NOTAS CIENTÍFICAS

Assessment of grain discoloration in the main rice genotypes of Corrientes Province, Argentina

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ABSTRACT

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Rice grain discoloration affects grain yield and quality. Corrientes is the main rice producing province in Argentina. Previous studies were carried out in this province, where only panicle incidence (PI) was evaluated. In view of the need to obtain more agronomic parameters to more exhaustively investigate the effects caused by this disease, the present study was carried out to evaluate panicle incidence (PI), percentage of discolored grains per panicle (GD), weight loss (WL), disease severity index (DSI) and sterility (S) in eight rice genotypes. Although PI and GD are estimated as disease incidence, both were significantly different. GD is obtained by the grain-by-grain evaluation, while PI considers a panicle diseased when the latter presents at least one spotted grain; thus, this last method overestimates the disease incidence. The genotype IRGA 424 recorded maximum and minimum GD and S values, which may be explained by different sowing dates in different regions in the province, with their corresponding environmental conditions during the critical period of the infection and during spikelet formation. WL and DSI had lower values than those reported by other authors, which indicates that the effects of rice grain discoloration on these parameters in Corrientes Province, Argentina, are less severe than in other rice cultivating countries.

Keywords: *Oryza sativa*, grain discoloration, weight loss, severity, sterility.

RESUMO

Dirchwolf, P.M.; Gutiérrez, S.A.; Carmona, M.A. Avaliação da descoloração de grãos nos principais genotipos de arroz da provincia de Corrientes, Argentina. ***Summa Phytopathologica,*** v.44, n.3, p.271-273, 2018.

Manchas de grãos de arroz afeta o rendimento e qualidade do grão. A província de Corrientes é o principal produtor de arroz da Argentina. Estudos anteriores foram realizados nesta província, onde apenas a incidência de panícula (PI) foi avaliada. Tendo em vista a necessidade de obter mais parâmetros agronômicos para investigar de forma mais exaustiva os efeitos causados por esta doença, o presente estudo foi realizado onde o por cento de panículas doentes (PI), a percentagem de grãos manchados por panícula (GD), a redução de peso (WL), a severidade (DSI) e a esterilidade (S) foram avaliadas em oito genótipos de arroz. Embora o PI e o GD sejam estimados como incidência de doença, ambos foram significativamente diferentes. GD é obtido pela avaliação grão por grão, enquanto PI considera uma panícula como doente quando apresentou pelo menos um grão manchado, então esse último método está superestimando a incidência da doença. O genótipo IRGA 424 registrou valores máximos e mínimos de GD e S, o que pode ser explicado por diferentes datas de semeadura em diferentes regiões da província, com as respectivas condições ambientais durante o período crítico da infecção da doença e também durante a formação de espetáculos. WL e DSI registraram valores mais baixos do que os relatados por outros autores, o que nos faz inferir que os efeitos da descoloração do grão de arroz nesses parâmetros na província de Corrientes, na Argentina, são menos severos do que em outros países cultivados com arroz.

Palavras-chave: *Oryza sativa*, manchas de grãos, perda de peso, severidade, esterilidade.

Grain discoloration, caused by various fungal pathogens, including *Bipolaris, Alternaria, Phoma, Curvularia* and *Microdochium* as the most important genera*,* is considered one of the major rice diseases worldwide (3, 8). The discoloration may appear externally on the glumes or internally on the kernels, or both. This disease leads to reduced seed viability and grain quality (8). According to Singh (9), favorable environmental conditions for the development of rice grain discoloration are intermittent rainfall and a low light period during four weeks prior to flowering. This period overlaps with the spikelet formation critical period, which is approximately 21 days before panicle formation (10). The cultivated rice area in Corrientes Province (Argentina), the main producer of the country, was 88,341 hectares during the 2015/2016 season (1). Rice cultivation develops in four different regions in the province, characterized by different soils and weather conditions (1), and therefore there are different sowing dates according to the region. Previous studies were carried out in this province, evaluating only the percentage of diseased panicles (PDP) or panicle incidence (PI) as an agronomic variable; a panicle was considering diseased when presented at least one spotted grain (3, 4). In view of the need to obtain more agronomic parameters to more

exhaustively investigate the effects caused by this disease, the present study was carried out, focusing on the percentage of grain discoloration, severity, sterility and associated weight loss.

Forty-three samples of eight different genotypes (Gurí INTA CL, Puitá INTA CL, IC107, IC 110, Taim, Yeruá, IRGA 424 and INOV) harvested from 11 locations of Corrientes Province (Itá Ibaté, Ramada Paso, Empedrado, Saladas, Santa Lucía, San Roque, Mercedes, Curuzú Cuatiá, Paso de los Libres, La Cruz and Santo Tomé) were evaluated. Each sample consisted of 50 panicles from 50 plants in dough/ mature grain stage (5) randomly selected from commercial lots. The following parameters were evaluated: Panicle incidence (PI) (%) (5); Grain discoloration (GD) (%) = (number of discolored grains per sample / total grains per sample) x 100 (2); Weight loss (WL) (%) = ((Wt. of healthy grains – Wt. of discolored grains)/ Wt. of healthy grains) x100 (2); Sterility (S) (%)= (number of empty grains in sample/ total grains per sample) x100 (6); Disease severity, determined in a 100 grain sample, using the Malavolta *et al.* scale, (6), where: 0= symptomless, 1= glumes with small spots, "pinhead" type, 2= Spots reaching up to 25% of the grain surface, 3= spots reaching 26-50% of the grain surface, 4= spots that exceed 50% of the grain surface. The disease severity index (DSI) was calculated by using the formula: ISE = Σ (Grade x Frequency) / total number of grains.

As shown in **Table 1,** PI presented higher values (96.09%) than those recorded by Gutiérrez & Cúndom (3, 4), who observed that rice grain discoloration had 10 to 70% incidence in the 2009-2012 growing season in Corrientes Province, as well as in the 2014-2015 season, when mean values of 50.91% were recorded for genotypes collected in the same region (1).

Considering PI according to the genotype, the values obtained for the 2015-2016 season are comparatively higher than those in the previous reports (3,4,1), since an average of 48.3% was observed in Gurí INTA CL, in comparison with the current percentage (93.34%). IRGA 424 presented 94.79% PI, in contrast with 52.75% exhibited in the 2014-2015 season, while IC107, IC110 and Taim showed 99.80%, 88.10% and 100% in the latest period, in comparison with the lower values of the previous reports (3,4,1) (54.9%, 77.1% and 36.15%, respectively) (1).

However, since one single spotted grain is enough to consider a panicle diseased, we may have overestimated the disease. For that reason, the percentage of grain discoloration (GD) was calculated. The genotype IRGA 424 (mean value of 23.48%) recorded maximum discolored seeds (52.20%), which exceeds the maximum found by Bodalkar & Awadhiya (2) for Kranti variety (32.95%), and the highest percentage of the 10 Indian genotypes evaluated by these authors. The minimum value was also found affecting IRGA 424 (3.30%); this was the most sown genotype during the 2015-2016 season in Corrientes Province (45% of the area) (1), and the extreme values are probably due to the fact that the crop was developed all over the province, in areas with different weather characteristics, according to different sowing dates (1), and therefore different environmental conditions during the critical period for the infection and during the spikelet formation, which is the rice crop critical period (9, 10).

To compare the methods used to calculate the disease incidence (PI and GD), a paired sample T-test was performed, with 0.01% probability. For all genotypes, the results between the PI and the method proposed by Bodalkar & Awadhiya (2), (GD), were significantly different. Although the conventional method is faster and simpler, grain-by-grain evaluation is preferred in order to obtain more accurate data.

Seed discoloration badly affects seed development and may cause weight loss (2). Weight loss (WL) in discolored seeds was maximum for Yeruá genotype (15.83%) but lower than the ones reported by Bodalkar & Awadhiya (2), who obtained 24.90% as the highest value, and smaller than those found by Misra & Vir (7), which were between 31.2 and 50.2%.

Regarding S, the mean value for all evaluated genotypes was 40.62%; however, very dissimilar minimum and maximum values (2.59 and 94.80%) were observed for the variety IRGA 424. Nevertheless, the mean values of this variable are not significantly different according to area, locality or place (based on a Ducan test, with 5% probability), which suggests that the found differences are due to the effect of different sowing dates and their corresponding environmental conditions during the critical period of the infection and the spikelet formation.

As regards disease severity, considering the affected surface of each discolored grain, used to obtain the DSI, results were between 0.09 and 1.12, on a scale ranging from 0 to 4. These values are lower than those found by Velozo & Gutiérrez (11), who reported DSI between 1 and 2, and even smaller than those observed by Malavolta *et al.,* (6), who studied 36 genotypes used in Brazil in the 2002/2004 season, and obtained minimum and maximum DSI values of 1.28 to 2.01 and 1.40 to 2.65, respectively.

Linear correlation analysis showed highly significant correlation coefficients ($P < 0.01$) between S and GD ($r = -0.58$), and significant correlation between S and WL ($r = 0.31$), among the evaluated genotypes ($r = 0.36$).

The conventional method to calculate disease incidence in panicles (PI) (5) is faster and simpler, but the method proposed by Bodalkar & Awadhiya (2), (GD), is preferred since evaluation is done grain by grain, which therefore yields more accurate data.

Linear correlation analysis showed highly significant correlation

Table 1. Effects of rice grain discoloration. Mean values and standard error of agronomic parameters: Panicle incidence (PI) (%), Grain discoloration (GD) (%), Weight loss (WL) (%), Sterility (S) (%) and Disease severity index (DSI) of eight rice genotypes.

Genotype	Panicle incidence (%)	Grain discoloration (%)	Weight loss (%)	Sterility (%)	Severity disease index
Gurí INTA CL	93.34 ± 8.1	15.24±7.2	2.01±1.3	41.48±23.8	0.44±0.3
IC 107	99.80±0.3	34.70±1.8	2.04±0.8	34.25±10.7	0.74±0.2
IC 110	88.10±16.8	9.21±0.6	5.28±5.1	52.80±24.3	0.18±0.1
IRGA 424	94.79±13.1	23.48±14.8	5.94±4.2	35.61±21.6	0.60±0.3
Puitá INTA CL	99.50±1	13.55±5.8	3.59±4.2	52.23±27.5	0.66±0.4
Taim	100±0	31.27±7	5.47±1.9	25.33±9.3	0.68±0.4
Yeruá	97.85±3	23.70±1.6	11.69±5.8	48.85±15.3	0.63±0.4
INOV	98.18±2.7	17.06±7.2	8.36±12.6	47.44±23.4	0.44±0.1

coefficients between S and GD; in addition, the maximum and minimum values of GD and S were found for genotype IRGA 424. This genotype was sown in 45% of the cultivated area of Corrientes Province, being most used in the 2015-2016 period. We believe that the differences found in the evaluation of this genotype are due to the effect of different sowing dates in different regions and their corresponding environmental conditions both during the critical period of the infection and during spikelet formation.

The maximum WL recorded in this study was lower than the ones reported by Bodalkar & Awadhiya (2) and Misra & Vir (7); similarly, the reported DSI values were smaller than the ones obtained by Malavolta et al. (6). Although we found high GD values, the lower WL values, which consider the weight of discolored and healthy grains, and the smaller surface obtained in the DSI analysis indicate that the effects of rice grain discoloration on these parameters in Corrientes Province, Argentina, are less severe than in other rice cultivating countries.

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