also calculated based on the number of emerged seedlings observed at the same time every day, using the formula proposed by Edmond & Drapala (1958):

$$ES = \frac{(N_1 G_1) + (N_2 G_2) + \dots + (N_n G_n)}{G_1 + G_2 + G_n}$$

where: ES = emergence speed (days); G = number of seedlings observed at each count; N = number of days from planting to counting. The result was expressed in days.

Shoot and root length were measured in 20 plants per repetition using a digital pachymeter and the results expressed in millimeters. And after was determined the fresh mass plants through weighing on a scale and dry mass in an oven at 50°C for 48 hours, which were then weighed, and the results expressed in grams.

The experimental design used was completely randomized in a factorial arrangement. The germination and ESI averages were transformed by logRatio and chi-square, respectively, to meet homogeneity. Subsequently, they were subjected to Tukey test (5% significance) using the R software (R CORE TEAM, 2017), version 3.5.1.

There was a significant interaction between cultivars and level of incidence in the variables germination, vigor and root length. Germination of the lots with an incidence of fungus in the seed greater than 40% varied from 78% to 90%, while the lots with an incidence equal to or less than 40% varied from 82% to 89%. The cultivars SCSBRS Tio Taka and SCS118 Marquês had their germination affected negatively, differing statistically, presenting 78% and 81%, respectively (Table 1).

In the other cultivars there was no effect on the level of incidence of the pathogen. Unlike what was observed by PRABHU & VIEIRA (1989) who reported that the intensity of brown spot on seeds affects germination, presenting a negative linear relationship. MALAVOLTA et al. (2002) also observed that *B. oryzae* causing the brown spot negatively affects the germination of rice seeds.

The vigor due to accelerated aging of the lots with an incidence of fungus in the seed greater than 40% varied from 71% to 83%, while in the lots with an incidence equal to or less than 40% it varied between 63% to 85%. Only the cultivars SCS116 Satoru and SCS109 Epagri differed statistically, presenting 63% and 75% vigor, respectively, in the incidence of the fungus equal to or less than 40% (Table 1). This behavior may have occurred if the pathogen has infected a region close to the embryo, which would affect the performance of these seeds.

The greenhouse emergence of cultivars with an incidence of fungus in the seed greater than 40% varied from 99% to 95%, while in lots with an incidence equal to or less than 40%, they presented around 98%. Only the cultivar SCSBRS Tio Taka

Table 1 - Physiological performance and rice seedlings¹ with different levels of incidence the fungus *Microdochium albescens*.

Cultivar	IS	G (%)	AA (%)	E (%)	FM (gr)	SL (cm)	RL (cm)	EI	ES (days)
SCS122 Miura	> 40%	83 a ²	78 a	99 a	1.3 ns	22.4 ns	11.6 a	40.2 ns	1.5 a
	≤ 40%	82 a	81 a	100 a	1.2 ns	22.2 ns	11.4 a	43.0 ns	1.3 a
SCS118 Marquês	> 40%	78 b	81 a	99 a	1.3 ns	23.3 ns	13.5 a	42.5 ns	1.3 b
	≤ 40%	82 a	79 a	98 a	1.1 ns	22.5 ns	12.1 a	37.2 ns	1.6 a
SCSBRS Tio Taka	> 40%	81 b	83 a	95 b	1.1 ns	22.1 ns	10.1 b	38.9 ns	1.6 b
	≤ 40%	84 a	82 a	99 a	1.1 ns	23.0 ns	12.8 a	33.6 ns	1.9 a
SCS121 ClearField	> 40%	83 a	83 a	97 a	1.2 ns	22.6 ns	11.2 a	37.2 ns	1.6 a
	≤ 40%	89 a	85 a	99 a	1.1 ns	24.1 ns	10.2 a	37.8 ns	1.6 a
SCS116 Satoru	> 40%	87 a	71 a	100 a	1.2 ns	24.5 ns	10.6 a	35.2 ns	1.7 a
	≤ 40%	85 a	63 b	99 a	1.2 ns	22.9 ns	10.2 a	35.9 ns	1.6 a
SCS109 Epagri	> 40%	90 a	83 a	99 a	1.3 ns	22.0 ns	12.6 a	38.1 ns	1.6 a
	≤ 40%	87 a	75 b	98 a	1.3 ns	23.0 ns	11.7 a	35.4 ns	1.7 a
	CV (%)	7.1	7.2	2.8	17.0	9.0	16.2	11.8	17.7

¹IS (Incidence in the seed); G (Germination); AA (vigor by accelerated aging); E (Emergence); FM (fresh mass); SL (Shoot length); RL (Root length); EI (emergence index); ES (Emergence speed).

²Means followed by the small letter in the column do not differ in the cultivar by the Tukey test at 5%.

was negatively affected, with 95% emergence in an incidence greater than 40% (Table 1).

As observed in the cultivars SCS118 Marquês and SCSBRS Tio Taka, the presence of certain pathogens in the seeds can result in direct effects, such as a reduction in germination potential, vigor, emergence, storage period and even yield (ITO & TANAKA, 1993).

However, for the other cultivars there was no influence of the incidence of the pathogen on the physiological quality. As the fungus *M. albescens* has a greater capacity to infect the endosperm than the embryo (MANANDHAR, 1999; SCHEIDT, 2020 (data in press), which is the vital part of the seed, it manages to develop and form a normal seedling.

Fresh mass, shoot length and emergence index were not affected, regardless of the cultivar and incidence of the fungus in the seed (Table 1). Similar to that observed by MALAVOLTA et al. (2007) who also did not observe a significant difference in the height of seedlings infected with *B. oryzae*.

The root length in cultivar SCSBRS Tio Taka was compromised, differing statistically and showing a reduction to 10 cm of root in the incidence of the fungus in the seed above 40% (Table 1), indicating that the pathogen, in this case, limited the development of the seedling root, possibly due to its location in the seed.

The cultivars SCS118 Marquês and SCSBRS Tio Taka differed statistically in the emergence speed in the level of incidence of the fungus in the seed greater than 40%, presenting approximately 1.3 and 1.6 days respectively to emerge (Table 1). In these cultivars, the colonization of *M. albescens* in the seed endosperm may have been a physical barrier to seedling development, limiting the length of the root. However, there is an influence of the level of incidence of the pathogen *M. albescens* in the seed on the physiological quality.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

AUTHORS' CONTRIBUTIONS

BTS and RTC conceived and designed experiments. BTS and JG performed the experiments and the lab analyses. CMMC e JG performed statistical analyses of experimental data. BTS and JG prepared the draft of the manuscript. All authors critically revised the manuscript and approved of the final version.

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