Limitations in controlling white mold on common beans with *Trichoderma* spp. at the fall-winter season

Trazilbo José de Paula Júnior[1], Hudson Teixeira[2], Rogério Faria Vieira[1], Marcelo Augusto Boechat Morandi[3], Miller da Silva Lehner[4], Renan Cardoso Lima[4] and José Eustáquio de Sousa Carneiro[4]

[1]EPAMIG, Vila Gianetti 47, CEP 36570-000 Viçosa, MG, Brazil; [2]EPAMIG, CP 176, CEP 37200-000 Lavras, MG, Brazil; [3]Embrapa Meio Ambiente, CP 69, CEP 13820-000 Jaguariúna, SP, Brazil; [4]Univ. Fed. de Viçosa, CEP 36570-000 Viçosa, MG, Brazil. E-mail: hudsont@epamig.br, rfvieira@epamig.br, mmorandi@cnpma.embrapa.br, millerlehner@gmail.com, renan.lima@ufv.br, jesc@ufv.br
Autor para correspondência: Trazilbo José de Paula Júnior (trazilbo@epamig.br)
Data de chegada: 24/04/2012. Aceito para publicação em: 29/08/2012.

1815

ABSTRACT

Paula Júnior, T.J.; Teixeira, H.; Vieira, R.F.; Morandi, M.A.B.; Lehner, M.S.; Lima, R.C.; Carneiro, J.E.S. Limitations in controlling white mold on common beans with *Trichoderma* spp. at the fall-winter season. ***Summa Phytopathologica,*** v.38, n.4, p.337-340, 2012.

We studied the effectiveness of application of *Trichoderma* spp. in controlling white mold on common beans at the fall-winter crop in the Zona da Mata region of the State of Minas Gerais, Brazil. There was no effect of the antagonist in reducing the disease severity, which could be explained by the low temperatures and the high inoculum pressure in the field. We concluded that *Trichoderma* applications are not recommended for control of white mold on common beans at the fall-winter season in regions with average temperature bellow 20 °C, since this condition favor more the pathogen than the antagonist.

Additional keywords: *Phaseolus vulgaris*, *Sclerotinia sclerotiorum*, biological control, integrated management.

RESUMO

Paula Júnior, T.J.; Teixeira, H.; Vieira, R.F.; Morandi, M.A.B.; Lehner, M.S.; Lima, R.C.; Carneiro, J.E.S. Limitações do controle do mofo-branco do feijoeiro com *Trichoderma* spp. no cultivo de outono-inverno. ***Summa Phytopathologica,*** v.38, n.4, p.337-340, 2012.

Estudou-se a eficácia da aplicação de *Trichoderma* spp. no controle do mofo-branco do feijoeiro cultivado no outono-inverno na Zona da Mata de Minas Gerais. Não houve efeito do antagonista em reduzir a severidade da doença, o que pode ser explicado pelas baixas temperaturas e pela alta pressão de inóculo no campo. Conclui-se que aplicações de *Trichoderma* não são recomendadas para o controle do mofo-branco do feijoeiro no outono-inverno em regiões com temperatura média abaixo de 20 °C, considerando que essa condição climática favorece mais o desenvolvimento do patógeno do que o do antagonista.

Palavras-chave adicionais: *Phaseolus vulgaris*, *Sclerotinia sclerotiorum*, controle biológico, manejo integrado.

The spreading of white mold caused by *Sclerotinia sclerotiorum* (Lib.) de Bary have been favored by the environmental conditions of many irrigated areas cultivated with common beans (*Phaseolus vulgaris* L.) in Brazil, that usually present moderate temperatures (15-22 °C) during the fall-winter season (14). Most of these areas are infested with sclerotia leading frequently to expressive losses if disease is not adequately controlled. *S. sclerotiorum* can attack more than 400 plant species (3). Applications of fungicide are generally efficient to control the disease, but they increase the costs and have important ecological implications. Other strategies used to manage the disease include sowing of non-infested seeds, low plant population, upright cultivars, crop rotation with cereals, low irrigation frequency, and biological control (4, 14, 16).

Trichoderma is one of the more intensively investigated biocontrol agents (7). *Trichoderma* spp. are particularly prevalent in humid environments, but they can be isolated from all climatic zones (8). This antagonist associates with sclerotia of *S. sclerotiorum* and cause sclerotia to degrade or not germinate. The potential of the biological control with isolates of *Trichoderma* spp. has been reported for *S. sclerotiorum in vitro* (10). Applications of *T. harzianum* 1306 in Brazilian cerrado fields have successfully controlled the pathogen (4). The demand for *Trichoderma* products for the control of soilborne pathogens has increased significantly in Brazil (2, 12). However, applications of *Trichoderma* conidia to control white mold at moderate temperatures may be not efficient, since the antagonist is more adapted to temperatures above 25 °C (8). In a field trial with average temperature bellow 18 °C, Paula Júnior et al. (15) have not found antagonistic effects of *T. harzianum* against *S. sclerotiorum*. The purpose of this work was to test the application of *Trichoderma* isolates for white mold control at the fall-winter season.

A field experiment was carried out from May 5, 2008, in an experimental area of the Federal University of Viçosa, Minas Gerais, Brazil (20°46'05" S, 42°52'10" W, elevation 662 m). The inoculum of *S. sclerotiorum* in this area is high and homogenously distributed. Treatments were arranged in a randomized complete block design with four replicates. An isolate of *T. harzianum* (LQC 88) successfully selected *in vitro* and in greenhouse for *S. sclerotiorum* control at 18-22 ºC (11) and four *Trichoderma* isolates from commercial products were tested (Table 1). In the case of the isolate LQC 88, two 5 mm diameter mycelial-agar disks of the growing fungus on Petri dishes with PDA were transferred to 200 mL-Erlenmeyers flasks containing rice grains. After incubation for 15 days at 25 °C for conidia production, the inoculum was ground on trays. All *Trichoderma* isolates were applied (1 x 10^9 conidia g^{-1}) over the plants and soil through sprinkler irrigation water at 20 and 46 days after emergence (DAE). Another treatment was carried out with applications of the fungicide fluazinam (0.5 L ha^{-1}) at 46 (pre-flowering stage) and 56 DAE by a backpack spray equipped with one cone nozzle delivering 667 L ha^{-1} of fungicide solution. These treatments were compared with water (untreated control).

Irrigation was provided as needed to promote good seedling emergence and establishment, and a rate of approximately 40 mm of water per week thereafter, as generally used in the region. The common bean cultivar BRSMG Majestoso (prostate plants, type II/III, carioca class) was sown in rows spaced 0.5 m apart. Plots of seven 3.5 m-long rows were sown on May 2008. Density of 10 plants per meter was adjusted by thinning two weeks after sowing. All plots received a basal fertilization: 24 kg ha^{-1} of N, 37 kg ha^{-1} of P, and 40 kg ha^{-1} of K. Ammonium sulfate application (200 kg ha^{-1}) as side dressing was performed 20 DAE, together with foliage application of molybdenum (80 g ha^{-1}) as sodium molybdate. Weeds were controlled by hand hoeing and with a commercial mixture of the herbicides fomesafen (250 g ha^{-1}) and fluazifop-p-butyl (200 g ha^{-1}). Insects were controlled, when needed, with monocrotophos (400 mL ha^{-1}). The fungicide azoxystrobin (60 g ha^{-1}) was applied once before flowering to protect beans against foliar diseases.

An area of 1.2 m^2 (one internal row without 0.3 m at each end) in the plots was harvested separately at 90 DAE for white mold evaluation. Disease incidence was calculated as the percentage of plants with symptoms. Plants were rated for disease severity index (DSI) by means of a "quarter scale" (6), where 0 = no disease present, 1 = 1% to 25%, 2 = 26% to 50%, 3 = 51% to 75%, and 4 = 76% to 100% of the plant with white mold symptoms. DSI was calculated on a percentage basis: DSI (%) = Σ(scores of all plants)/[4 x (total number of plants)] x 100. Yield data were estimate based on mass of seeds with 12% moisture (w/w) harvested in 3.6 m^2 (included the 1.2 m^2 area harvested for disease evaluation). Data were subjected to variance analysis and means of either the *Trichoderma* or the fluazinam treatments were compared to the untreated control by Dunnett's test ($P < 0.05$).

In general, high intensity of white mold was observed, with disease incidence about 100% in all treatments (Table 1). Only the applications of fluazinam reduced the disease severity (26.3%), compared to the untreated control. There was no effect of *Trichoderma* spp. and fluazinam applications on bean yield. Results of field experiments in the same experimental area from 1997 to 2006 indicated an average yield increase of 35.6% with fluazinam application, with average disease incidence and severity of 58.0% and 31.8%, respectively (13). These results confirm that in 2008 the disease intensity was higher than the expected for this area, which can be explained by the climate conditions favorable to the white mold spread, especially high relative humidity and low temperatures (Fig.1).

In a study carried out at the 2004 fall-winter season in the same field, the attempts in controlling white mold on common beans with *T. harzianum* also failed (15). The high disease pressure in the field in 2004 and in this experiment may have influenced the efficacy of the antagonist, although the *Trichoderma* applications have been done according to manufactory's instructions in both trials. Low temperatures during the fall-winter crop may better explain the lack of effectiveness of the biological control of white mold on common beans with *Trichoderma* spp. in the Zona da Mata region in the State of Minas Gerais. Even the isolate LQC 88, which was selected at a suboptimal temperature, did not reduce the disease severity. *Trichoderma* is more adapted to temperatures higher than 25 °C (8). In this study, the average temperatures were 16.7 °C in June, 15.4 °C in July, and 18.4 °C in August (Fig. 1). The average of maximum temperatures was slight higher than 25 °C only in August. Isolates of *Trichoderma* spp. have been found in the soil (10) as well as associated to sclerotia of *S. sclerotiorum* (1) in Brazilian cerrado areas, where applications of the antagonist have reduced the severity of white mold in the field (4). In these areas average temperatures at the fall-winter season are higher than in the Zona da Mata region. Therefore, best results are expected for the antagonists in the cerrado areas, since the average temperature in these areas occurs outside the best temperature range for the pathogen (9). Interactions among bean plants, *S. sclerotiorum* and *Trichoderma* are also influenced by the relative

Table 1. Incidence and severity of white mold, and bean yield in response to applications of *Trichoderma* and fungicide. Viçosa, MG, Brazil. 2008.

Treatment	Commercial product	Incidence (%)	DSI[1] (%)	Yield (kg ha^{-1})
Trichoderma harzianum LQC 88	-	99.04[2]	87.69	840
Trichoderma harzianum 1306	Trichodermil SC®	100	86.91	962
Trichoderma asperellum	Quality WG®	100	88.13	1038
Trichoderma spp.	Trichodel Solo®	96.96	79.56	1252
Trichoderma spp., *T. harzianum*	Trichoplus JCO®	100	81.03	888
Untreated control	-	100	90.54	950
Fluazinam	Frowncide 500 SC®	96.14	66.75 *	1396
CV (%)		1.26	9.63	28.3

[1]DSI (%) = Σ (scores of all plants)/[4 x (total number of plants)] x 100. [2]Means followed by * in the columns are different from the untreated control according to Dunnett's test ($P < 0.05$).

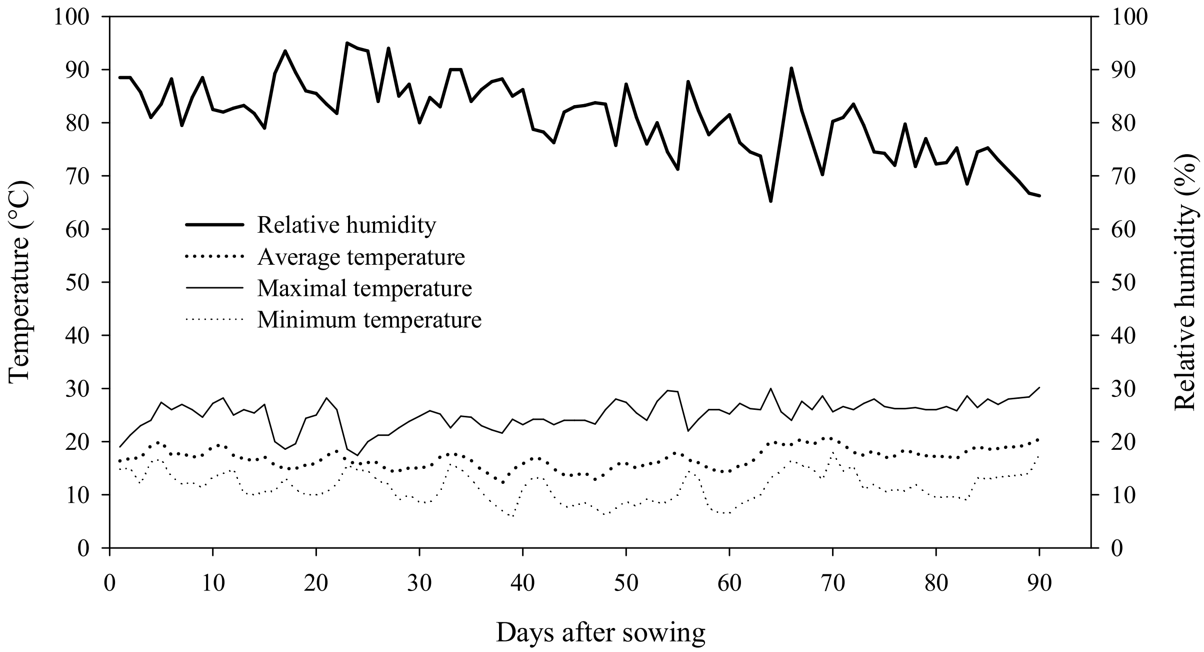

Figure 1. Relative humidity, maximum, minimum and average temperatures in the experimental area of Federal University of Viçosa, Minas Gerais, Brazil (May 28 – August 29, 2008).

humidity, since the activities of the antagonist may be also increased by high humidity (5). However, our results suggest that low temperatures are determinant for non recommending *Trichoderma* applications for control of white mold on common beans in the Zona da Mata region and other Brazilian regions where beans are cultivated as fall-winter crop, since this condition favor more the pathogen than the antagonist. Further studies in these regions could focus the biological control with antagonists more adapted to moderate temperatures, as *Conyothirium minitans* Campbell (14).

ACKNOWLEDGEMENTS

T.J. Paula Júnior, R.F. Vieira and J.E.S. Carneiro were supported by CNPq. H. Teixeira was supported by Fapemig. M.S. Lehner and R.C. Lima were supported by CAPES. Research was supported by Fapemig and CNPq.

REFERENCES

1. Arancibia, R. C.; Nasser, L. C. B., Gomes, A. C., Napoleão, R. Density, viability and frequency of fungi associated to sclerotia of *Sclerotinia sclerotiorum* in irrigated areas of the cerrado (savanna) region of Brazil. **Fitopatologia Brasileira**, Brasília, DF, v.26, p.338-339, 2001.
2. Bettiol, W.; Morandi, M.A.B.; Pinto, Z.V.; Paula Júnior, T.J.; Correa, E.B.; Moura, A.B.; Lucon, C.M.M.; Costa, J.C.; Bezerra, J.L. Bioprotetores comerciais para doenças de plantas. **Revisão Anual de Patologia de Plantas**, Passo Fundo, v.17, p.27-47, 2009.
3. Bolland G.J.; Hall, R. Index of plant hosts of *Sclerotinia sclerotiorum*. **Canadian Journal of Plant Pathology**, Ottawa, v.16, p.93-108, 1994.
4. Görgen, C. A.; Silveira Neto, A. N.; Carneiro, L. C.; Ragagnin, V.; Lobo Júnior, M. Controle do mofo-branco com palhada e *Trichoderma harzianum* 1306 em soja. **Pesquisa Agropecuária Brasileira**, Brasília, DF, v.44, p.1583-1590, 2009.
5. Hannusch, D.J.; Boland, G.J. Influence of air temperature and relative humidity on biological control of white mold of bean (*Sclerotinia sclerotiorum*). **Phytopathology**, St. Paul, v.86, p. 156-162, 1996.
6. Hall, R.; Phillips. L.G. Evaluation of parameters to assess resistance of white bean to white mold. **Annual Report of the Bean Improvement Cooperative**, East Lansing, v.39, p.306-307, 1996.
7. Hjeljord, L.; Tronsmo, A. *Trichoderma* and *Gliocladium* in biological control: an overview. In: Harman, G. E.; Kubicek, C. P. (Ed.). ***Trichoderma & Gliocladium***: enzymes, biological control and commercial applications. London: Taylor & Francis, 1998. v.2, p.131-151.
8. Klein, D.; Eveleigh, D.E. Ecology of *Trichoderma*. In: Kubicek, C.P.; Harman, G.E. (Ed.). ***Trichoderma & Gliocladium***: enzymes, biological control and commercial applications. London: Taylor & Francis, 1998. v.1, p. 57-74.
9. Lobo Júnior, M.; Abreu, M.S. Inibição do crescimento micelial de *Sclerotinia sclerotiorum* por metabólitos voláteis produzidos por alguns antagonistas em diferentes temperaturas e pH's. **Ciência e Agrotecnologia**, Lavras, v.24, p.521-526, 2000.
10. Louzada, G. A. S.; Carvalho, D. D. C.; Mello, S. C. M.; Lobo Júnior, M.; Martins, I.; Braúna, L. M. Potencial antagônico de *Trichoderma* spp. originários de diferentes agroecossistemas contra *Sclerotinia sclerotiorum* e *Fusarium solani*. **Biota Neotropica**, Campinas, v.9, p.145-149, 2009.
11. Morandi, M.A.B.; Pomella, A.W.V.; Santos, E.R.; Fernandes, M.; Caovila, L.E.; Fernandes, A.O. Selection of *Trichoderma* spp. isolates to control the bean white-mold fungus *Sclerotinia sclerotiorum* in winter crops. In: IOBC/WPRS Workshop - Fundamental and practical approaches to increase biocontrol efficacy, 9., 2006, Spa. **Proceedings**. Spa: IOBC; WPRS, 2006. p.81.
12. Paula Júnior, T.J.; Venzon, M.; Morandi, M.A.B.; Bettiol, W.; Pallini, A.; Teixeira, H. Comercialização de produtos biológicos para o controle de doenças de plantas e pragas no Brasil. **Informe Agropecuário**, Belo Horizonte, v.30, n.251, p.116-123, 2009a.
13. Paula Júnior, T.J.; Vieira, R.F.; Teixeira, H.; Carneiro, J.E.S. Benefits of management of *Sclerotinia sclerotiorum* on dry beans.

In: Deutsche Pflanzenschutztagung, 57., 2010, Berlin. **Proceedings**. Berlin: Deutsche Phytomedizinische Gesellschaft, 2010. p.352-353.

14. Paula Júnior, T.J.; Vieira, R.F.; Lobo Júnior, M.; Morandi, M.A.B.; Carneiro, J.E.S.; Zambolim, L. **Manejo integrado do mofo-branco do feijoeiro** - Guia Técnico. Viçosa: EPAMIG-CTZM, 2006. 48p.
15. Paula Júnior, T.J; Vieira, R.F.; Rocha, P.R.R.; Bernardes, A.; Costa, E.L.; Carneiro, J.E.S.; Vale, F.X.R.; Zambolim, L. White mold intensity on common bean in response to plant density, irrigation frequency, grass mulching, *Trichoderma* spp., and fungicide. **Summa Phytopathologica**, Botucatu, v.35, p.44-48, 2009.
16. Vieira, R.F.; Paula Júnior, R.F.; Carneiro, J.E.S.; Teixeira, H.; Queiroz, T.F.N. Management of white mold in type III common bean with plant spacing and fungicide. **Tropical Plant Pathology**, Brasília, DF, v.37, p.95-101, 2012.