



Evaluation of three doses of *Trichoderma harzianum* for the control of black scab (*Rhizoctonia solani*) of potatoes in Huari, Ancash

Evaluación de tres Dosis de *Trichoderma harzianum* para el control de la costra negra (*Rhizoctonia solani*) de la papa en Huari, Ancash

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Abstract

Objectives: To evaluate the effect of three levels of concentration of the biological agent *Trichoderma harzianum* (Tricho-D) in the control of *Rhizoctonia solani* potato cv. Yungay in Huari, Ancash. **Methods:** The research was carried at Tumbos farm, located in the district of Chavin de Huantar, Huari, from November 2018 to February 2019. A completely randomized block design was used, with four treatments (three levels of Tricho-D, and a control). The variables evaluated were: the degree of severity, percentage of incidence, AUDPC, control efficiency, and tuber yield per plant. **Results:** The dose of 0.3 kg ha⁻¹ of Tricho-D reported less severity with a degree of 0.75 and 7.5% incidence of *R. solani* disease. Likewise, the dose of 0.3 kg ha⁻¹ of Tricho-D had an effect antagonistic about the fungus *R. solani* obtaining a high control efficiency with 82.5%. The highest dose of 0.3 kg ha⁻¹ of Tricho-D reported a higher yield per plant with 757.5 g plant⁻¹ in cv. Yungay. **Conclusions:** The dose of 0.3 kg ha⁻¹ of Tricho-D had an antagonistic effect with the parasitic activity of the *R. solani* fungus controlling the black scab in potatoes cv. Yungay under field conditions in Chavín of Huantar, Huari-Ancash.

Keywords: Black scab, incidence, severity, efficiency, performance

Resumen

Objetivos: Evaluar el efecto de tres niveles de concentración del agente biológico *Trichoderma harzianum* (Tricho-D) en el control de *Rhizoctonia solani* en papa variedad “Yungay” en condiciones de Huari. **Metodología:** La investigación se realizó en la finca Tumbos, ubicada en el distrito de Chavín de Huantar-Huari, entre los meses de noviembre 2018 a febrero 2019, se utilizó el diseño de bloques completamente al azar, con 4 tratamientos (3 niveles de concentración de *Trichoderma harzianum*, más un testigo sin control). Las variables evaluadas fueron: grado de severidad, porcentaje de incidencia, ABCPE, eficiencia de control, y rendimiento por planta. **Resultados:** La dosis de 0,3 kg ha⁻¹ de Tricho-D reportó menos severidad con un grado de 0,75 y 7,5 % de incidencia de *R. solani*, asimismo, la dosis de 0,3 kg ha⁻¹ de Tricho-D tuvo un efecto antagónico sobre el hongo obteniendo una alta eficiencia de control con 82,5%. La dosis más alta de 0.3 kg ha⁻¹ de Tricho-D, reportó mayor peso de tubérculos por planta con 757,5 g planta⁻¹ de papa. **Conclusiones:** La dosis de 0,3 kg ha⁻¹ de Tricho-D tuvo un efecto antagónico con actividad parasítica en *R. solani* controlando la costra negra en la variedad de papa Yungay en condiciones de Huari, Ancash.

Palabras claves: Costra negra, incidencia, severidad, eficiencia, rendimiento

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Introduction

The potato (*Solanum tuberosum* L.) is an annual, herbaceous and dicotyledonous plant of the Solanaceae family; it is commonly considered a vulnerable crop due to diseases caused by phytopathogenic fungi (Rauf et al., 2015).

Agricultural activity depends on many factors: to achieve high productivity it is necessary to control the attack of pests and phytopathogens, which cause serious damage and losses to crops. To avoid such negative effects on crops, techniques are carried out, being the chemical control the most used. The potato is susceptible to a wide variety of diseases, including the disease caused by the fungus *Rhizoctonia solani*.

The control of *R. solani* with synthetic pesticides (the causative agent of the disease rhizoctoniasis or black scab) is not always effective, and there is a current trend to reduce the use of synthetic agrochemicals in crop production.

Therefore, the biological control of *Rhizoctonia* in potatoes could become an important strategy in the integrated pest and disease management system in the crop (Bienkowski, 2012). *R. solani* is transmitted by inoculums and both mycelium and sclerotia inhabit microorganisms, insects, and nematodes (Van den Brink & Wustman, 2014).

Tovar (2008) mentions that *Trichoderma* spp. is a biological agent that controls pathogenic fungi that are being used in the agricultural area since it has the ability to colonize mycelia of pathogenic fungi and allows it to resist the attack of these microorganisms; in addition, it promotes the growth of plants. Therefore, it is necessary to use it as a biological control to inhibit the growth and development of *R. solani* in potatoes under conditions of Chavín de Huantar, Huari.

The objective of the study was to evaluate the effect of three concentration levels of the biological agent *Trichoderma harzianum* (Tricho-D) in the control of black scab (*Rhizoctonia solani*) in potato cv. Yungay under cultivation conditions of Chavín de Huantar, Huari.

Methodology

The research was carried out in the Tumbos farm, located in the district of Chavín de Huantar-Huari, between the months of November 2018 to February 2019, in a field of potatoes cv. Yungay. A completely randomized block design was used, with 4 treatments (3 levels of concentration of Tricho -D, plus a control). The variables evaluated were: the degree of severity, incidence percentage, AUDPC (area under disease progression curve), control efficiency, and tuber yield per plant. The experiment was conducted in two phases:

Laboratory tests

The isolation of *R. solani* was carried out complying with the methodology of Ibrahim (2017) which indicates that the first step is to obtain samples with symptoms of *Rhizoctonia* disease, whether they were the pieces of potato plant (stem, tuber, root, stolon) showing symptoms of *R. solani* disease, which were soaked in bleach for three minutes and then soaked in 70% ethanol for one minute. After rinsing with sterile water several times, the infected potato tuber peel was divided into small pieces, transferred to potato dextrose agar (PDA) plates supplemented with rose bengal and chloramphenicol, and incubated at 28 °C for four days. The plates were observed daily for mycelial growth. The hyphal tips emerging from the shell pieces were transferred to fresh PDA and CYA (Czapek yeast extract agar) plates. The isolated strains of *R. solani* were stored at 5 °C in a plate containing PDA. Then the strains were used to inoculate the potato plants.

Field tests

The field phase was carried out using the methodology of Tarazona (2009). Once the potato seed tubers were transplanted in the experimental field, the *R. solani* strain was used, multiplied in 250 g of pre-cooked wheat in polypropylene bags, incubating for 7 days enough time for the fungus to colonize the wheat of the bags. Once colonized, the infected wheat was inoculated in each study treatment. The application of the concentration levels of Tricho-D, was carried out forty-eight hours after the inoculation of the pathogen. Then the soil

reached field capacity condition, and the high humidity allowed the fungus to colonize into the inoculated substrates in about 20 days.

Evaluation parameters

The degree of severity of the black scab caused by *R. solani* was determined using a scale of 0 - 4, where 0 = no lesion symptoms, 1 = less than 25% of the covered stem of the lesion, 2 = 26 - 50% of the covered stem of the lesion, 3 = 51 - 75% of the covered stem of the lesion, 4 = greater than 75% of the covered stem of the lesion (Beagle & Papavizas, 1985). The evaluation of the incidence of the black scab disease caused by *R. solani* was carried out by counting the number of plants with symptoms of the covered stem of the lesion on the total number of plants, expressed in percentage.

$$\% \text{ Incidence} = \frac{N^{\circ} \text{ infected plants}}{N^{\circ} \text{ total plants}} \times 100$$

To obtain the area under the disease progression curve (AUDPC), which is used to measure disease progression and incidence in a single value through a time interval, the Campbell and Madden procedure was used, cited by Chang (2018). To evaluate the weight of tubers per plant, the tubers of each sampled plant were extracted and then weighed on a scale, expressing them in g plant⁻¹.

Data Processing

The statistical analysis for the variables was with ANOVA and the use of the Tukey tests at 5% probability for mean comparison. For data processing of the evaluated parameters, the statistical software SAS (version 9.3) was used.

Results

Degree of severity of *Rhizoctonia solani*

In Table 1, it is shown that the control without application stood out statistically to all treatments, presenting the highest degree of severity with 3.50 then followed by the dose of 0.2 kg ha⁻¹ of Tricho-D with 2.25 of severity, followed by doses of 0.25 and 0.3 kg ha⁻¹ Tricho-D, statistically similar treatments with grades of 1.00 and 0.75 respectively.

Table 1

*Degree of severity of *Rhizoctonia solani* in potato cv. Yungay*

Treatments	Degree of severity
Control	3.50 ^a
0.20 kg ha ⁻¹ Tricho-D	2.25 ^b
0.25 kg ha ⁻¹ Tricho-D	1.00 ^c
0.30 kg ha ⁻¹ Tricho-D	0.75 ^c

^{a,b,c} Means with different letter are statistically significant ($P < 0.05$).

Rhizoctonia solani incidence

In Table 2, it is shown that the control treatment inoculated without application presented the highest percentage of incidence of the disease with 60%, followed by 0.20 kg ha⁻¹ of Tricho-D with 25% incidence with an average similar to treatment 0.25 kg ha⁻¹ of Tricho-D with 15%. Finally, the 0.3 kg ha⁻¹ Tricho-D treatment presented a lower value with 7.5% incidence.

Table 2

*Percentage of incidence of *R. solani* in potato cv. Yungay*

Treatments	Degree of severity
Control	60 ^a
0.20 kg ha ⁻¹ Tricho-D	25 ^b
0.25 kg ha ⁻¹ Tricho-D	15 ^{bc}
0.30 kg ha ⁻¹ Tricho-D	7.5 ^c

^{a,b,c} Means with different letter are statistically significant ($P < 0.05$).

Area Under the Disease Progress Curve (AUDPC) of *R. solani* lactea

In Table 3, the control with 862.5 of the AUDPC is observed, statistically higher than the dose of 0.20 kg ha⁻¹ of Tricho-D with 547.5 of the AUDPC, then followed by the dose of 0.25 kg ha⁻¹ of Tricho-D with 412.5 of the AUDPC and finally the dose of 0.30 kg ha⁻¹ of Tricho-D with 287.5 of the AUDPC.

Table 3

Area Under the Disease Progress Curve of R. solani in potatoes cv. Yungay

Treatments	AUDPC (% day)
Control	862.5 ^a
0.20 kg ha ⁻¹ Tricho-D	547.5 ^b
0.25 kg ha ⁻¹ Tricho-D	412.5 ^c
0.30 kg ha ⁻¹ Tricho-D	287.5 ^c

^{a,b,c} Means with different letter are statistically significant ($P < 0.05$).

Tuber weight

Table 4 shows that the dose of 0.3 kg ha⁻¹ of Tricho-D stood out statistically to all treatments, presenting the highest weight per plant with 757.5 g plant⁻¹ together with 0.25 kg ha⁻¹ Tricho-D with 607.5 g plant⁻¹, statistically higher than the dose of 0.2 kg ha⁻¹ of Tricho-D with 472 g plant⁻¹, being the control with the lowest yield with 225 g plant⁻¹.

Table 4

Weight of tubers in potato cv. Yungay

Treatments	Tuber weight (g plant ⁻¹)
Control	757.5 ^a
0.20 kg ha ⁻¹ Tricho-D	607.5 ^{ab}
0.25 kg ha ⁻¹ Tricho-D	472.0 ^b
0.30 kg ha ⁻¹ Tricho-D	225.0 ^c

^{a,b,c} Means with different letter are statistically significant ($P < 0.05$).

Discussion

The results showed that the highest degree of severity with 3.50 was for the control without application, while the doses of 0.25 and 0.3 kg ha⁻¹ Tricho-D obtained degrees of 1.00 and 0.75 of severity, these results being similar to those reported by Beagle & Papavizas (1985). The highest percentage of incidence of the disease was the control with 60%, while the dose of 0.25 kg ha⁻¹ of Tricho-D obtained 15% of incidence, and the dose of 0.3 kg ha⁻¹ of Tricho-D presented the lowest percentage, about 7.5% incidence.

Similar results were observed by Tsror (2001) who mentions that the incidence of the disease was significantly reduced with *T. harzianum* when applied in the furrows (50 g m⁻¹) obtaining an incidence of 3%.

The results indicate that the dose of 0.3 kg ha⁻¹ of *T. harzianum* was the one that obtained the highest percentage of control efficiency with 82.5%, together with the dose of 0.25 kg ha⁻¹ Tricho-D with 70% efficiency, higher statistically at the dose of 0.2 kg ha⁻¹ of Tricho-D with 22.5%. These results were similar to that observed by Melo and Faull (2000) who mention that the parasitism of *R. solani* by strains of *Trichoderma spp.* It has high efficiency because *Trichoderma* has proven to be particularly effective in controlling the pathogen.

The results show at the dose of 0.3 kg ha⁻¹ of Tricho-D with the highest weight of tubers with 757.5 g plant⁻¹ together with the dose of 0.25 kg ha⁻¹ with 607.5 g plant⁻¹, statistically higher than the dose of 0.2 kg ha⁻¹ of Tricho-D with 472 g plant⁻¹, being the control the one that produced the lowest weight of tubers with 225 g plant⁻¹. These results indicate that the highest doses of Tricho-D increase the weight of the tubers per plant, due to the characteristics that this bio controller possesses, such as parasitism and the mobilization of nutrients in the soil. Similar results were observed by Sharma & Ram (2007) who mention that the tuber yield was significantly higher in the plots treated with *T. harzianum* (25.12 t ha⁻¹) compared to the farmers' plots.

Conclusions

The dose of 0.3 kg ha⁻¹ of Tricho-D (*T. harzianum*) had an antagonistic effect with the parasitic activity of the *Rhizoctonia solani* fungus, influencing the control of black scab and the weight of tubers in potatoes cv. Yungay under the conditions of Chavín de Huantar, Ancash.

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