Title: Use of Plant Activators to Control Common Diseases of Tomato

Project Leader: Christine D. Smart, Department of Plant Pathology, NYSAES

Cooperators:
Maryann Borsick Herman (Graduate Student)
Holly Lange (Research Technician)

Abstract:

Plant activators induce defense responses in plants, which can prevent or slow pathogen infection and some of these products have been reported to enhance yield. This project tested several activators labeled for use in NY to determine if there is any yield improvement or efficacy against common tomato diseases. While we did not see a yield enhancement in 2006 using products that are suggested to increase yield, we did see encouraging results for disease control. We found that one class of activators (the SAR-inducing type) controlled bacterial speck of tomato without negatively affecting yield. The ISR-inducing activator failed to provide any growth enhancement or protection from bacterial diseases.

Background and Justification:

Inducing plants to protect themselves from disease and insect pests is a wonderfully enticing concept. Laboratory research aimed at understanding induced resistance has been ongoing for decades. Compounds that can activate plant defense responses are known as plant activators, plant defense activators or systemic acquired resistance (SAR) inducers and are frequently termed biopesticides. Additionally, many of these compounds are said to increase plant health and yield, and are expected to be environmentally friendly, having no direct effect upon the pathogen. Plant activators could fit into an integrated pest management (IPM) program as a way to delay initial fungicide and/or insecticide applications or they could be alternated with chemical control. Some activators are certified for organic use, and thus they could also fit into organic production systems. Several such compounds are commercially available, but their use by growers in NY is quite limited. This is because unfortunately, plant activators have not been consistently effective against many pests in the field.

Tomato is one of the few examples where a plant activator is currently recommended to growers for use in disease control against bacterial speck and spot. This recommendation applies to NY State as well as other states in the Northeast, but the compound is not widely used. The control of bacterial diseases of tomato is a high priority for the vegetable commodity group, and a study of plant activators was necessary to determine the efficacy and utility of these products in NY.

There are two types of plant activators, and one example of each was included in this study. The first type consists of living microbes that colonize plant roots and activate a resistance mechanism known as induced systemic resistance (ISR). These products are frequently plant growth-promoting rhizobacteria (PGPR), or yield-enhancement biologicals, which claim to increase yield while reducing pathogen problems. PGPR are living bacteria (many are *Bacillus* sp.) which can be mixed in with soil just prior to planting seed. While the exact mechanism by which PGPR act is unknown, yield-enhancement is thought to be due to the 'growth-promoting' aspect of the product. The bacteria colonize the roots of the plant and aid in nutrient uptake. At the same time, PGPR apparently provide pest control via ISR.

The second type of activator induces a specific plant defense pathway known as systemic acquired resistance (SAR). The SAR activator included in this study is acibenzolar-S-methyl, a salicylic acid analog which is applied to the foliage. This SAR-inducing compound is commonly used in New Jersey and other states to control bacterial diseases of tomato, but has not been used in the Northeast. Unlike ISR, there have been several reports of a decrease in yield following application of an SAR-inducing compound. While both ISR and SAR induce the plant's natural defense mechanisms, they are not the same and it is unknown which mechanism will have greater efficacy against pathogens of tomato in NY. Additionally, it is completely unknown if the two products used together could act synergistically to enhance both yield and disease control.

Because plant activators have been shown in previous studies to have greatest efficacy against bacterial pathogens, this study focused on bacterial speck disease of tomato, caused by *Pseudomonas syringae* pv. *tomato*. We did not have fungal pathogen pressure on our plots in 2006, however a second bacterial disease, bacterial canker caused by *Clavibacter michiganensis* subsp. *michiganensis* did occur in our field plots. Thus efficacy against both pathogens was evaluated.

Objectives:

1. To identify the most effective use of plant activators for disease control in an integrated pest management program for tomato.
2. To quantify fruit yield in all treatments to determine if any of the activators had an impact on yield.
3. To evaluate the success of the project based on disease control and yield data, which will lay the foundation for new IPM control strategies that incorporate activators.

Procedures:

1. All field trials were conducted at the Gates Road farm in Geneva, NY. Tomato seedlings, cultivar Sunchief, were grown in the greenhouse and transplanted into the field 5 weeks after sowing. Each plot consisted of 10 tomato plants spaced 45 cm apart. Treatments were arranged in a randomized complete block design with three replications.

Treatments were applied using labeled rates of commercially available products. Treatments included: Actigard (acibenzolar-S-methyl, produced by Syngenta), BioYield (plant growth-promoting rhizobacteria produced by Bayer), Actigard + BioYield, the conventional pesticides Cuprofix 40 (copper sulfate) and Cuprofix MZ (copper sulfate + mancozeb). BioYield is a soil amendment and was added to seedling mix, as described by the product label. Foliar applications of all other treatments began two weeks prior to inoculation so that the plant had an opportunity to "activate" prior to the presence of the pest. One of the Actigard treatments was started 1 week after planting with increasing rates as the season progressed, as directed on the label (see Table 1 for details).

To insure the presence of bacterial speck in our trial, plants were spray inoculated with *P. syringae* pv. *tomato* ($1x10^8$ bacteria/ml) on July 20, approximately 5 weeks after planting. Disease severity was assessed twice by counting the total number of lesions on 20 leaflets randomly picked from each plot.

2. For yield assessment, unripe fruit was harvested on 22 August, due to severe hail damage. Number and weight of fruit from five plants per plot were recorded. The number of extra large fruit harvested from each plot was also recorded.

3. The data collected have been evaluated to determine the utility of plant activators in fresh market tomato production in NY. Information on the efficacy of plant activators to control common tomato diseases is being presented at educator and grower meetings throughout the state. Results of the project are also being presented at the Fruit and Vegetable Expo, and a written report of the results will be given to Extension Educators for use in newsletters.

Results and discussion:
Greenhouse grown transplants were planted in the field and grew beautifully prior to inoculation. Plants were inoculated late in the day on 20 July following a damaging hail storm with high winds. The wind and hail damage to the plants was extreme. Bacterial speck symptoms were severe across all treatments due to the large number of wounds caused by the hail storm. Although disease levels were high in all plots, the number of lesions in all treated plots was significantly less than the untreated control on 28 July (Table 1). The Actigard treatments reduced the number of leaf lesions and the early Actigard treatment (starting one week after transplanting) had the fewest infected fruit and the highest yield. Yield for both BioYield and the control treatments were reduced compared to the other treatments, but this difference was not significant (Table 1).

In addition to bacterial speck, bacterial canker moved into the field plots in late July. Based on the timing and pattern of symptom development, we speculate that several flats of transplants were contaminated with the pathogen in the greenhouse prior to planting in the field. Bacterial canker was most severe in lower areas of the field where standing water occurred after the hail storm. By the time of harvest (August 22) many of the plants were nearly dead due to a combination of flood damage, wind and hail damage, bacterial speck and bacterial canker. While no treatment was extremely effective against canker, the Actigard early treatment appeared a bit healthier than other treatments (although not statistically significant).

At harvest, fruit were evaluated for the presence of bacterial speck and canker symptoms (Table 2). The Actigard Early treatment had the lowest levels of fruit infected with bacterial speck, though this was not significantly lower than the unsprayed control. The combination of both activators provided the best protection from fruit infection with bacterial canker.

The Actigard results are encouraging for growers. In contrast to previous studies, we did not find any decrease in yield relative to the untreated control. Actigard treatments provided the best control of bacterial speck, although they were not statistically different from the copper treatments. This provides evidence that Actigard can be a weapon used to compliment a copper spray program. Unfortunately, the PGPR product did not provide protection from bacterial speck or canker of tomato nor did it provide any growth enhancing effects.

In summary, we found that one plant activator, Actigard, does have efficacy against bacterial pathogens of tomato. Thus, it offers growers an additional component in an integrated management program. Many growers have asked about the efficacy of activators and yield-enhancement products, and wonder if they truly increase yield. We have found that this is dependent upon the year, as we saw an increase in yield in 2004, but not in 2005 or 2006.

Table 1. Results of plant activator trials.

Treatment	Rate	Bacteria speck lesion no.[z]		Fruit no.[y]	Fruit wt (lb)[x]	X-lg fruit no.[y]	X-lg fruit (lb)[x]
		24 Jul	28 Jul				
Unsprayed control	NA	13.3 ab[w]	79.6 a	54.0 bcde	19.1 bc	13.0 c	8.8 c
BioYield Concentrate	2 lb/cu yd	10.5 cde	59.1 b	43.5 e	17.4 c	15.5 bc	9.6 bc
Cuprofix 40	2.5 lb/A[t]	7.9 efg	32.5 cd	47.0 de	16.8 c	16.5 abc	10.5 abc
CuprofixMZ	5 lb/A[t]	7.7 fg	36.2 c	44.5 de	19.7 bc	20.0 abc	12.6 abc
Actigard 50 WG	0.75 oz/A[t]	5.8 g	24.8 de	55.5 bcd	21.9 bc	19.0 abc	11.5 abc
Actigard 50 WG early	0.33oz/A[v]						
+ Actigard 50 WG	0.50oz/A[u]						
+ Actigard 50 WG	0.75 oz/A[t]	6.2g	22.0 e	70.5 a	27.7 a	24.5 ab	15.0 ab
Actigard 50WG	0.75 oz/A[t]						
+ BioYield	2 lb/cu yd	6.7 fg	25.7 de	65.0 ab	23.6 ab	23.5 ab	14.0 abc

[z] Mean number of lesions on 20 leaflets per plot.
[y] Mean number of fruit harvested from 5 plants per plot.
[x] Mean fruit weight harvested from 5 plants per plot.
[w] Column numbers followed by the same letter are not significantly different at *P*=0.05 as determined by Fisher's LSD.
[v] Applied on 15 and 22 Jun.
[u] Applied on 29 Jun, 6 Jul.
[t] Applied on 13, 20, 27 Jul, 3,10 17 Aug.

Table 2. Efficacy of plant activators to prevent bacterial fruit symptoms on tomato.

Treatment	Fruit *P. syringae* pv. *tomato* infection[s]	Fruit *C. michiganensis* subsp. *michiganensis* infection[r]
Unsprayed control	0.9116 ab	0.9803 a
BioYield Concentrate	1.0608 a	0.5870 ab
Cuprofix 40	0.8880 ab	0.4390 ab
CuprofixMZ	1.0156 a	0.9849 a
Actigard 50 WG	0.8813 ab	0.9627 a
Actigard 50 WG early	0.7538 b	0.4371 ab
Actigard 50WG + BioYield	0.8488 ab	0.3424 b

[s] Mean proportion of fruit with bacterial speck (caused by *P. syringae* pv. *tomato*) lesions

[r] Mean proportion of fruit with bacterial canker (caused by *C. michiganensis* subsp. *michiganensis*) lesions

[q] Column numbers followed by the same letter are not significantly different at P=0.05 as determined by Fisher's LSD. Data were transformed using the arcsin transformation and analyzed using ANOVA.