Microorganisms growth promoters as affecting biomass production and nutrients uptake in upland rice plants

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INTRODUCTION

The hypothesis of this study is that the previously selected bioagents, when applied, either via seed or soil/foliar spray, significantly affect the development of rice plants, which is reflected in biomass production and nutrient concentration. The objective was to determine the effect of different methods of applying microorganisms, previously identified as growth inducers, on the production of biomass dry matter and nutrient content of upland rice plants.

METHODS

The experimental design was completely randomized in a factorial 3x7 + 1, with four replications. The treatments consisted of combining seven microorganisms (R-46, R-55, R-235, 20.7, 82, 138, and *Trichoderma asperellum* pool) with three application forms (1 seed - microbiolized seed,; 2 seed-soil - microbiolized seed + soil drenched with microorganism suspension at 7 and 15 days after sowing (DAS), and 3 seed-plant - microbiolized seed + plant sprayed with microorganism suspension at 7 and 15 DAS). The control treatment consisted of microbiolized seed, soil drenched and plant sprayed with water.

RESULTS AND DISCUSSION

Treatments with R-235, 82, 138 and *T. asperellum* pool provided, on average, the highest dry matter biomass of rice shoots (Table 1). Plants treated with R-46, R-235, R-55 and 20.7 led to the greatest nutrient uptake by rice shoots (Table 2). R-235 was the most effective for promoting an increase in the photosynthetic rate, and for the greatest accumulation of nutrients and dry matter at 84 DAS, in rice shoots. Martins (2015) identified and characterized the genera of rhizobacterias R-46 and R-235 that produce AAI, cellulase and siderophores. In the same study, rhizobacterias R-55 and 20.7 were identified and characterized, showing that they produce cellulase phosphatase and siderophores. This information helps to partly explain the higher biomass gain in plants treated with R-235 (by seed application) and in plants treated with the rhizobacteria R-46 (by seed-plant application). In addition, the plants treated with the rhizobacterias R-55 and 20.7 (solubilizing phosphate), showed the highest levels of P and Fe.

Based on the results, it appears that the use of bioagents can be a sustainable alternative for increasing the biomass production of rice plants, which is a characteristic that is positively correlated to crop yield. This study also indicated that the bioagents R-235, 82, 138 and *T. asperellum* pool are the most promising for use on a commercial scale, since it excelled in promoting better performance of upland rice plants, besides being effective antagonists to the main rice pathogens (Martins, 2015). Also, in general, these bioagents provided higher nutrient concentration (Table 2) in the rice plants, which indicates that their presence encourages the availability of nutrients in the soil and, consequently, the uptake of these by plants. It is worth mentioning that the rhizobacteria R-235 was the best bioagent that promote greater accumulation of dry matter at 84 DAS in the rice plants, independent of application form.

Table 1. Application form of microorganism as affecting biomass dry matter of rice shoots.

Factors	Shoot biomass (grams)
Microorganism	
R-46	18.02 [b]+
R-55	11.24 [c]*
R-235	21.53 [a]*
20.7	18.88 [b]
82	19.37 [ab]
138	19.30 [ab]
Pool *T. asperellum*	19.04 [ab]
Control	18.54
Aplication form	
Seed	17.74 [a]
Seed-soil	18.50 [a]
Seed-plant	18.35 [a]

[+]Same letter lower case vertically or upper case horizontally do not differ at p <0.05 by Tukey test. *Means followed by this symbol differ from the control by the Dunnett test at p<0.05.

Table 2 Application form of microorganism as affection nutrient content in rice shoots.

Factors	N	P	K	Ca	Mg	Cu	Fe	Mn	Zn
Microorganism	g kg^{-1}					mg kg^{-1}			
R-46	25*	2.1	21 [a+]	4.7*	3.4 [bc]	7.9	123 [c]	1766	42
R-55	25*	2.3	23 [a]	4.4*	3.3 [c]	10.3	169 [a]	2190 *	41
R-235	24	2.1	23 [a]	4.8	3.6 [abc]	7.2	136 [bc]	1666	43
20.7	24	2.4	22 [a]	5.1	3.8 [a]	9.0	161 [ab]	1799	44
82	23	2.1	21 [a]	5.2	3.6 [abc]	8.7	124 [c]	1637	48
138	25*	2.2	21 [a]	5.2	3.7 [ab]	8.4	133 [bc]	1657	43
Pool *T. asperellum*	24	2.4	22 [a]	5.0	3.6 [ab]	8.4	155 [ab]	1717	45
Control	23	2.1	21	5.6	3.6	8.7	122	1864	43
Aplication form									
Seed	25	2.3	21 [a]	4.8	3.5 [b]	8.7	151 [a]	1644	42
Seed-soil	23	2.1	22 [a]	4.9	3.7 [a]	8.5	115 [b]	1904	43
Seed-plant	24	2.2	22 [a]	5.0	3.5 [ab]	8.4	162 [a]	1762	46

+ Same letter lower case vertically or upper case horizontally do not differ at p <0.05 by Tukey test. *Means followed by this symbol differ from the control by the Dunnett test at p<0.05.

CONCLUSION

The microorganism application positively and differently affected the growth parameters evaluated in rice plants. Rice plants treated with bioagents R-235, 82, 138 and *T. asperellum* pool provided, on average, the highest dry matter biomass of rice shoots. Plants treated with bioagents R-46, R-235, R-55 and 20.7 led to the greatest nutrient uptake by the rice shoots. Among the evaluated microorganisms, R-235 was the most effective for promoting, in rice shoots and for the greatest accumulation of nutrients and dry matter at 84 DAS.

REFERENCES

Martins, B.E.M. (2015) Caracterização morfológica, bioquímica e molecular de isolados bacterianos antagonistas a *Magnaporthe oryzae*. 80 p. Thesis, Universidade Federal de Goiás, Goias State, Brazil.