Control of Target Spot of Tomato with Fungicides, Systemic Acquired Resistance Activators, and a Biocontrol Agent

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Abstract

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Control of target spot of tomato, caused by the fungus *Corynespora cassiicola* (Berk. & Curt.) Wei., was studied in three seasons in southern Florida, USA. The strobilurin fungicide azoxystrobin and a combination product of mancozeb and fumoxate provided excellent control of target spot. In these treatments, accumulated disease severity values were only 10–15% of those in the untreated control and marketable yields were doubled. Excellent disease control also was achieved with acibenzolar-S-methyl, a systemic acquired resistance activator (SAR). This compound reduced defoliation of tomato plants by 42% compared to the control. An experimental compound, BAS 510 02, provided good control of target spot, reducing defoliation by 40% and increasing marketable yields by 34%. Harpin protein and *Bacillis subtilis* strain QST 713 were not effective for control of target spot.

Keywords: target spot; *Corynespora cassiicola*; tomato; *Lycopersicon esculentum*; biocontrol agents; systemic acquired resistance; fungicides

Target spot of tomato, caused by the fungus *Corynespora cassiicola* (Berk. & Curt.) Wei., is one of the most serious foliar diseases of tomato (*Lycopersicon esculentum* Mill.) in the winter tomato production areas of Florida, USA. Losses in marketable yield of 11 800 kg/ha have been recorded in test plots when target spot has not been adequately controlled (PERNEZNY *et al.* 1996). Leaf symptoms of target spot include necrotic lesions with light-brown centers. These lesions often coalesce and result in large blighted areas on leaves that lead to premature defoliation. Perhaps the most serious aspect of target spot is the development of lesions on fruit. These fruit symptoms range from small, brown, sunken flecks to large, deeply pitted areas that render the fruit totally unsuitable for market. Fruit are often predisposed to target spot by injury from sand and soil particles impinging the fruit surfaces during stormy weather (VOLIN *et al.* 1989).

Host-plant resistance and cultural methods have not been effective strategies for management of this disease (BLAZQUEZ 1977). Foliar sprays with fungicides have offered the best alternative for Florida growers to date (JONES & JONES 1984). The objective of this research was to investigate the management of target spot with newer generation fungicides, systemic acquired resistance (SAR) activators, and a biocontrol agent.

MATERIALS AND METHODS

Field experiments were conducted at the University of Florida Indian River Research and Education Center, Ft. Pierce, FL in the Spring 2001, Fall 2001, and Spring 2002 seasons. For each of these experiments, tomato transplants were grown from seeds in polystyrene trays. Approximately one month later, transplants were set into raised, plastic-mulched beds formed from Oldsmar fine sand soil

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on the research center farm. Beds were spaced 2.1 m apart center to center with seedlings 61 cm apart within rows. A seepage irrigation system was used in all tests. Transplants received an application of the insecticide imidacloprid in the transplant water at 0.42 kg a. i./ha, primarily for control of the whitefly, *BemIsia argentifolii* Bellows & Porring. An application of 4–16–4 (NPK) fertilizer was broadcast at 770 kg/ha and incorporated into beds. An additional 1537 kg/ha of 8–12–20 (NPK) fertilizer was applied as two bands near the shoulders of the bed just prior to coverage with plastic mulch. Dolomite (2.7 metric tonnes/ha) was applied as needed to help prevent fruit loss from blossom-end rot. Insect pests and interbed weeds were controlled as needed (POHRONEZNY *et al.* 1986).

Tomato cultivar and transplanting date were: Agriset 6153, 21 February 2001 for Spring 2001; Agriset 6153, 12 September 2001 for Fall 2001; and Florida 91, 19 February 2002 for Spring 2002. Weekly applications of foliar sprays were initiated seven days after transplanting and were continued until seven days before the final harvest. Treatments were applied using a hand-held, 11.3-L garden sprayer at approximately 10.3-KPa pressure with thorough wetting of foliage to run-off. The design for all experiments was a randomized complete block with four replications of each treatment.

The compounds and formulations tested for target spot control over these three seasons are shown in Table 1. Specific treatments, rates, and timing for each experiment are shown in Tables 2–4. Several different types of compounds were evaluated in our trials, including standard broad-spectrum fungicides (chlorothalonil, copper hydroxide, mancozeb); strobilurin fungicides (azoxystrobin, pyraclostrobin); a biocontrol agent (*Bacillus subtilis,* strain QST 713); chemicals that induce SAR in the host plant (acibenzolar-S-methyl, harpin protein); and new classes of fungicides (fumoxate and BAS 510 02).

Plants were rated for disease weekly, beginning three weeks after transplanting. An estimate of the percentage of foliage covered by lesions and foliage lost due to disease were combined into one defoliation rating (PERNEZNY *et al.* 1996). For the Spring 2001 trial, standard iterative procedures were used to calculate the area under the disease progress curve (AUDPC) (SHANER & FINNEY 1977). Plots were harvested 2 to 3 times at 10–14 day intervals beginning when about 10% of fruit began to turn pink. Final harvest dates were 30 May 2001, 27 December 2001, and 16 May 2002 for each of the experiments. At each harvest, all pink and red fruit within 3 m of row in the center of each plot were counted, weighed, and sorted into several cull (defect) categories, including direct damage from target spot. All data were subjected to analysis of variance and Fisher's Protected LSD mean separation procedure at $P \leq 0.05$ (STEEL & TORRIE 1980).

RESULTS

Target spot damage was severe in experimental plots in the Spring 2001 trial, as evidenced by the high AUDPC values that accumulated by the end of the season (Table 2). The defoliation ratings, upon which these AUDPC values were based, reached 75% in control plots. All spray treatments except the *Bacillus subtilis* strain QST 713 reduced foliar damage compared to the control. The most effective treatments for management of target spot were those using the strobilurin fungicide azoxystrobin, and those containing fumoxate, a new class of fungicide. The manufacturer's formulation of fumoxate and man-

Table 1. Materials tested for control of target spot, formulation, and manufacturer

Material	Pesticide category	Formulation	Manufacturer
Acibenzolar-S-methyl	SAR[1]	wettable granule	Syngenta Crop Protection, Inc.
AMSF 187	fungicide	wettable granule	Bayer Corp.
AMS 2168 480	fungicide	soluble concentrate	Bayer Corp.
Bacillus subtilis strain QST 713	biocontrol agent	wettable powder	AgraQuest
Chlorothalonil	fungicide	emulsifiable concentrate	Zeneca, Inc.
Copper hydroxide	fungicide	wettable powder	Griffin L. L. C.
Dupont DPX-KP481	fungicide	wettable powder	E. I. du Pont de Neimours & Co.
Fumoxate + mancozeb	fungicide	wettable powder	E. I. du Pont de Neimours & Co.
Harpin protein	SAR[1]	soluble powder	Eden Bioscience
Mancozeb	fungicide	wettable powder	Elf Altochem
Pyraclostrobin	fungicide	wettable granule	BASF
BAS 510 02F	fungicide	wettable granule	BASF

[1] SAR = Systemic acquired resistance activator

Table 2. Disease ratings and yields for tomato target spot control trial, Spring 2001, Ft. Pierce, Fl.[a] USA

Treatment and rate[b]	AUDPC[cd]	Marketable number	Marketable weight (kg)	Total number	Total weight (kg)	Average weight/fruit (g)[e]	Fruit damage from target spot (% by weight)
1. Untreated control	880.10 a	594 d	66.1 c	975 b	111.0 b	111 b	8.71
2. *Bacillus subtilis,* strain QST 713 (4.5 kg /ha) sprayed weekly	934.76 a	815 abc	121.6 abc	1189 a	155.6 ab	128 ab	7.70 NS
3. Harpin protein (0.63 kg/ha) sprayed every 14 days throughout season	381.40 b	851 abc	123.2 ab	1237 a	159.5 a	126 ab	5.20
4. Copper hydroxide (1.7 kg a.i/ha) + *Bacillus subtilis* strain QST 713 (2.2 kg/ha) weekly	375.56 b	728 cd	98.1 bc	1173 ab	144.4 ab	122 ab	13.5
5. Chlorothalonil (1.7 kg a.i./ha) + copper hydroxide (1.7 kg a.i/ha) + mancozeb (1.8 kg a.i./ha) sprayed weekly	239.23 bc	803 bc	116.8 abc	1135 ab	144.2 ab	130 ab	14.9
6. Fumoxate + mancozeb (1.5 kg a.i./ha) sprayed weekly	196.67 bc	865 abc	116.8 abc	1218 a	150.8 ab	124 ab	1.60
7. Chlorothalonil (1.3 kg a.i./ha) 7 days after transplanting, again 7 days later, then azoxystrobin (0.11 kg a.i./ha) 7 days later. Chlorothalonil and azoxystrobin alternated throughout season	139.35 c	901 abc	135.4 ab	1274 a	173.8 a	134 ab	6.10
8. Mancozeb (1.4 kg a.i./ha) for first 2 week, then Dupont DPX-KP481 (0.42 kg a.i./ha) sprayed weekly	128.11 c	899 abc	134.1 ab	1208 a	161.7 a	132 ab	2.61
9. Harpin protein (0.63 kg/ha) sprayed 7 days after transplanting, chlorothalonil (1.3 kg a.i./ha) 7 days later, then harpin protein + azoxystrobin (0.11 kg a.i./ha) 7 days later, then alternate chlorothalonil and harpin protein + azoxystrobin weekly throughout season	111.61 c	984 ab	132.4 ab	1300 a	159.3 a	124 ab	2.39
10. Fumoxate + mancozeb (1.2 kg a.i./ha) sprayed weekly	87.10 c	1003 a	157.1 a	1300 a	189.2 a	144 a	3.31

[a] Based on totals from 2 harvests of 3 m of ground tomatoes, cv. Agriset 6153 taken from the center of 3.6 m, plastic-mulched beds. Plots harvested and fruit graded on 15, and 30 May 2001. Transplants set on 21 February and weekly sprays initiated on 1 March

[b] All materials were applied with a hand-pumped garden sprayer at ca. 10.3 kPa pressure until run-off

[c] AUDPC = Area Under the Disease Progress Curve, calculated by standard iterative procedures based on 8 weekly disease ratings. Majority of defoliation was caused by target spot

[d] Major foliar disease was target spot caused by *Corynespora cassiicola.* Means in columns followed by the same letter are not significantly different by Fisher's Protected LSD at $P \leq 0.05$

[e] Average weight/fruit based on total harvest weights

Table 3. Disease ratings and yields for tomato target spot control trial, Fall 2001, Ft. Pierce, Fl.[a] USA

Treatment and rate[b]	% defoliation Nov. 28[c]	Marketable number
1. Untreated control	70.0 a	532 c
2. Harpin protein (0.63 kg/ha) sprayed 7 days prior to transplanting, & 7 days after transplant. Then chlorothalonil (1.3 kg a.i./ha) 7 days later, harpin protein + azoxystrobin (0.11 kg a.i./ha) 7 days later, & alternate chlorothalonil & harpin protein + azoxystrobin throughout season	72.5 a	682 abc
3. Chlorothalonil (1.3 kg a.i./ha) 7 days after transplanting and 7 days later, then azoxystrobin (0.11 kg a.i./ha) alternating with chlorothalonil every 7 days for rest of season	68.8 a	733 ab
4. Harpin protein (0.63 kg/ha) sprayed 7 days prior to transplanting, 7 days after transplanting, and every 14 days throughout season. In alternate weeks, copper hydroxide (1.7 kg a.i/ha) + mancozeb (1.4 kg a.i./ha) sprayed	46.2 b	585 bc
5. Copper hydroxide (1.7 kg a.i/ha) + mancozeb (1.4 kg a.i./ha) weekly beginning at transplanting	46.2 b	719 ab
6. Copper hydroxide (1.7 kg a.i/ha) + mancozeb (1.4 kg a.i./ha) weekly, beginning at transplanting. In 3rd week, acibenzolar-S-methyl (12.1 g a.i./ha) added to tank mix for weeks 3–6. Beginning 7th week, copper hydroxide + mancozeb was sprayed weekly to end of season	35.0 bc	666 abc
7. Acibenzolar-S-methyl (12.1 g a.i./ha) weekly for 6 weeks beginning at transplanting. Beginning with 7th week, copper hydroxide (1.7 kg a.i/ha) + mancozeb (1.4 kg a.i./ha) added in weekly sprays until end of season	31.2 bc	753 a
8. Acibenzolar-S-methyl (12.1 g a.i./ha) weekly beginning at transplanting for 4 weeks. Beginning with 5th week, copper hydroxide (1.7 kg a.i/ha) + mancozeb (1.4 kg a.i./ha) added until end of season	27.5 c	622 abc

[a] Based on totals from 2 harvests of 3 m of ground tomatoes, cv. Agriset 6153 taken from the center of 3.6 m, plastic-mulched beds. Plots fruit graded on 28 Nov., 12 and 27 Dec. 2001. Transplants set on 10 Sept. and weekly sprays initiated on 4 Oct.

[b] All materials were applied with a hand-pumped garden sprayer at ca. 10.3 kPa pressure until run-off

cozeb reduced defoliation caused by *C. cassiicola* by over 90% compared to the untreated control.

In many instances, this disease control was associated with significant increases in fruit yield. For example, the weight of marketable fruit harvested from plots with azoxystrobin as part of the treatment regimen was about double that in untreated control plots (Table 2). Marketable fruit weights in plots treated with the 1.2 kg a.i./ha rate of fumoxate and mancozeb were 2.4 times as large as the control. It is interesting to note that although disease ratings in plots receiving the *Bacillus subtilis* strain QST 713 treatment were as high as those in the control, yields in the biocontrol plots were almost double that of the control.

In Fall 2001, target spot was again very severe, causing an average of 70% defoliation in control plots a full month before the final harvest (Table 3). Fruit damage from target spot was severe with an average of 42% of fruit culled because of target spot lesions. There was no difference detected in the amount of target spot fruit damage among treatments. The SAR activator, acibenzolar-S-methyl, provided excellent protection whether used throughout the crop or only sprayed in the middle of the crop cycle. On 28 November, defoliation from target spot was reduced 42% in plots where acibenzolar-S-methyl was sprayed weekly from the time of transplanting with the addition of weekly applications of copper hydroxide and mancozeb 5 weeks after transplanting.

Treatments containing the strobilurin fungicide azoxystrobin were much less effective in this experiment than in Spring 2001. The defoliation ratings for plots sprayed with chlorothalonil and azoxystrobin in alternate weeks were virtually the same as those for the untreated control. In contrast to acibenzolar-S-methyl, the harpin protein SAR activator was relatively ineffective in controlling target spot. Little control was achieved where harpin protein and azoxystrobin tank mixes were alternated with chlorothalonil on a weekly basis (Table 3).

In this experiment, there was no strong association between marketable or total yields and disease control. For example, even though defoliation ratings were high for the chlorothalonil-alternated-with-azoxystrobin treat-

Table 3 to be continued

Marketable wt. (kg)	Total number	Total wt. (kg)	Average wt/fruit (g)[d]	Fruit damage (% by weight)	
				Target spot	Bacterial spot
79.8 b	1057 d	116.7 d	152.5 ab	42.3 N.S.	1.36 abc
102.6 ab	1201 bcd	187.0 abc	156.0 ab	45.4	2.39 ab
107.3 a	1299 ab	188.7 abc	145.8 b	37.8	0.68 bc
94.2 ab	1272 abc	207.7 ab	167.8 a	38.3	2.45 ab
99.6 ab	1237 abc	190.4 abc	154.0 ab	42.6	1.99 abc
99.6 ab	1339 a	213.7 a	159.8 ab	44.0	2.69 a
104.1 a	1259 abc	188.0 abc	149.2 ab	42.5	0.42 c
90.7 ab	1122 bc	183.1 cd	164.8 a	43.2	1.54 abc

[c] Major foliar disease was target spot caused by *Corynespora cassiicola*. Means in columns followed by the same letter are not harvested and significantly different by Fisher's Protected LSD at $P \leq 0.05$

[d] Average weight/fruit based on total harvest weights

ment, some of the highest marketable and total yields were recorded in these plots.

Because of unusually dry weather in the spring of 2002, target spot development was delayed in this trial. For most of the season, disease levels were lower than usually observed. However, target spot did begin to cause noticeable damage by about the beginning of the harvest period. A disease rating was taken on 23 May, one week after the final harvest in order to sufficiently separate treatment ratings.

The experimental fungicide BAS 510 02 alternated with chlorothalonil provided the best control of target spot, reducing defoliation by 40% (Table 4) compared to the untreated control. This degree of target spot control was associated with a 34% increase in yield of marketable fruit. The strobilurin fungicides azoxystrobin and pyraclostrobin also significantly reduced the amount of disease compared to the untreated control but were numerically less effective than BAS 510 02. Azoxystrobin rotated with chlorothalonil on a weekly basis was associated with a statistically significant increase over the control in marketable and total yield. As in the Spring 2001 test, the *B. subtilis* strain used alone did not control target spot.

DISCUSSION

Target spot is one of the major threats to tomato production in Florida as evidenced by the severe disease in our plots from natural infection in three seasons of study. However, bacterial spot is often cited as the most serious foliar disease affecting tomato in Florida (POHRONEZNY & VOLIN 1983; POHRONEZNY *et al.* 1986; JONES *et al.* 1998). These results confirm the suggestion of PERNEZNY *et al.* (1996) that, absent effective control, target spot is the most destructive of several foliar diseases of tomato in southern Florida.

Chlorothalonil is a broad-spectrum, protectant fungicide that has been the generally accepted control of choice for target spot for a number of years (JONES & JONES 1984). For the most part, chlorothalonil also performed well in our tests. However, several newer compounds provided outstanding control of target spot. Azoxystro-

Table 4. Disease ratings and yields for tomato target spot control trial, Spring 2002, Ft. Pierce, Fl.[a] USA

Treatment and rate[b]	% defoliation May 23[c]	Marketable number	Marketable weight (kg)	Total number	Total weight (kg)	Average weight/fruit (g)[e]	Fruit damage from target spot (% by weight)
1. Untreated control	76.2 a	727 b	140.2 c	805 c	155.2 b	193 NS	5.2 ab
2. *Bacillus subtilis,* strain QST 713 (4.5 kg/ha) sprayed weekly	73.8 a	670 b	135.1 c	847 bc	168.1 ab	198	6.8 ab
3. AMSF 187 15 WG (0.03 kg a.i./ha) + AMS 21618 480 SC (0.12 kg a.i./ha)	53.8 b	838 ab	169.4 abc	1090 abc	217.6 ab	200	5.2 ab
4. *Bacillus subtilis,* strain QST 713 (4.5 kg/ha) + copper hydroxide (1.7 kg a.i/ha) weekly	51.2 bc	1033 a	135.1 ab	1149 a	218.3 a	190	8.2 a
5. Pyraclostrobin (0.17 kg a.i./ha) alternating with mancozeb (1.4 kg a.i./ha) throughout season	50.0 bc	757 b	144.0 bc	1075 ab	201.5 ab	187	5.2 ab
6. Pyraclostrobin (0.11 kg a.i./ha) alternating with chlorothalonil (1.3 kg a.i./ha) throughout season	50.0 bc	820 ab	158.5 abc	1104 a	208.8 ab	189	5.4 ab
7. AMSF 187 15 WG (0.036 lb a.i./acre) + AMS 21618 480 SC (0.11 kg a.i./ha)	46.2 bc	805 ab	152.3 abc	942 abc	188.4 ab	200	4.5 ab
8. Azoxystrobin (0.11 kg a.i./ha) every other week, alternating with chlorothalonil (1.3 kg a.i./ha) throughout season	46.2 bc	1015 a	206.6 a	1207 a	243.9 a	202	2.8 b
9. BAS 510 02 F, 70 WG (0.17 kg a.i./ha) every other week, alternating with chlorothalonil (1.3 kg a.i./ha) throughout season	36.2 c	874 ab	187.5 ab	1071 abc	201.9 ab	213	2.4 b

[a] Based on totals from 2 harvests of 3 m of ground tomatoes, cv. Florida 91, taken from the center of 3.6 m plastic-mulched beds. Plots harvested and fruit graded on 7 May and 16 May 2002. Transplants set on 19 February and weekly sprays initiated on 7 March

[b] All materials were applied with a hand-pumped garden sprayer at ca. 10.3 kPa pressure until run-off

[c] Major foliar disease was target spot, caused by *Corynespora cassiicola.* Means in columns followed by the same letter are not significantly different by Fisher's Protected LSD at P ≤ 0.05

[d] Average weight/fruit based on total harvest weights

bin, one of the strobilurin fungicides with a chemistry based on a natural product from a mushroom, provided excellent control of target spot in Spring 2001 and was nearly as effective in Spring 2002. This compound is now labeled for use on tomatoes in the United States and fits well into an integrated pest management (IPM) program. It has low mammalian toxicity and is environmentally safe. Azoxystrobin was used in rotation with chlorothalonil in our tests because of the manufacturer's legitimate concerns for rapid development of fungicide resistance. The limited mode of action of azoxystrobin makes it vulnerable to development of resistance among target fungus populations. The current label for azoxystrobin reads that the farmer is not to make more than two sequential applications of this compound and to alternate applications with broad-spectrum fungicides. We followed this advice in our tests and tank-mixed or alternated azoxystrobin with broad-spectrum materials such as chlorothalonil. Pyraclostrobin, another strobilurin fungicide, tested in Spring 2002, has very recently received full registration for use on tomatoes in the United States and gives growers another option for rotation in an integrated program for target spot control.

Azoxystrobin did not provide adequate control in Fall 2001. This is a disturbing outcome. Strobilurin fungicides with this specific and limited biochemical mode of action might be expected to be prone to development of resistance. In all three experiments, target spot epidemics were initiated by ingress of natural inoculum, probably from commercial tomato farms in the Ft. Pierce vicinity. It may be that one of these natural populations in Fall 2001 contained a variant isolate or isolates resistant to azoxystrobin. Isolates of *Didymella bryoniae* (Auersw.) Rehm, causal agent of gummy stem blight of cucurbits, have recently been shown to be resistant to azoxystrobin after limited use (STEVENSON *et al.* 2002).

Acibenzolar-S-methyl showed great promise for target spot management. SAR activator compounds, such as acibenzolar-S-methyl, control plant diseases in a novel way. When applied to plant surfaces, they elicit a plant defense reaction, analogous to the immune reaction in animal systems (STRICHER *et al.* 1997). SAR activators tend to be of low mammalian toxicity and are environmentally friendly. Acibenzolar-S-methyl should fit well in an integrated pest management program for tomatoes (POHRONEZNY *et al.* 1986). This compound has full registration for use on tomato in the United States, and many Florida growers are beginning to use it on their tomato crops. Acibenzolar-S-methyl has also been shown to be effective against two other foliar diseases of tomato, bacterial spot and bacterial speck (LOUWS *et al.* 2001). Not all SAR activators may be equally efficacious against all diseases, however. For example, in our tests, the SAR activator harpin protein did not provide economically acceptable levels of target spot control.

The new classes of fungicides, fumoxate and BAS 510 02, are not currently registered for use on tomato, but fumoxate, in particular, should be legally cleared for use in the near future. Biocontrol agents are another class of materials that have been studied for management of foliar pathogens (BLAKEMAN & FUKKEMA 1982; BEER *et al.* 1984). Such products registered by the U.S. Environmental Protection Agency are safe to humans and the environment and are specifically effective for a limited number of plant pathogens in the phyllosphere. Unfortunately, we did not find *B. subtilis* strain QST 713 to appreciably reduce target spot damage. Since target spot is a key foliar disease in the pathogen complex facing Florida tomato growers, there is little likelihood that QST 713 will fit into an integrated disease program at this time.

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Souhrn

PERNEZNY K., STOFFELLA P., COLLINS J., CARROLL A., BEANEY A. (2003): **Regulace skvrnitosti rajčete způsobované houbou** *Corynespora cassiicola* **aplikací fungicidů, aktivátorů systémové získané rezistence a bioagens**. Plant Protect. Sci., **38**: 81–88.

Regulace skvrnitosti rajčete způsobované houbou *Corynespora cassiicola* (Berk. & Curt.) Wei. byla sledována ve třech vegetačních obdobích na jižní Floridě (USA). Vynikající regulace skvrnitosti se dosáhlo strobilurinovým fungicidem azoxystrobinem a kombinovaným přípravkem s obsahem mancozebu a fumoxatu. Po těchto ošetřeních dosáhly hodnoty souhrnné síly choroby pouze 10–15 % hodnot na neošetřených kontrolách a objem zpeněžitelné sklizně se zdvojnásobil. Vynikající regulace choroby se také dosáhlo acibenzolar-S-methylem, aktivátorem systémové získané rezistence. V porovnání s kontrolou tato sloučenina snížila opad listů rajčete o 42 %. Dobrou účinnost prokázala experimentální sloučenina BAS 510 02; opad listů se snížil o 40 % a objem zpeněžitelné sklizně se zvýšil o 34 %. Účinnými regulátory skvrnitosti nebyl harpinový protein a kmen *Bacillis subtilis* QST 713.

Klíčová slova: skvrnitost; *Corynespora cassiicola*; rajče; *Lycopersicon esculentum*; bioagens; systémová získaná rezistence; fungicidy

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