Cultivar response to fungicide application in relation to rice blast control, productivity and sustainability[1]

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Abstract – Four field trials were conducted, from 1995 to 1997, with the objective of studying the response of four upland cultivars to foliar fungicide application in relation to panicle blast control, grain yield and sustainability. Differential disease control and yield response of cultivars to fungicide treatment were obtained. Losses in grain yield of cultivars IAC 202, Caiapó, Rio Paranaíba and Araguaia due to panicle blast were 44.8%, 27.4%, 24.4% and 18.2%, respectively. Two applications of tricyclazole or benomyl controlled panicle blast, as indicated by lower values of disease progress curve and relative panicle blast severity, and increased grain yield of the cultivar IAC 202. The losses in 100 panicle grain weight and grain yield were significantly reduced by 22.3% and 25.1% in IAC 202 and 23.6% and 20.5% in Caiapó, respectively, with two sprays of tricyclazole. Sustainable value index for yield was maximum with two applications of tricyclazole (0.59), followed by one application at booting (0.46) and at heading (0.40) in cultivar IAC 202. Results showed no yield response of the cultivars Rio Paranaíba and Araguaia to fungicide applications for panicle blast control.

Index terms: *Oryza sativa*, yield factors, pest control, chemical control.

Resposta de cultivares de arroz à aplicação de fungicidas em relação ao controle da brusone nas panículas, produtividade e sustentabilidade

Resumo – Foram realizados quatro experimentos no campo, de 1995 a 1997, com o objetivo de estudar a resposta das cultivares de arroz de terras altas à aplicação de fungicidas foliares, em relação ao controle da brusone nas panículas, produtividade e sustentabilidade. Foram obtidas respostas diferenciais das cultivares às aplicações de fungicidas quanto ao controle da brusone e produtividade. As perdas em produtividade, causadas pela brusone, nas panículas, foram de 44,8%, 27,4%, 24,4% e 18,2% nas cultivares IAC 202, Caiapó, Rio Paranaíba e Araguaia, respectivamente. Os valores da área sob curva de progresso da doença e da severidade relativa da brusone nas panículas foram menores, resultando em aumento de produtividade com duas aplicações de tricyclazole ou benomyl na cultivar IAC 202. As perdas quanto ao peso de 100 panículas e produtividade foram 22,3% e 25,1% na IAC 202, e 23,6% e 20,5% na Caiapó, respectivamente, com duas aplicações de tricyclazole. O valor do índice de sustentabilidade para produtividade foi máximo (0,59) com duas aplicações de tricyclazole, seguido por uma aplicação no emborrachamento (0,46) e na emissão de panícula (0,40) na cultivar IAC 202. Houve ausência de resposta das cultivares Rio Paranaíba e Araguaia às aplicações de fungicidas no controle da brusone nas panículas em relação à produtividade.

Termos para indexação: *Oryza sativa*, fatores de rendimento, combate às pragas, controle químico.

Introduction

Grain yield loss due to rice blast caused by *Pyricularia grisea* (Cooke) Saccardo [= *Magnaporthe grisea* (Hebert) Barr] is directly related to the cultivar susceptibility, cultural practices and the prevailing climatic conditions. Improved rice cultivars, such as IAC 202 and Caiapó, are superior in grain quality to Rio Paranaíba and Araguaia but susceptible to blast (Prabhu & Filippi, 2001). There has been considerable emphasis on the integrated rice blast control including fungicides as one of the inputs to keep the disease at tolerable levels (Filippi & Prabhu, 1997a). The economic viability of disease control largely depends upon potential of the pathogen to

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cause significant yield reduction. The indirect and direct effects of leaf and panicle blast, respectively, complicate the quantification of loss estimates (Pinnschmidt et al., 1994). Leaf blast in upland rice reaches maximum disease severity 25 to 40 days after seeding and gradually decreases as the resistance of the newly formed leaves increases with age. It affects growth and development resulting in total death of many plants, when an epidemic starts earlier, in late sown plantings (Filippi & Prabhu, 1997b).

Controlled greenhouse inoculations with *P. grisea* have shown that leaf blast, in addition to reducing the amount of green leaf area, decreases the photosynthetic rate of the infected leaves which in turn results in significant reduction in spikelet number and 1,000 grain weight (Bastiaans et al., 1994). Panicle or neck blast first appears seven to ten days after heading and continues to increase until maturity. Positive and linear relationships between panicle blast severity and yield loss have been established (Prabhu et al., 1989; Torres & Teng, 1993). While the seed treatment is one of the recommended components in the blast disease management, one or two applications of foliar fungicide are applied to prevent the panicle blast. A number of fungicides possessing systemic activity are available in the market and are reported to control the panicle blast. Previous studies have shown that one spray at the heading is economical in upland rice on susceptible traditional cultivars (Prabhu et al., 1990). However, there is no information on their efficacy, the timing and number of applications required with reference to rice cultivars, improved for grain quality. An integrative concept of blast management that recognizes the concern for sustainability needs to be developed (Teng, 1994). The fungicide treatment that guarantees superior yield over a range of environments and disease severities may be considered as a sustainable disease management practice under upland conditions.

The objective of this work was to study the response of four upland rice cultivars to foliar fungicide application in relation to panicle blast control, grain yield and sustainability.

Material and Methods

Four field trials were conducted, two of them in 1995/96 and the others in 1996/97 rice growing seasons, at Embrapa-Centro Nacional de Pesquisa de Arroz e Feijão, Santo Antônio de Goiás, GO, Brazil, on a Dark-Red Latosol. The layout of the experiments was a randomized complete block design with four replications. The treatments consisted of four upland rice cultivars (Araguaia, Caiapó, IAC 202, Rio Paranaíba) and eight fungicide foliar applications at booting and heading of rice, corresponding to growth stages 5 and 6, respectively, according to the Standard Evaluation System for rice (International Rice Research Institute, 1988). Fungicide treatments were nontreated control (1), and application of tricyclazole at booting (2), tricyclazole at heading (3), tricyclazole at booting and heading (4), tebuconazole at booting (5), tebuconazole at heading (6), tebuconazole at booting and heading (7) and benomyl at booting and heading (8), arranged in a split-plot scheme. Cultivars and fungicide foliar treatments were assigned to main plots and subplots, respectively.

Each subplot consisted of six rows, 5.0 m long and spaced 0.35 m. Plots were fertilized at planting with 400 kg/ha of 4-30-15 (N, P and K) in addition to 25 kg/ha of N in the form of ammonium sulfate, 20 kg/ha of zinc sulfate and 20 kg/ha of micronutrients FTE BR-12 (Ferro Enamel do Brasil Ind. Com. Ltd., São Paulo, Brazil).

Seeds were drill planted in plots at the rate of 40 kg/ha, on December 13, 1995 (Experiment I), January 15, 1996 (Experiment II), November 27, 1996 (Experiment III) and December 26, 1997 (Experiment IV). Fungicide was applied as foliar sprays in 200 L/ha of water with CO_2 pressurized backpack sprayer with a constant boom pressure of 18.12 kg/cm^2. Tricyclazole, tebuconazole and benomyl were administered each at the rate of 0.250 kg/ha of a.i.

Two and a half-meters observational row units, in each one of the two central rows were demarcated for panicle blast assessment. All panicles in each one of the two observational row units were evaluated using a six-grade scale (0%; 5%; 25%; 50%; 75% and 100% infected spikelets/panicle) at three to four-day intervals. Five observations were made starting seven days after heading. The mean percentage of panicle blast severity (PBS) was calculated based on 100 panicles per treatment using the formula: PBS (%) = Σ (class value x class frequency)/total number of panicles of the sample.

One hundred panicle grain weight was determined with panicles harvested in two observational units of each plot. These panicles were threshed, bulked the grain, and weighed. The unfilled grains were separated manually by winnowing and weighed again. The central 6.0 m^2 plots were harvested and grain yield (kg/ha) was adjusted at 13% moisture.

Area under disease progress curves (AUDPC) were computed from each subplot treatment according to Shaner & Finney (1977). The panicle blast epidemic was considered to start at zero level, seven days after heading. The values represent panicle blast epidemic and the total damage caused by disease during the grain formation stage, starting seven days after heading to maturity. Log transformation of data was performed to reduce the heterogeneity of variance because of the association between mean and standard deviation. Analysis of variance (ANOVA) was made with the transformed values.

Relative panicle blast severity (RPBS) was assessed as a proportion of maximum observed plot yield of respective cultivars by the formula RPBS = D_t/D_{max}, where D_t is the terminal disease in the test plot and D_{max} is the maximum disease in the block to obtain values ranging from zero to one. Similarly, relative grain yield (RGY) was determined by the formula RGY = GY_t/GY_{max}, where GY_t is the absolute yield of test plot, and GY_{max} is the highest yield in the block of the respective cultivar.

The loss in 100 panicle grain weight (LGW) and the loss in grain yield (LGY) were calculated as follows: LGW(%) or LGY(%) = (total weight of filled and unfilled grain weight - filled grain weight)100/total weight of filled and unfilled grains.

Analysis of variance of the pooled data was performed after transformation of RPBS and RGY proportions and LGW and LGY percentages to arcsin. Combined analysis of variance, of four experiments, was performed to determine the effect of fungicide application, and the fungicide x cultivar interactions for AUDPC, RPBS, GY, LPGW and LPGY. Treatment mean comparisons were made using Tukey´s test at 0.05 probability level.

The quantitative assessment of the sustainability of the agricultural practice developed by Singh et al. (1990) was adopted to study the comparative performance of fungicide treatments in four different commercial upland rice cultivars. The sustainable yield index (SYI) was calculated as follows: SYI = Y - Sd/Y_{max}, where Y is the average yield across experiments; Sd is the standard deviation and Y_{max} is the maximum observed yield over years in the experiments. This index represents minimum guaranteed yield in response to fungicide treatment as a percentage of the maximum observed yield with high probability. In this index, Sd quantifies the risk associated with the average performance of Y of a treatment. The SYI in response to a given treatment can have any value from zero to one. When Sd = 0 and Y = Y_{max}, the numerical value of SYI = 1. This treatment is ideal because it gives maximum yield in all the experiments. In general, the Sd is always greater than zero and when it is high the value of SYI will be closer to zero indicating the unstable nature of the treatment.

Results and Discussion

Fungicide treatment differences as well as cultivar x treatment interaction were significant for AUDPC and RPBS when the pooled data of all four experiments were subjected to analysis of variance. It is evident, from the AUDPC values of non-treated control, that the mean panicle blast severity of four experiments was highest for IAC 202 followed by Caiapó, Araguaia and Rio Paranaíba (Table 1). Two applications of tricyclazole significantly reduced AUDPC in three of the four cultivars as compared to non-treated control. One application of tricyclazole at booting produced similar level of control to that one with two applications in all four cultivars. The tricyclazole spray at booting significantly differed from the application at heading for RPBS, only in the cultivar IAC 202 which is highly susceptible to panicle blast. The treatments with tebuconazole did not differ from non-treated control for AUDPC. Considering RPBS, one or two applications of tricyclazole and two applications of benomyl significantly controlled PBS in three of the four cultivars. The overall cultivar response to tebuconazole sprays was similar for AUDPC and RPBS.

Because of significant cultivar x fungicide treatment interaction, the data on the effect of fungicide applications on GY, RGY, LGW and LGY according to cultivar are presented in Tables 2 and 3. Differences in fungicide treatments were significant for GY and RGY in two of the four cultivars. Two applications of tricyclazole increased grain yield from 847 kg/ha to 1,521 kg/ha in IAC 202, and were superior to one application at heading. One application of tricyclazole at heading increased GY of controls, from 847 kg/ha to 1,203 kg/ha in IAC 202, and from 994 kg/ha to 1,331 kg/ha in Caiapó. However, the yield differences with one application at booting or two applications were not significant for Caiapó. The response of cultivars to two applications of benomyl in relation to yield was evident only in IAC 202. Similar results were obtained with the assessment parameter RGY, and yield response of cultivars to fungicide treat-

Table 1. Panicle blast severity in four upland rice cultivars submitted to fungicide applications at booting (B) and at heading (H), from 1995 to 1997.

Treatment	Rio Paranaíba		Araguaia		IAC 202		Caiapó	
	AUDPC	RPBS	AUDPC	RPBS	AUDPC	RPBS	AUDPC	RPBS
Control	48.2ab	0.56ab	62.2a	0.82a	404.8a	0.83a	144.7a	0.65a
Tricyclazole (B)	36.3b	0.43bc	21.8ab	0.37c	158.9b	0.35a	43.9c	0.24c
Tricyclazole (H)	28.6b	0.35c	30.0ab	0.40bc	283.0a	0.62bc	44.7c	0.27c
Tricyclazole (B+H)	23.0b	0.34c	21.6b	0.34c	145.5b	0.30d	24.2c	0.23c
Tebuconazole (B)	62.7a	0.67ab	44.2a	0.66ab	378.0a	0.79ab	147.3a	0.59ab
Tebuconazole (H)	67.8a	0.77a	36.1a	0.55ab	361.8a	0.79ab	124.9a	0.62a
Tebuconazole (B+H)	57.6a	0.64a	36.3a	0.49bc	377.7a	0.80ab	117.5b	0.58ab
Benomyl (B+H)	28.3b	0.37c	23.9b	0.44bc	206.7b	0.45cd	77.5bc	0.36bc

(1)Means followed by the same letter do not differ significantly by Tukey's test at P≤0.05; data presented as average response of cultivar to fungicide treatment in four field experiments; AUDPC: area under disease progress curve calculated according to Shaner & Finney (1977) based on the 0-5 scale; RPBS: relative panicle blast severity expressed as a proportion of the maximum disease in the block and calculated by the formula RPBS = D_t/D_{max}, where D_t is terminal panicle blast rating in the test plot and D_{max} is maximum disease in the block of the respective cultivar to obtain values ranging from zero to one.

Table 2. Grain yield (GY) in four upland rice cultivars submitted to fungicide applications at booting (B) and at heading (H), from 1995 to 1997.

Treatment	Rio Paranaíba		Araguaia		IAC 202		Caiapó	
	GY	RGY	GY	RGY	GY	RGY	GY	RGY
	(kg/ha)							
Control	1,125a	0.68a	1,419a	0.79a	847a	0.44a	994a	0.60a
Tricyclazole (B)	1,127a	0.68a	1,509a	0.84a	1,343b	0.76bc	1,152a	0.76ab
Tricyclazole (H)	1,161a	0.73a	1,468a	0.81a	1,203ab	0.68ab	1,331b	0.87b
Tricyclazole (B+H)	1,277a	0.77a	1,385a	0.77a	1,521b	0.88c	1,187ab	0.74ab
Tebuconazole (B)	1,193a	0.71a	1,556a	0.84a	1,015a	0.52ab	982a	0.62a
Tebuconazole (H)	1,182a	0.70a	1,502a	0.82a	943a	0.51ab	1,080a	0.65a
Tebuconazole (B+H)	1,324a	0.78a	1,384a	0.75a	1,067a	0.57ab	983a	0.60a
Benomyl (B+H)	1,292a	0.77a	1,478a	0.81a	1,412b	0.79bc	1,199ab	0.74ab

(1)Means followed by the same letter do not differ significantly by Tukey's test at P≤0.05; data presented as average response of cultivar to fungicide treatment, in four field experiments; RGY: relative grain yield expressed as a proportion of highest yield of the cultivar in the block.

Table 3. Loss in 100 panicle grain weight (LGW) and grain yield (LGY), and on sustainability yield index (SYI), in four upland rice cultivars submitted to fungicide applications at booting (B) and at heading (H), from 1995 to 1997.

Treatment	Rio Paranaíba			Araguaia			IAC 202			Caiapó		
	LGW	LGY	SYI	LGW	LGY	SYI	LGW	LGY	SYI	LGW	LGY	SYI
	(%)											
Control	22.6a	24.4a	0.47	25.5a	18.2a	0.61	46.5a	44.8a	0.18	29.0a	27.4a	0.26
Tricyclazole (B)	22.0a	23.5a	0.42	20.3a	17.6a	0.62	26.1c	29.4c	0.46	22.4ab	21.5ab	0.42
Tricyclazole (H)	20.6a	20.7a	0.54	19.9a	16.2a	0.66	31.9b	43.9ab	0.44	21.4b	18.4b	0.49
Tricyclazole (B+H)	18.8a	19.5a	0.54	21.5a	17.2a	0.61	22.3c	25.1c	0.59	23.6ab	20.5ab	0.46
Tebuconazole (B)	21.8a	21.8a	0.44	21.1a	16.9a	0.65	43.3a	40.0ab	0.22	29.2a	26.4a	0.31
Tebuconazole (H)	22.0a	21.1a	0.43	21.1a	18.5a	0.66	44.1a	38.5ab	0.25	27.3ab	23.2ab	0.27
Tebuconazole (B+H)	20.4a	21.0a	0.52	23.1a	20.4a	0.57	42.4ab	37.8ab	0.26	27.2ab	25.5ab	0.25
Benomyl (B+H)	19.8a	19.3a	0.49	22.2a	17.6a	0.66	29.0c	32.3cb	0.45	26.0ab	22.3ab	0.34

(1)Means followed by the same letter do not differ significantly by Tukey's test at P≤0.05; data presented as average response of cultivar to fungicide treatment, in four field experiments; SYI = Y - Sd/Y_{max} (where Y is the average yield across experiments; Sd is the standard derivation; Y_{max} is the maximum observed yield over years in the experiments).

ments was not significant for Rio Paranaíba and Araguaia.

The loss in grain yield due to panicle blast in cultivar IAC 202 was as high as 44.8% followed by 27.4%, 24.4%, and 18.2% in cultivars Caiapó, Rio Paranaíba and Araguaia, respectively (Table 3). The LGW and LGY were reduced with a single application of tricyclazole, at booting in IAC 202, and at heading in Caiapó, over the non-treated control. Two applications of tricyclazole significantly reduced LGY from 44.8% in non-treated control to 25.1% in IAC 202. The cultivar IAC 202 responded to benomyl treatment in reducing grain yield losses.

The correlation coefficients between panicle blast assessment parameters AUDPC and RPBS, across fungicide treatments, were positive and highly significant (Table 4). The grain yield parameters GY and RGY for IAC 202 were negatively correlated to AUDPC and RPBS. The non-significant correlation coefficients showed that panicle blast severity did not account for the grain yield (GY) differences in Caiapó. However, the correlation between RGY and AUDPC was negative and significant. The positive correlation of AUDPC and RPBS to LGY demonstrated the disease effect on loss in grain yield.

Considering significant yield differences in the cultivar IAC 202 in response to fungicide treatments, two applications of tricyclazole produced maximum sustainable yield index (SYI = 0.59) followed by one application at booting (SYI = 0.46) and heading (SYI = 0.44). Two applications of benomyl showed relatively lower index (SYI = 0.45) than two applications of tricyclazole, indicating that the treatment is sensitive to climatic changes (Table 3). The difference in SYI values between one or two applications of tricyclazole in Caiapó was not as great as in IAC 202.

Table 4. Correlation coefficients (r) among panicle blast and grain yield parameters in the rice cultivars IAC 202 and Caiapó(1).

Parameters	GY	RGY	LGY	RPBS
		IAC 202		
AUDPC	-0.344**	-0.407**	0.177*	0.564**
RPBS	-0.347**	-0.514**	0.323**	-
		Caiapó		
AUDPC	-0.104^{ns}	-0.311**	0.328**	0.657**
RPBS	-0.062^{ns}	0.212*	0.225*	-

(1)Number of observations in the analysis = 128; GY: grain yield; RGY: relative grain yield; LGY: loss in grain yield; RPBS: relative panicle blast severity; AUDPC: area under disease progress curve. ^{ns}No-significant. * and **Significant at 5% and 1%, respectively.

Weather conditions were favorable for panicle blast incidence and severity in all four experiments. Leaf blast epidemic had occurred in the experiment II causing death of tillers mainly in the cultivar Rio Paranaíba and Caiapó at the vegetative phase, and the plants recovered with the advent of rains. High and uniform leaf scald incidence has been observed in experiments I and III, at the boot stage. However, fungicide applications did not aim to control leaf diseases. The first application of fungicide in the present study was made at the end of booting after leaf blast or leaf scald had taken the toll. It is not a usual practice to apply fungicide to control foliar disease because of low yield and risk due to intermittent drought periods under upland conditions. Leaf blast at the vegetative phase is controlled by seed treatment with systemic fungicide (Filippi & Prabhu, 1997a, 1997b). Leaf scald is sporadic in occurrence, unpredictable and the incidence is largely dependent upon the rainfall at booting.

The cultivar IAC 202 exhibited maximum values of AUDPC, RPBS and minimum yield in non-treated control, indicating the high degree of susceptibility to panicle blast followed by Caiapó, Araguaia and Rio Paranaíba. The differential response of cultivars to fungicide sprays may be attributed to the degree of susceptibility to panicle blast. Two applications of tricyclazole significantly controlled panicle blast of cultivars IAC 202 and Caiapó. Even though the disease control with tricyclazole sprays was significant, the yield increase was not significant for cultivars Rio Paranaíba and Araguaia. The lack of yield response of cultivars Araguaia and Rio Paranaíba to two tricyclazole sprays may possibly be due to low AUDPC values as compared to IAC 202 and Caiapó in the non-treated control. The results further showed that one application of tricyclazole at booting or heading did not differ from two applications in controlling panicle blast in Caiapó. Two applications of benomyl were included as a standard treatment to compare the relative efficacy of one or two applications of tricyclazole and tebuconazole in controlling panicle blast. The RPBS varying from zero to one allowed comparison of relative importance of a given treatment and served as a standard measure in different cultivars. The positive and highly significant correlation between AUDPC and RPBS showed that the latter may be utilized as panicle blast assessment parameter because of the ease with which it can be determined with terminal disease severities. Similarly RGY is a better measure to relate the disease effect on grain yield.

The yield response of cultivars IAC 202 and Caiapó to two applications of benomyl was similar to one or two applications of tricyclazole. The average yields of four experiments over a period of two years ranged from 847 kg/ha to 1,419 kg/ha of four cultivars, considering non-treated plot yields. The grain yields under upland conditions are not only low but risk prone and require judicious use of fungicides. The use of cultivars with moderate levels of susceptibility is one of the ways to reduce the number of applications from two to one. The results of evaluation of cultivar response using different yield parameters were consistent and did not affect the ranking of cultivars. RGY allowed comparison of yield response of cultivars to fungicide treatment despite the differences in yield potential. The effect was largely based on the disease level in the non-treated control plots or cultivar susceptibility to panicle blast. The grain yields were relatively high in Araguaia and Rio Paranaíba in the non-treated controls and apparently were not affected by panicle blast. The loss estimates, LGW and LGY, based on filled and unfilled grains, demonstrated that the yield effect due to panicle blast is on grain filling, confirming the earlier reports that the variability in yield is mainly explained by percentage filled grains (Prabhu et al., 1986).

One of the main constraints in adopting the recommended practice of one application at heading with a systemic fungicide is the uncertainty of returns and the lack of information regarding the efficiency of the fungicide and sustainability. Results have shown that two applications of tricyclazole, one at booting and the other at heading, are more efficient in increasing yield of cultivars IAC 202 with a high sustainability yield index. The value of SYI = 0.59 indicates that the minimum guaranteed yield would be more than 59% of potential yield with high probability. Two applications of tricyclazole are superior to one application as far as sustainability is concerned. Fungicide applications with benomyl were less sustainable compared to two applications with tricyclazole. The SYI values of non-treated plots were lower than the treated plots indicating that yield is affected by seasonal changes and disease level. In general, sustainable agricultural systems are those which are typically associated with lower inputs (Stinner & House, 1987).

However, according to Rutton (1988), the concept of sustainability should serve as a guide to agricultural practice, and it must also include the use of technology and practices that both sustain and enhance productivity to meet the increasing food demand. Sustainability has been defined and redefined in different ways by several authors, but in essence, the sustainable agricultural practice is the one which maintain and increase the productivity as well as minimize the impact on environment. The response of a cultivar to fungicide treatment over a wide range of disease levels in the same location may be considered as a sustainable practice. The quantification of yield effects due to panicle blast with and without fungicide application in cultivars with different degrees of susceptibility is useful for further studies on economic viability of the treatment. The results are expected to be variable under different locations due to conditions that favor or mitigate incidence of leaf blast and other foliar diseases such as leaf scald.

Even though the potential of tricyclazole in controlling panicle blast with one or two applications has been shown to increase yield, and sustainable, in two of the four cultivars, the validation of these results should be tested in multi location on-farm trials for generalized recommendation to include as an essential input in blast disease management of upland rice.

Conclusions

1. Cultivar response to fungicide sprays in relation to panicle blast control is variable depending on the degree of susceptibility.

2. Two applications of tricyclazole, one at booting and the other at heading, are sustainable and more efficient in increasing yield of the susceptible cultivar IAC 202.

3. There is no yield response of the cultivars Rio Paranaíba and Araguaia to fungicide applications for panicle blast control.

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