

Effects of Actigard on Tomato Yields

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Introduction

Kentucky growers currently produce about 1,000 acres of staked vine ripened tomatoes for both local and national markets. Kentucky tomatoes have an excellent reputation for quality in many market areas. During the past few years bacterial diseases (bacterial spot, speck and canker) have become major concerns for many fresh market producers. The traditional spray program used by growers offers little in the way of control for these bacterial diseases. The emergence of bacterial diseases that are resistant to copper or streptomycin has complicated traditional control of bacterial diseases on tomatoes. All of these bacterial diseases can be seedborne and with increased reliance on foreign production of hybrid seeds, the number of transplants carrying one or more of these diseases has increased. A new approach to disease control (plant immunity), Actigard, recently received a label for use on tomatoes.

Actigard, a plant activator, stimulates the plant's natural defense system, inducing systemic activated resistance (SAR) in the plant. This allows the plant to defend itself against fungal, bacterial or viral attacks. The evolution of pathogens resistant to chemicals is all but inevitable. Already, some pathogens are resistant to our conventional chemical weapons, such as copper. By choosing a chemical that stimulates the plants natural defense system, we may begin to win the battle against the rapidly evolving pathogens. Although it has been shown that Actigard can reduce the percentage of fruit and leaves infected, adequate research has not been done on the effects of Actigard on the horticultural and morphological characteristics of the tomato plant. It is reasonable to believe that since the plant is giving more of its overall energy to activating its immune system, less energy will be available for other plant functions (growth, fruit development). This could affect the size, shape, or number of the leaves, stems, or fruits.

We need to compare various disease management strategies to determine their impact on quality and yield. This research focused on measuring the effects of Actigard use on tomato fruit yield under Kentucky conditions.

Materials and Methods

Three different tomato cultivars, Cherry Grande, Heavy Weight and Mountain Fresh were used. Cherry Grande is a 66-day, determinate, red cherry tomato cultivar. Heavy Weight is a 78-day, indeterminate, red-fruited cultivar and Mountain Fresh is a 77-day, determinate, red-fruited cultivar that is commonly grown in Kentucky.

Tomato transplants were started in the greenhouse on 4 April 2001 and transplanted to the field on 5 May. Based on soil test results, 50 lb/A N and 100 lb/A K₂O fertilizer were applied preplant. An additional 75 lb of N and 50 lb of K₂O were applied during 10 weekly applications through the drip irrigation lines. Tomatoes were planted in rows 7 ft apart with plants spaced 18 in. apart in the row.

Tomato plants were treated with one of two spray regimes. The traditional regime consisted of a weekly spray program using alternating applications of mancozeb and Quadris

early in the growing season, followed by weekly applications of Bravo plus fixed copper late in the season. A total of 13 applications were made. Fixed copper was added to the Bravo spray program because of the appearance of bacterial spot. The Actigard regime was the same as the traditional regime, plus it included 6 weekly applications of Actigard starting on 25 May, 16 days after the tomatoes were transplanted. The last application was made 27 June. The first two weekly applications consisted of one-third of an ounce Actigard 50WG in 50 gallons. One-half of an ounce in 70 gallons was applied during weeks three and four and three-fourths of an ounce Actigard 50WG in 100 gallons was used for weeks five and six.

In addition to the weekly fungicide treatment all plots received insecticides (Endosulfan 3EC or Pounce 3.2 EC) as needed to control Colorado Potato Beetles or aphids.

Harvests began on 24 July and continued until 30 August for a total of 9 or 10 harvests depending on the cultivar. Tomatoes were graded, counted and weighed.

Results

For early yield of Cherry Grande, application of Actigard did not affect yield or fruit number (Tables 1 and 2), but did result in reduced yield (pounds and number) of jumbo/extra large and large 'Heavy Weight' tomatoes compared to the traditionally treated controls. Interestingly, treatment with Actigard was associated with a reduction in pounds of Heavy Weight cull fruit. Early yields of jumbo/extra large 'Mountain Fresh' fruit were also reduced in the Actigard treatment. Total early yields (Tables 1 and 2) were less when Actigard was applied to the Heavy Weight and the Mountain Fresh cultivars, compared to their traditionally treated controls. However, total yield of Cherry Grande was unaffected by Actigard application. Yields of medium and No. 2 fruit were unaffected by treatment with Actigard regardless of tomato cultivar. Differences in early yield between traditional treatment and the Actigard treatment were mainly related to differences in the size and number of large or extra large/jumbo fruit.

Trends for total season yields (pounds and fruit number) were very different from those for early yield (Tables 3 and 4). Cherry Grande had a significant reduction in medium and small fruit numbers and pounds of medium/small tomatoes and a reduction in cull fruit numbers when Actigard was used, compared to the traditionally treated control. Application of Actigard on 'Heavy Weight' tomato was associated with a severe reduction in pounds of large fruit and number of large and extra large/jumbo fruit, compared to its traditionally treated control. Pounds and number of cull fruit were reduced when Actigard was used on Heavy Weight. For Mountain Fresh total season yields, application of Actigard resulted in an increase in the pounds and number of extra large/jumbo tomatoes and a reduction in the pounds of cull tomato fruit.

There was an interaction between tomato cultivar and the spray treatment used. Compared to its traditionally treated control, Mountain Fresh treated with Actigard had a lower yield early in the season but season-long total yield for the Actigard treatment was greater than its control. On the other hand, both early and total yield of Heavy Weight was reduced by application of Actigard. Cherry Grande early season yields were not affected by the spray program but for the full season, number and pounds of medium/small fruit and culls were reduced by Actigard application. In general the application of Actigard reduced the number and pounds of cull fruit. This reduction was not associated with any obvious fruit disease. A late season infection of bacterial leaf spot developed in the trial during harvest.

There was a significant difference between the three tomato cultivars in disease severity (Table 5). Mountain Fresh had less disease than the other two cultivars. Cherry Grande had significantly more. At the time of the first evaluation, the Mt. Fresh plants that had been treated with Actigard had significantly less disease than the traditionally treated Mt. Fresh plants (Table 6). Two weeks later this difference had disappeared. The final traditional spray was applied to the tomatoes on 2 August. Actigard's effects on tomato fruit yield occurred prior to the development of the bacterial disease.

Additional studies are needed: 1) to determine the affects of Actigard on the majority of tomato cultivars grown in Kentucky; 2) to determine the best timing of Actigard sprays; and 3) to determine the affects of location and time of year on Actigard application. There is no doubt that the use of Actigard can significantly reduce potential yield losses due to bacterial spot/speck epidemics. However, this protection may have a price associated with it. We recommend that growers practice sanitation and follow a recommended spray program in tomato transplant production. Tomato fields should be properly fertilized and rotated to reduce disease problems. Actigard, if used, should probably be applied biweekly, separate from other pest control applications. Thorough coverage with Actigard is not necessary, so spray volume/acre could be reduced.

Table 1. Early yield in each grade category of three tomato cultivars, treated or not treated with Actigard, Quicksand, 2001

Cultivar	Treat-ment ¹	No. 1 Jumbo + Extra Large ²	No. 1 Large ²	No. 1 Med + Small ²	No. 2 ²	Culls ²	Total
Pounds/A							
Cherry Grande	T	-	9,231 ns	8,880 ns	3,799 ns	1,997 ns	23,906 ns
	T & A	-	9,827	7,869	3,630	1,854	23,180
Heavy Weight	T	12,990*	13,185*	9,373 ns	920 ns	5,315**	41,784*
	T & A	6,887	8,167	8,142	2,048	3,539	28,781
Mt. Fresh	T	19,343*	2,009 ns	363 ns	1,296 ns	1,245 ns	24,256*
	T & A	15,132	1,063	207	700	882	17,981

¹T = Traditional spray regime, T&A = Traditional spray regime plus Actigard; see Materials and Methods

²Jumbo fruit ≥ 3.5 in., Extra Large ≥ 2.75 but < 3.5 in., Large ≥ 2.5 but < 2.75 , medium < 2.5 in.

The ns, *, and ** indicate a non-significant difference between the pair of means for a cultivar, a difference at P=0.05 and 0.01, respectively. The means are least square means, compared by t-test. Preplanned comparisons were used.

Table 2. Number of fruit per acre in each grade category for the early harvests of three cultivars of tomato treated with Actigard or not treated, Quicksand, 2001.

Cultivar	Treatment ¹	No. 1 Jumbo + Extra Large ²	No. 1 Large ²	No. 1 Med + Small ²	No. 2 ²	Culls	Total
Cherry Grande	T	0	38,763 ns	49,523 ns	21,910 ns	17,243 ns	127,439 ns
	T & A	0	42,782	40,449	19,187	14,779	117,197
Heavy Weight	T	30,985*	40,838*	43,041 ns	2,334 ns	21,650 ns	138,847*
	T & A	15,816	27,484	37,856	7,390	16,465	105,011
	T	32,540*	5,964 ns	1,426 ns	2,593 ns	3,371 ns	45,893 ns
Mt. Fresh	T & A	26,577	2,852	778	1,296	1,815	33,318

¹T = Traditional spray regime, T&A = Traditional spray regime plus Actigard; see Materials and Methods

²Jumbo fruit \geq 3.5 in., Extra Large \geq 2.75 but $<$ 3.5 in., Large \geq 2.5 but $<$ 2.75, medium $<$ 2.5 in.

The ns, *, and ** indicate a non-significant difference between the pair of means for a cultivar, a difference at P=0.05 and 0.01, respectively. The means are least square means, compared by t-test. Preplanned comparisons were used.

Table 3. Total yield in each grade category of three tomato cultivars, treated or not treated with Actigard, Quicksand, 2001.

Cultivar	Treatment ¹	No. 1 Jumbo + Extra Large ²	No. 1 Large ²	No. 1 Med + Small ²	No. 2 ²	Culls	Total
Cherry Grande	T	0	23,362 ns	36,663**	4,615 ns	4,836 ns	69,476 ns
	T & A	0	25,695	33,098	4,719	3,656	67,167
Heavy Weight	T	21,521 ns	24,191*	28,353 ns	2,502 ns	9,542*	86,108*
	T & A	13,509	16,581	25,890	3,850	6,651	66,481
Mt. Fresh	T	59,428**	10,644 ns	2,437 ns	2,865 ns	3,228**	78,602 ns
	T & A	70,655	10,735	3,150	1,727	1,516	87,781

¹T = Traditional spray regime, T&A = Traditional spray regime plus Actigard; see Materials and Methods

²Jumbo fruit \geq 3.5 in., Extra Large \geq 2.75 but $<$ 3.5 in., Large \geq 2.5 but $<$ 2.75, medium $<$ 2.5 in.

The ns, *, and ** indicate a non-significant difference between the pair of means for a cultivar, a difference at P=0.05 and 0.01 respectively. The means are least square means, compared by t-test. Preplanned comparisons were used.

Table 4. Number of fruit per acre in each grade category for entire season of three cultivars of tomato treated with Actigard or not treated, Quicksand, 2001.

Cultivar	Treatment ¹	No. 1 Jumbo + Extra Large ²	No. 1 Large ²	No. 1 Med + Small ²	No. 2 ²	Culls	Total
Cherry Grande	T	0	105,400 ns	228,171*	27,873 ns	56,395*	417,839 ns
	T & A	0	116,419	198,613	27,613	37,078	379,724
Heavy Weight	T	51,875**	79,341**	146,756 ns	8,297 ns	51,728**	337,979**
	T & A	31,244	55,876	131,717	14,260	42,134	275,232
Mt. Fresh	T	106,955*	33,707 ns	12,057 ns	7,260 ns	12,316 ns	172,295 ns
	T & A	136,644	33,448	14,261	4,667	4,667	193,686

¹T = Traditional spray regime, T&A = Traditional spray regime plus Actigard; see Materials and Methods

²Jumbo fruit \geq 3.5 in., Extra Large \geq 2.75 but $<$ 3.5 in., Large \geq 2.5 but $<$ 2.75, medium $<$ 2.5 in.

The ns, *, and ** indicate a non-significant difference between the pair of means for a cultivar, a difference at P=0.05 and 0.01 respectively. The means are least square means, compared by t-test. Preplanned comparisons were used.

Table 5. Bacterial speck disease ratings on 31 August and 14 September for three tomato cultivars. Means are averages for tomato plants treated and not treated with Actigard.

Cultivar	Bacterial Speck Rating ¹	
	31 August	14 September
Mt Fresh	1.8c	2.1b
Heavy Weight	2.6b	2.1b
Cherry Grande	3.5a	4.4a

¹Bacterial Speck was rated on 8/31/01 by T. Jones using a 0-5 scale, with 0 = no speck to 5 = near total leaf coverage with spot. Dr. W. Nesmith rated on 9/14/01 using the same subjective scale. Means followed by the same letter are not significantly different, LSD (P=0.05).

** The ratings were made 65 and 79 days after the last application of Actigard on June 27.

Table 6. Bacterial speck disease ratings for three varieties of tomato treated with Actigard or not treated.

		Bacterial Speck Rating¹	
Variety	Treatment²	31 August	14 September
	T	2.5bc	2.125b
Mt. Fresh	T&A	1.0d	2.0b
	T	3.0abc	2.125b
Heavyweight	T&A	2.25c	1.875b
	T	3.75a	4.375a
Cherry Grande	T&A	3.25ab	4.5a

¹Bacterial Speck was rated on 31 August by T. Jones using a 0-5 scale, with 0 = no speck to 5 = near total leaf coverage with spot. Dr. W. Nesmith rated on 14 September using the same subjective scale. The ratings were made 65 and 79 days after the last application of Actigard on June 27. Means within a column followed by the same letter are not significantly different, LSD (P=0.05).

²T = Traditional spray regime, T&A = Traditional spray regime plus Actigard; see Materials and Methods