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SHORT COMMUNICATION

Control of potato early blight with triazole fungicide using preventive and curative spraying, or a forecasting system

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Abstract

J.D. Mantecón. 2009. Control of potato early blight with triazole fungicide using preventive and curative spraying, or a forecasting system. Cien. Inv. Agr. 36(2):291-296. During the 2005 and 2006 growing seasons, two field trials were conducted at the INTA Balcarce Experimental Station (Argentina) to study the control of potato early blight (*Alternaria solani*). Uncut virus-free seed tubers of potato (*Solanum tuberosum*) cv. Pampeana INTA that were susceptible to early blight and resistant to late blight were machine planted in 0.20-m intervals in rows spaced 0.8 m apart. Each plot consisted of 4 rows that were 5 meters long. Difenoconazole (Bogard 25EC) was sprayed weekly at a rate of 0.25 L·ha^{-1} or bi-weekly at a rate of 0.50 L·ha^{-1} on a preventive program and on a curative program. The same treatments and rates were also applied when the forecast model (Specware 6.02) reached 300 P-Days after emergence, and applications were then repeated thereafter every 7 FAST severity values. Disease severity was rated using the 0-50 rating scale (0 = no infection; 50 = maximum infection). Tubers from the two center rows of each plot were harvested and graded into two categories, either marketable (>60 g) or undersize tubers "seeds" (<60 g), and weighed for total yield. Climatic conditions were very favorable for disease development. In both years, untreated plants showed severe early blight symptoms and reached the maximum disease severity. Preventive fungicide applications at the high dose and applications following the Specware 6.02 disease prediction model showed similar efficacy. Curative fungicide applications at the lowest dose and applications on the basis of the Specware 6.02 disease prediction model resulted in a poor control of foliar symptoms, and yields were lower than those obtained with a preventive control program.

Keywords: *Alternaria solani*, Argentina, disease control, early blight, potato, prediction model, *Solanum tuberosum*.

Introduction

Early blight (*Alternaria solani*) of potato (*Solanum tuberosum*) has been recognized as a problem since its discovery in 1892. Although it is possible to control early blight genetically, the most effective control measure has been the frequent application of protectant fungicides starting early in the growing season and continuing until vine kill. When infection occurs in mature plants and the disease symptoms appear late in the season, yields are only slightly affected. Field resistance to foliage infection has been associated with plant maturity (Christ and May, 2004). Late-maturing cultivars are usually more resistant than early-maturing cultivars.

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Protective fungicides recommended to control late blight (*Phytophthora infestans*) are also effective against early blight when applied at approximately seven-day intervals (Douglas and Groskopp, 1974; Harrison *et al*., 1965a,b). However, protectant fungicides are also needed for disease control, particularly for susceptible potato cultivars if conidia of *A. solani* are present early in the growing season and weather conditions are favorable for disease development. Previous works (Mantecón, l992-1996) have demonstrated that the use of triazole and imidazole fungicides used in a preventive program provide greater control than the use of traditional non-systemic fungicides. The most common and effective control method for early blight is foliar fungicide application (Mantecón l998; 2000a, b; 2006).

Disease forecasting models may be used to predict the onset of early blight and specify when the initial fungicide application of the season should be applied. The potato model developed by Specware 6.02 (Seedmech S.A., Rosario, Argentina) to forecast early blight is a computer program providing information that warns growers of the potential for early blight development. It is a useful tool to schedule fungicide applications. This forecasting model estimates the increased susceptibility of potato plants according to their physiological age. It determines the number of days (P-days) after potato emergence at which plants become susceptible to the disease. In general, early-maturing cultivars should be sprayed at approximately 250 P-days, whereas fungicide applications for late-maturing cultivars should commence at approximately 300 P-days.

The objective of this study was to determine the efficacy of a systemic triazole fungicide for the control of potato early blight when it was applied either before or after symptoms of the disease appeared on the crops, or following disease prediction based on the Specware 6.02 model (which detects favorable environmental conditions for the development of *A. solani*).

Materials and methods

During the 2005 and 2006 seasons, two field trials were conducted at the INTA Balcarce Experimental Station (Argentina) in a Brunizen soil containing 4.5% organic matter. Uncut virus-free seed tubers (cv. Pampeana INTA) that were susceptible to early blight but resistant to late blight were machine planted at 0.20-m intervals in rows spaced 0.8 m apart.

Experimental plots consisted of four rows that were 5 m long and spaced 0.7 m apart. Each plot was bordered by unsprayed potato guard rows that were 4 m long. The guard rows function to promote disease development and minimize drift from adjacent plots. Weed control, insect control, and fertilization were conducted according to standard recommended practices for the region. To increase disease development, the crops were irrigated 4 times with a total of 120 mm of water.

Difenoconazole (Bogard 25EC), a triazole fungicide, was sprayed weekly at a rate of 0.25 L·ha-1 or biweekly at a rate of 0.50 L·ha-1. Fungicide applications were initiated 70 days (at the end flowering stage) after planting. The preventive program consisted of either five sprays applied weekly or three sprays applied biweekly. The curative program consisted of the same treatments and rates except four sprays were applied weekly or two sprays applied biweekly. This curative program began 80 days after planting or when the forecast model (Specware 6.02 model) reached 300 P-Days after emergence. Thereafter, treatments were repeated every 7 FAST severity values (Specware values) with three spray applications in total. To enhance late blight control, the entire trial was sprayed on a 7-day schedule with Previcur (propamocarb) LS72 at a rate of 1.0 L·ha-1 beginning 40 to 70 days after planting. All of the fungicide solutions were made using water. The fungicides were applied with a boom CO2 pressurized backpack sprayer equipped with four ceramic disc-types at 50 lb·in-2 at a rate of 250 L·ha-1.

Disease severity was rated using a 0-50 rating scale (0 = no infection; 50 = maximum infection) (Reifschneider *et. al*., 1984). Tubers from the two center rows of each plot were harvested. After the tubers were harvested, they were graded into one of two categories, either marketable (>60 g) or undersize tubers "seeds" (<60 g), and the total yield by weight was determined. Each treatment

was arranged in a randomized complete block design and replicated four times. Data were subjected to analysis of variance, and means from each year were compared using the least-significant difference test (LSD) at p = 0.05.

Results

Climatic conditions were highly favorable for disease development during both growing seasons, implying that maximum disease severity was reached in untreated plants (Table 1). Under these environmental conditions, fungicide treatments significantly reduced disease severity in comparison to the untreated plots. None of the fungicide treatments provided complete control of the foliar symptoms of early blight; however, they exceeded the untreated control plots in the number of marketable potato tubers produced and in total yield. Only a treatment of 0.50 L·ha^{-1} of difenoconazole applied according to the Specware 6.02 prediction model overcame the untreated control in potato yields in the 2005 season. Preventive fungicide treatments applied at the high rate following the Specware 6.02 disease prediction model showed similar efficacy in the control of foliar symptoms and yield. A poor efficacy was obtained following curative fungicide programs and the Specware 6.02 disease prediction model when difenoconazole was used at the lowest rate. In these trials, the Specware 6.02 system reduced the frequency of fungicide sprays, but it did not reduce the amount of fungicide applied per hectare compared to the standard preventive program based on weekly fungicide applications.

Table 1. Effects of fungicide treatments on early blight (*Alternaria solani*) control on both foliage infection and potato yield in field trials conducted in the 2005 and 2006 growing seasons.

	Early blight severity Days after planting time				Potato yield, kg·plot^{-1}			
Difenoconazole[1] treatments L·ha^{-1}	82	92	102	110	Market >60 g	Seeds <60 g	Total	t·ha^{-1}
2005 growing season								
Untreated	15.0 a[2]	25.0 a[2]	50.0 a[2]	50.0 a[2]	10.8 c[2]	5.8 b[2]	16.6 c[2]	27.6
Preventive program								
0.25	0.0 b	0.0 c	5.0 cd	5.0 d	20.6 a	6.4 ab	26.0 ab	43.2
0.50	0.0 b	5.0 bc	5.0 cd	5.0 d	19.5 a	6.5 ab	25.8 ab	42.8
Curative program								
0.25	5.0 b	5.0 bc	15.0 bc	25.0 b	15.4 b	6.9 ab	22.3 b	36.9
0.50	5.0 b	10.0 b	10.0 b	15.0 c	16.0 b	7.2 ab	23.2 b	39.5
Forecast program[3]								
0.25	5.0 b	10.0 b	15.0 bc	25.0 b	15.5 b	7.0 ab	22.5 b	37.7
0.50	5.0 b	5.0 bc	5.0 d	5.0 d	19.8 a	7.6 a	27.4 a	45.5
LSD (P=0.05)	5.0	5.5	5.4	7.0	3.3	1.55	3.75	
2006 growing season								
Untreated	5.0 a[2]	15.0 a[2]	25.0 a[2]	50.0 a[2]	10.6 c[2]	4.0 a[2]	14.6 c[2]	22.8
Preventive program								
0.25	0.0 b	0.0 b	5.0 c	5.0 c	19.9 a	5.1 a	25.0 a	39.0
0.50	0.0 b	0.0 b	5.0 c	5.0 c	20.1 a	4.6 a	24.7 a	38.5
Curative program								
0.25	0.0 b	5.0 b	15.0 b	15.0 b	15.9 b	5.2 a	21.1 b	32.9
0.50	0.0 b	5.0 b	5.0 c	5.0 c	16.5 ab	4.4 a	20.9 b	32.6
Forecast program[3]								
0.25	0.0 b	5.0 b	15.0 b	15.0 b	15.0 b	4.4 a	19.4 b	30.3
0.50	0.0 b	5.0 b	5.0 c	5.0 c	18.6 ab	4.3 a	22.9 ab	35.7
LSD (P=0.05)	0	5.0	5.5	5.0	3.7	0.9	3.2	

[1]Difenoconazole was applied as Bogard 25 EC.
[2]The same letters within each column and each growing season are not significantly different according to the Least Significant Differences (LSD) test (p = 0.05).
[3]Forecast program was based on the Specware 6.0 prediction model.

Discussion

These results confirm that fungicide applications based on prediction methods for early blight reduce the number of fungicide applications and provide effective control of potato early blight in comparison to the use of systematic preventive sprayings. In previous results, preventive sprayings using strobilurin fungicides showed a complete control of early blight symptoms in the field. These results were not obtained with triazole fungicide applications whether triazoles were applied preventively, curatively or according to prediction methods. Therefore, strobilurins may be more efficient than triazole for early blight control. In this study, the control efficacy of triazole applied according to epidemic prediction methods and following a preventive strategy was similar. The control efficacy of triazole applied following a curative strategy appeared to be closely related to the dose of the applied fungicide.

In conclusion, the efficacies of a triazole fungicide (difenoconazole) for the control of potato early blight (A. solani), at the fungicide rates used in this study, and under the climatic conditions in the Southeast of the province of Buenos Aires, were similar following either the traditional preventive method or based on the disease prediction model. Triazole fungicide applications based on the prediction models reduce the number of sprays needed for the efficient control of early blight; however, they do not reduce the amount of fungicide applied per hectare. The control efficacy for the disease based on the curative applications of triazole fungicides is closely related to the dosage of fungicide applied.

Resumen

J.D. Mantecón. 2009. Control del tizón temprano de la papa con triazol aplicado en forma preventiva y curativa o siguiendo el pronóstico de la enfermedad. Cien. Inv. Agr. 36(2):291-296. Durante los años 2005 y 2006 se desarrollaron ensayos de control del tizón temprano (*Alternaria solani*) de la papa (*Solanum tuberosum*) en la Estación Experimental del INTA en Balcarce, Argentina. Se utilizaron tubérculos "semilla", cultivar Pampeana INTA, susceptible a tizón temprano y resistente a tizón tardío. Se evaluó el fungicida difenoconazole (Bogard 25EC), triazol, el cual se pulverizó semanalmente en dosis de 0,25 $L \cdot ha^{-1}$ y quincenalmente en dosis de 0,50 $L \cdot ha^{-1}$, siguiendo un programa preventivo. Los mismos tratamientos se aplicaron según un programa curativo y luego de la emergencia del cultivo cuando el sistema predictivo de aparición de la enfermedad alcanzó los 300 P-Days de acuerdo con el modelo de Specware 6.02, repitiendo las pulverizaciones cuando la severidad en el sistema Specware 6.02 alcanzó valores de 7. La severidad de la enfermedad se evaluó en escala 0-50 (0 = sin síntomas; 50 = máxima infección). Se evaluó el rendimiento de tubérculos comerciales, "semilla" y total. Las condiciones climáticas fueron muy favorables para el desarrollo del tizón temprano. En ambas temporadas las plantas testigo presentaron severos niveles de infección y alcanzaron los máximos valores en la escala de evaluación. Difenoconazol aplicado en la mayor dosis según el programa preventivo de control y el sistema predictivo Specware 6.02 mostró similar eficacia de control de los síntomas foliares, obteniéndose similares rendimientos. El programa curativo de control y el sistema predictivo utilizando difenoconazole en la menor dosis fue menos eficaz y se obtuvieron menores rendimientos que en el programa preventivo de control de esta enfermedad.

Palabras clave: *Alternaria solani***,** Argentina, control de enfermedades, modelos de predicción, papa, *Solanum tuberosum*, tizón temprano.

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