Control of root necrosis of strawberry caused by *Colletotrichum acutatum*

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Introduction

Strawberries are grown as an annual crop on 4,000 to 5,000 ha of land in west central Florida. Transplants are set in the fall, harvested over the winter, and destroyed in the spring. Each year, approximately 200,000,000 transplants from northern and high-elevation nurseries are planted into Florida fields. Unfortunately, some arrive infected with the anthracnose fungus *Colletotrichum acutatum*, a pathogen that can be propagated along with the plants in the nursery.

C. acutatum-infected transplants may or may not show obvious symptoms such as petiole lesions or premature darkening of large structural roots. After transplanting, diseased plants grow slowly and become stunted or may die and require replacement. Yields from seriously affected fields are much reduced (Fig. 1). If stunted transplants are dug 3 to 6 weeks after planting, a mixture of dark necrotic and diseased living roots may be observed (Fig. 2). These symptoms have been referred to as root necrosis.

Poor plant establishment due to root necrosis occurs sporadically. Numerous strawberry nurseries produced *C. acutatum*-infected transplants in 2004. Two nurseries had similar problems in 2013. Naturally-infected plants from both outbreaks were utilized in experiments to determine the most efficacious plant dip treatments.

Materials and Methods

Trials were conducted at the University of Florida's Research and Education Center in Wimauma during the 2004-05 and 2013-14 strawberry-growing seasons. Transplants were dipped in a solution or suspension of test product in water for 5 minutes, and immediately planted in raised, plastic-mulched beds in an open strawberry field. Treatments were replicated four times in randomized complete block designs. Blocks consisted of adjacent beds and plots consisted of 15 or 20 plants each. In 2004-05, plant mortality was assessed 5 weeks after planting (WAP) and marketable yield was recorded for the entire season. In 2013-14, plant mortality was assessed 4 WAP, and yield was obtained for the first month of production.

Three products were tested in 2004-05:

1. Abound (22.9% azoxystrobin) at .. 0.5 ml/L
2. Oxidate (27.0% hydrogen dioxide) at .. 5.0 ml/L
3. Switch (36,5% cyprodinil & 25% fludioxonil).. 0.5 g/L

All three were tested again in 2013-14 along with:

5. Actinovate (10^7 cfu/g *Streptomyces lydicus*)... 1.8 g/L
6. Fontelis (20.4% penthiopyrad) .... 1.9 ml/L
7. Serenade Soil (10^9 cfu/g *Bacillus subtilis*) .. 10 ml/L
8. Regalia (5% extract of giant knotweed) .. 10 ml/L
9. Rovral (41.6% iprodione) .. 2.5 ml/L

Plants soaked in water served as controls in both trials.

Fig. 1. Root necrosis (above ground symptoms)

Fig 2. Below-ground symptoms

Table 1. Mortality and yield for plant dip treatments in 2004-05

Treatment	Mortality (%)	Yield (kg/ha)
Switch	6.7 a	20,900 a*
Abound	5.8 a	10,400 b
Oxidate	44.2 b	3,700 c
Water control	25.0 ab	7,150 bc

*Means followed by the same letter are not significantly different according to Fishers protected LSD test (α = 0.05).

Results and Discussion

In 2004-05, plant mortality in Abound and Switch treatments ranged from 5 to 7% compared to 25% in the control (Table 1). These values were not statistically different. The highest loss (44.2%) occurred with Oxidate.

Switch produced higher yields of marketable fruit than any other treatment. Abound produced roughly half as much as Switch (10,400 vs 20,900 kg/ha), and was not significantly different from the control (7,150 kg/ha). These differences may be explained by failure of Abound and Oxidate to meaningfully reduce internal colonization of the plants. *C. acutatum* was isolated from crowns of 7-week-old plants treated with Abound or Oxidate at significantly higher rates than plants treated with Switch (data not shown).

In 2013-14, Actinovate, Fontelis and Switch reduced plant mortality to 5% or less. Plant mortality exceeded 15% in all other treatments including Abound and the control. Actinovate, Fontelis, and Switch also increased early season marketable yield. Regalia's yield statistically grouped with these three products, in spite of a plant mortality of 15.2%.

The relatively poor performance of Abound was surprising. With respect to plant mortality, Abound was comparable to Switch in 2004-05, but significantly less effective than Switch in 2013-14. Reports of resistance to strobilurin fungicides such as Abound have become commonplace. *C. acutatum* isolates are being tested for resistance to azoxystrobin, the active ingredient in Abound.

In summary, we recommend Actinovate for the control of root necrosis disease and poor plant establishment due to *C. acutatum*. Switch and Fontelis are also effective. However, Switch should be reserved for control of Botrytis fruit rot if at all possible. Fontelis is not currently labeled for plant dip applications in strawberry.

Table 2. Mortality and yield for plant dip treatments in 2013-14

Treatment	Mortality (%)	Yield (kg/ha)
Switch	5.0 abc	3,270 a
Actinovate	2.5 a	3,110 a
Fontelis	3.7 ab	2,860 a
Regalia	15.2 bcd	2,540 ab
Serenade Soil	18.8 d	1,990 bc
Abound	23.8 d	1,840 bc
Rovral	16.3 cd	1,770 bc
Oxidate	17.5 d	1,770 bc
A + A*	25.2 d	1,340 c
Water control	15.1 bcd	1,970 bc

*A + A = a mixture of Abound and Actinovate