EVALUATION OF THE ASSOCIATION OF 8-HYDROXYQUINOLINE WITH FUNGICIDES AGAINST PHYTOPATHOGENIC FUNGI IN RICE SEEDS

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Key words: *Fusarium graminearum*, *Fusarium meridionale*, seeds, rice, fungicides.

INTRODUCTION

In most countries, rice (*Oryza Sativa* L.) is one of the main components of people's diet and, due to its direct consideration as human food or indirectly as animal feed, it is considered one of the most important nutritious food crops in the world (VERMA & SRIVASTAV, 2020). The application of fungicides helps to reduce the incidence of *Fusarium* infection, also reducing the levels of mycotoxins in grains and rice seeds (SHISHATSKAYA et al., 2018).

Considering the importance of the economic impact caused by the contamination of grains by phytopathogenic fungi, and also the use of agricultural fungicides, evaluated the efficacy of Mancozeb (MZ), Difenoconazole (Score®) and 8-hydroxyquinoline (8-HQ) against *Fusarium graminearum* and *Fusarium meridionale in vivo* on rice seeds, with the aim of obtaining an agricultural fungicide developed in reduced concentrations that can reduce the damage caused to agriculture.

MATERIAL AND METHODS

Quantitative analysis of the incidence of *F. graminearum* and *F. meridionale* in rice seeds: rice seeds were obtained from IRGA (Rio Grandense Institute of Rice), in the city of Itaqui, Rio Grande do Sul, Brazil. Rice seeds of the variety BR/IRGA 409 were used. The preventive treatment was evaluated, where first the fungicide is applied, after 1 hour the seeds are infected and after 48 hours, 14 days are counted for the final reading. As for the curative treatment, the seeds are first infected, wait 48 hours, then apply the fungicide and count 14 days for the final reading (NEVES et al., 2009).

Permeation determination and histopathological evaluation: using tissue from adult male pigs, slaughtered at the Federal Institute of Santa Catarina - Concordia campus, the formation of tissue damage caused by the action of the MZ and 8-HQ was evaluated, where these animals were slaughtered following the rules of the Brazilian Ministry of Agriculture, Livestock and Supply (BRASIL, 2000).

RESULTS AND DISCUSSION

Quantitative analysis of the incidence of *F. graminearum* and *F. meridionale* in rice seeds*:* For curative treatments, the inoculum showed a total reduction in seed viability, providing minimum counts in all tests performed (Table 1 and 2) (Figure 1).

Table 1. Quantitative analysis evaluated in the curative treatment of rice seeds contaminated with *F. meridionale*

Samples	Concentration	Number of healthy seeds	Mean (120 seeds)

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***Fusarium meridionale* (Positive Control)**	2.5 X 10^5	0	0,00
DMSO	2%	12	3,00
MZ	2 g/L	70	17,50
MZ	0.5 g/L	61	15,25
8-HQ	0.25 g/L	65	16,25
8-HQ	0.031 g/L	58	14,50
Score®	2 g/L	90	22,50
Score®	0.5g/L	73	18,25
MHQ	2 g/L + 0.25 g/L	115	28,75
MHQ	0.5 g/L + 0.031 g/L	112	28,00
MHQ	0.25 g/L + 0.031 g/L	79	19,75
MHQ	0.125 g/L + 0.031 g/L	40	10,00
SHQ	2 g/L + 0.25 g/L	102	25,50
SHQ	1 g/L + 0.25 g/L	95	23,75
SHQ	0.5 g/L + 0.25 g/L	71	17,75
SHQ	0.25 g/L + 0.25 g/L	49	12,25

DMSO: Dimethylsulfoxide; MZ: Mancozeb; 8-HQ: 8-hydroxyquinoline; MHQ: Mancozeb + 8-hydroxyquinoline; SHQ: Score® + 8-hydroxyquinoline.

Table 2. Quantitative analysis evaluated in the curative treatment of rice seeds contaminated with *F. graminearum*

Samples	Concentration	Number of healthy seeds	Mean (120 seeds)
***Fusarium graminearum* (Positive Control)**	2.5 X 10^5	0	0,00
DMSO	2%	13	3,25
MZ	2 g/L	67	16,75
MZ	0.5 g/L	58	14,50
8-HQ	0.25 g/L	86	21,50o
8-HQ	0.031 g/L	58	14,5
MHQ	2 g/L + 0.25 g/L	117	29,25
MHQ	0.5 g/L + 0.031 g/L	113	28,25
MHQ	0.25 g/L + 0.031 g/L	95	23,75
MHQ	0.125 g/L + 0.031 g/L	51	12,75

DMSO: Dimethylsulfoxide; MZ: Mancozeb; 8-HQ: 8-hydroxyquinoline; MHQ: Mancozeb + 8-hydroxyquinoline.

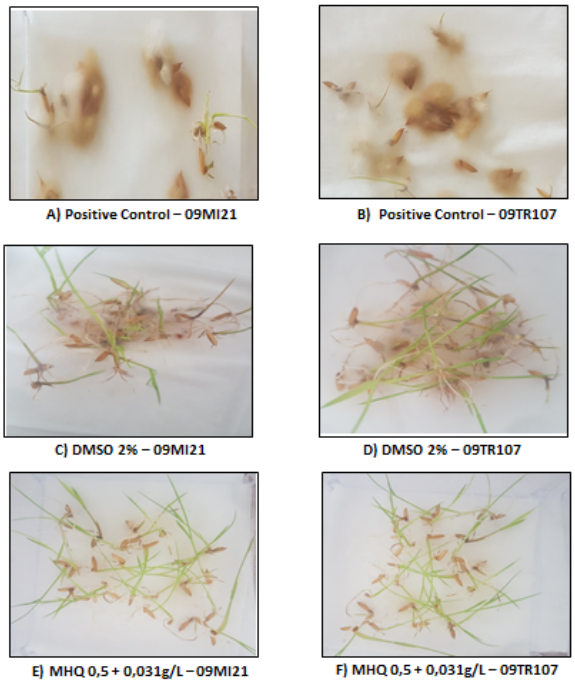

Figure 1. Curative treatment of rice seeds against fungal control and fungicide treatment. A) Control performed with the fungus *F. meridionale* (09Mi21); B) Control performed with the fungus *F. graminearum* (09TR107); C) Control performed with DMSO 2% with the fungus F. *meridionale* (09Mi21); D) Control performed with DMSO 2% with the fungus *F. graminearum* (09TR107); E) Test performed with the fungicides MZ + 8-HQ (MHQ) at a concentration of 0.5 + 0.031 g/L, with the fungus *F. meridionale* (09Mi21); F) Test performed with the fungicides MZ + 8-HQ (MHQ) at a concentration of 0.5 + 0.031 g/L, with the fungus *F. graminearum* (09TR107).

Among the samples tested, two treatments, and for both strains tested there was only no statistical difference between MZ (0.5 g/L) and 8-HQ (0.031 g/L) (P>0.9999). The MZ and 8-HQ at 2, 0.250, 5 and 0.031 g/L combinations were equally effective, probably due to a synergistic effect between these agents. For a preventive treatment of seeds (Figure 2), a similar effect is observed against *F. meridionale* on the combinations (Table 3). The preventive treatment performed for *F.*

graminearum showed that the associations were more efficient than the isolated treatments (Table 4). The two associations already important in the other examples with MZ and 8-HQ (2 + 0.25 and 0.5 and 0.031 g/L).

Table 3. Quantitative analysis evaluated in the preventive treatment of rice seeds contaminated with *F. meridionale*

Samples	Concentration	Number of healthy seeds	Mean (120 seeds)
***Fusarium meridionale* (Positive Control)**	2.5 X 10^5	0	0,00
DMSO	2%	15	3,75
MZ	2 g/L	115	28,75
MZ	0.5 g/L	109	27,25
8-HQ	0.25 g/L	99	24,75
8-HQ	0.031 g/L	80	20,00
Score®	2 g/L	116	29,00
Score®	0.5g/L	115	28,75
MHQ	2 g/L + 0.25 g/L	120	30,00
MHQ	0.5 g/L + 0.031 g/L	120	30,00
MHQ	0.25 g/L + 0.031 g/L	94	23,50
MHQ	0.25 g/L + 0.031 g/L	33	8,25
SHQ	2 g/L + 0.25 g/L	120	30,00
SHQ	1 g/L + 0.25 g/L	110	27,50
SHQ	0.5 g/L + 0.25 g/L	108	27,00
SHQ	0.25 g/L + 0.25 g/L	107	26,75

DMSO: Dimethylsulfoxide; MZ: Mancozeb; 8-HQ: 8-hydroxyquinoline; MHQ: Mancozeb + 8-hydroxyquinoline; SHQ: Score® + 8-hydroxyquinoline.

Table 4. Quantitative analysis evaluated in preventive treatment of rice seeds contaminated with *F. graminearum*

Samples	Concentration	Number of healthy seeds	Mean (120 seeds)
***Fusarium graminearum* (Positive Control)**	2.5 X 10^5	0	0,00
DMSO	2%	10	2,50
MZ	2 g/L	110	27,50
MZ	0.5 g/L	104	26,00
8-HQ	0.25 g/L	114	28,50
8-HQ	0.031 g/L	74	18,50
MHQ	2 g/L + 0.25 g/L	120	30,00
MHQ	0.5 g/L + 0.031 g/L	120	30,00
MHQ	0.25 g/L + 0.031 g/L	75	18,75
MHQ	0.125 g/L + 0.031 g/L	36	9,00

DMSO: Dimethylsulfoxide; MZ: Mancozeb; 8-HQ: 8-hydroxyquinoline; MHQ: Mancozeb + 8-hydroxyquinoline.

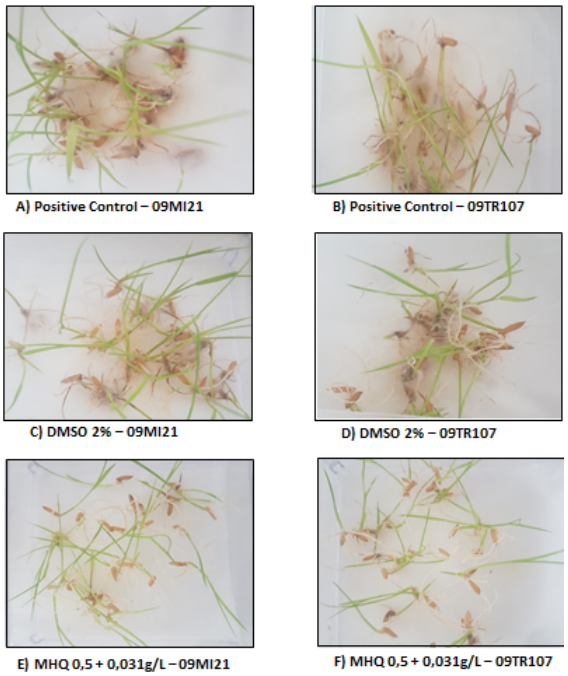

Figure 2. Preventive treatment of rice seeds against fungal control and fungicide treatment. A) Control performed with the fungus *F. meridionale* (09Mi21); B) Control performed with the fungus *F. graminearum* (09TR107); C) Control performed with DMSO 2% with the fungus *F. meridionale* (09Mi21); D) Control performed with DMSO 2% with the fungus *F. graminearum* (09TR107); E) Test performed with the fungicides MZ + 8-HQ (MHQ) at a concentration of 0.5 + 0.031 g/L, with the fungus *F. meridionale* (09Mi21); F) Test performed with the fungicides MZ + 8-HQ (MHQ) at a concentration of 0.5 + 0.031 g/L, with the fungus *F. graminearum* (09TR107).

In the dermal toxicity test (Figure 3), it is possible to observe that all the treatments (MZ, 8-HQ and our combinations) have a histopathological profile different from the positive control of tissue damage (NaOH) and similar to the negative control (PBS). This test showed no apparent microscopic lesions, even at higher concentrations.

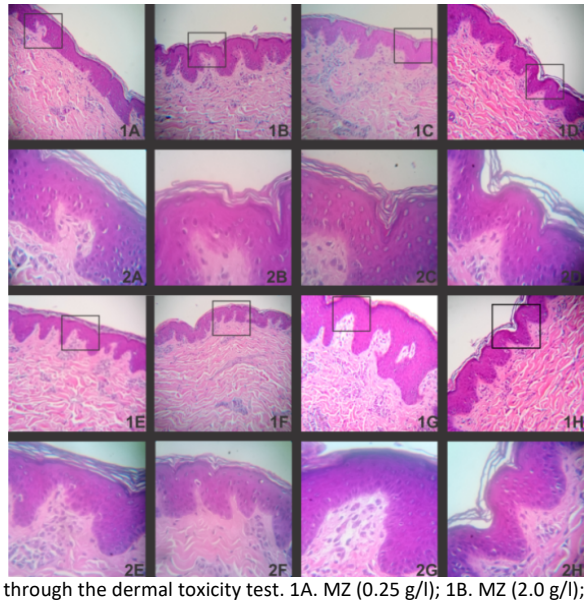

Figure 3. Histopathological evaluation through the dermal toxicity test. 1A. MZ (0.25 g/l); 1B. MZ (2.0 g/l); 1C. 8-HQ (0.031 g/L); 1D. 8-HQ (0.25 g/L); 1 AND. MZ + 8-HQ 0.5 and 0.031 g/L, respectively); 1F. MZ + 8-HQ (at concentrations of 2.0 and 0.25 g/L, respectively); 1G. PBS (negative control); 1H. NaOH (positive damage control).

CONCLUSION

It was possible to satisfactorily observe the effectiveness of the associations, and especially of MZ with 8-HQ (0.25 g/L + 0.031 g/L), allowing us to approach an effective and safe product. Which will be available in the market in the future, to its use as a fungicide, being able to either treat infection by *F. graminearum* and *F. meridionale* or prevent it from occurring.

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