Project Title: Evaluation of Insecticide Programs in Processing Tomatoes for the Management of BCTV and TSWV Vectors and Viruses

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Principle Investigator:
Thomas A. Turini
University of California Ag and Natural Resources
Fresno County Cooperative Extension
550 E. Shaw Avenue, Suite 210-B
Fresno, CA 93611
taturini@ucanr.edu
559-375-3147

Executive Summary:
Beet curly top virus (BCTV), which is vectored by beet leafhopper, and *Tomato spotted wilt virus (TSWV)*, which is primarily transmitted by Western flower thrips in California, occur annually in California, occasionally causing massive economic losses. In work previously sponsored by CTRI, *BCTV* incidence was significantly lower in treatments that included insecticides within two modes of action that include anthranilic diamides [Verimark (cyantraniliprole)] and neonicotinoids [Admire (imidacloprid), Platinum (thiamethoxam) and Venom (dinotefuran)]. Verimark was consistently effective when applied to transplants 72- to 24-hours before planting, but did not demonstrate efficacy when drip-injected. Neonicotinoids were effective applied in transplant water or injected into the sub-surface drip irrigation systems. However, on 1 January 2024, The Department of Pesticide Regulation adopted regulations restricting use of nitroguanidine neonicotinoid insecticides, which include imidacloprid, thiamethoxam, and dinotefuran as well as all commercial products containing those active ingredients. This substantially limits usage, which included prohibiting application of any regulated neonicotinoid after flowering, which is approximately two weeks post-plant depending upon transplant age and environmental conditions. Because Verimark must be applied pre-transplant and may have a 28- to 35-day residual, and neonicotinoids must be applied pre-bloom and may have 21-day residual under heavy pressure, there are no registered insecticides with experimental verification of efficacy in reducing BCTV incidence for protection after approximately 35-days post-transplant. Infection at that stage of crop development can occur and substantially reduce yields.
The focus of this work was to evaluate ability of insecticides registered for mid-season use to reduce *BCTV* incidence within an IPM program. This project is particularly relevant in consideration that during season with very high pressure, mid- and late-season has caused economic damage and in areas with a history of losses, neonicotinoids used beyond bloom are a common part of the pest management program.

Insecticide programs were compared at the University of California West Side Research and Extension Center in Fresno County in a four-replication randomized complete block experiment in which programs that included Verimark-transplant treatments or pre-bloom Admire applications were followed by foliar programs that included rotations of insecticides, which included Assail (acetamiprid), Exirel (cyantraniliprole), Mustang Max (Zeta-cypermethrin) and Sivanto (flupyradifurone) at four-, six- and/or eight-weeks post-plant. This trial was designed to complement an IR-4 trial that focused on early
Due to low disease pressure, the results of the 2024 study were inconclusive. However, the issue remains critical and similar studies should be conducted in 2025.

Introduction:
CTRI supported work conducted in Fresno County showed that a systemic insecticide program using neonicotinoids (IRAC Group 4A) such Admire and Platinum provides significant reduction in curly top. In addition, Verimark (cyantraniliprole, IRAC Group 28) transplant treatments consistently and significantly reduced BCTV incidence.

On 1 Jan 2024, use of neonicotinoid insecticides in California were restricted. California Department of Pesticide Regulation released 'Text of Final Regulation' Neonicotinoid Pesticide Exposure Protection Section 6990 that reduces both the maximum allowable rate of restricted neonicotinoids per season and limits applications to pre-bloom stage of crop development. Total allowable rate of any combination of neonicotinoid insecticide, or one material applied to both soil and foliage is not to exceed 0.172 lbs active ingredient per acre per season. Before this regulation, it was permissible to use up to 0.38 lbs imidacloprid, 0.172 lbs thiamethoxam and 0.263 lbs dinotefuron per acre per season and it could be applied regardless of the presence of bloom. A single active ingredient applied either to the soil or to the foliage may be applied at the previous label rates. However, prior to the regulation, neonicotinoids were used in sequence through the season to reduce transmission of *BCTV* when there was risk of beet leafhopper migrations at later stages of crop development.

The issue is that efficacy of the available materials under the new regulations does not provide a potential for use of a tool with documented, consistent effect in reducing the incidence of beet curly that will protect the plants after approximately five weeks post plant. It is unlikely that Verimark would have efficacy 45 days after application, and the neonicotinoids that were applied pre-bloom are also unlikely to have efficacy under heavy pressure five weeks post-plant, which is likely to be approximately 31 to 35 days after the latest possible application before bloom.

In view of the limitations on the use of neonicotinoid insecticides, the efficacy of alternative insecticides that are less likely to be subjected to regulatory pressures, such as Assail (acetamiprid a neonicotinoid unaffected by the regulation) and Sivanto (flupyradifurone, IRAC Group 4D) and the use of Exirel (cyantraniliprole, IRAC Group 28) as a foliar equivalent to Verimark will be evaluated in programs to bridge the mid-season gap in protection from BCTV that is left by the neonicotinoid restrictions. Although impact of neonicotinoids on Western flower thrips has not been documented in local studies, additional materials should be evaluated given the seriousness of the issue with *TSWV* in this this production area and the absence of highly efficacious insecticides or insecticide programs. Therefore, *TSWV* incidence was recorded.

Main Goal and Objectives:
To generate efficacy data of insecticide programs allowable under current regulations that mitigate the risk of loss due to BCTV and TSWV.

- Evaluate effect of alternative insecticides on beet curly top disease incidence in processing tomatoes.
- Evaluate effect of alternative insecticides on Western flower thrips population densities and tomato spotted wilt virus incidence in processing tomatoes.

Methodology and Results:
Commercially produced transplants (H5608) were mechanically planted into 60-inch beds with sub-surface drip tape injected at a 10-inch depth into Panoche clay-loam soil at the University of California West Side Research and Extension Center on May 23. Because there is greater risk of infection under

low to moderate pressure before the canopy closes due to leafhopper behavior, the transplant spacing was placed at 16-inches rather than the typical 12-inch spacing between plants.
The experimental design was a randomized complete block with four replications. Each plot was a single bed x 60 ft. Experimental plots were separated by one untreated, planted row and there was a 10 ft planted buffer within the row between plots.

Application details are as follows: Verimark was applied to the transplants on May 22 at a rate of the equivalent of 13.5 fl oz per acre based on a plant density of 6534 plants per acre. Each 192 cell tray was treated with 12 ml Verimark in 275 ml water. All materials applied through the sub-surface drip irrigation were injected with generator-powered electric metering pumps (A-1600 FlexFlo® Peristaltic Pump Blue and White Industries, Huntington Beach, CA) over 30 minutes, which was followed by 2 hours of additional irrigation time. Dyne-Amic 0.25% v/v was included in all foliar tank mixes. On the 21 Jun, sprays were directed; applied with a CO2-pressurized back-pack sprayer at 30 psi with two TeeJet 8003EVS nozzles 19-inches apart at an equivalent volume of 20 gallons per acre. On 5 and 23 July, broadcast applications were made with CO2-pressurized back-pack sprayer at 30 psi with three TeeJet 8003EVS nozzles 19-inches apart at an equivalent volume of 30 gallons per acre.

transplant trt (22 May)[z]	pre-bloom drip (6 Jun)[y]	4th week post-plant (21 Jun)	6th week post-plant (5 Jul)	8th week post-plant (23 Jul)	BCTV incidence (%)			TSWV (%)	
					13-Jun	26-Jun	31-Jul	26-Jun	31-Jul
Verimark 13.5 fl oz					0.51	1.47	1.96	0.00	0.99
Verimark 13.5 fl oz	Admire Pro 10.5 fl oz				0.00	0.00	0.00	0.00	1.42
Verimark 13.5 fl oz		Beleaf 4.2 oz drip[y]	Exirel @20.5 fl oz foliar[x]		1.01	1.94	2.45	0.00	2.01
Verimark 13.5 fl oz		Beleaf 4.2 oz drip	Beleaf 4.2 oz drip	Exirel @20.5 fl oz/a foliar	0.00	0.48	0.00	0.00	0.00
Verimark 13.5 fl oz		Beleaf 4.2 oz drip	Beleaf 4.2 oz foliar	Exirel @20.5 fl oz/a foliar	0.00	0.00	0.00	0.00	1.00
Verimark 13.5 fl oz		Assail 30SC 3.4 fl oz			0.00	0.00	0.00	0.00	2.02
Verimark 13.5 fl oz		Mustang Mx 4 fl oz DF[w]			0.00	0.00	0.49	0.00	1.96
Verimark 13.5 fl oz		Sivanto 28 fl oz drip			0.00	0.51	0.51	0.00	0.97
Verimark 13.5 fl oz		Sivanto 9 fl oz foliar	Sivanto 9 fl oz foliar	Sivanto 9 fl oz foliar	0.00	0.00	0.50	0.00	2.50
	Admire Pro 10.5 fl oz		Assail 30SC 3.4 fl oz flr		0.00	1.68	1.68	0.00	0.50
	Admire Pro 10.5 fl oz		Mustang Mx 4 fl oz foliar		0.50	0.99	1.49	0.00	0.57
Untreated control					0.61	0.61	1.22	0.00	4.18
Probability					0.348	0.399	0.438	NS	0.408

[z] Verimark was applied to transplants on 22 May at a per acre equivalent of 13.5 fl oz.

[y] All drip-injected materials were applied with electric metering pumps over 30 minutes, which was followed by 2 hours additional irrigation.

[x] Broadcast foliar treatments were applied with a CO_2-pressurized back-pack sprayer at 30 psi in the equivalent of 30 gallons per acre with Dyne-Amic surfactant 0.25% v/v.

[w] Directed foliar treatments were applied with a CO_2-pressurized back-pack sprayer at 20 psi in the equivalent of 30 gallons per acre with Dyne-Amic surfactant 0.25% v/v.

Discussion:
Disease through the production area was relatively low in 2024. Although *beet curly top virus* was present in the trial, it remained at very low levels throughout the season, so treatment differences were not present. *Tomato spotted wilt virus* was also present in the field but did not increase until very late in the season.

The impact of a post-bloom ban on applications of neonicotinoid insecticides poses a serious limitation in avoiding economic loss in the event of a year with high population densities of beet leafhoppers carrying *BCTV*. Neonicotinoids have demonstrated efficacy in reducing incidence of this virus. Currently, under the California Department of Pesticide Regulation Neonicotinoid Pesticide Exposure Protection Section 6990 the prohibition of post-bloom applications, no insecticides that have shown efficacy in reducing BCTV incidence in tomato experimentally can be used to protect against mid-season infection that will weaken or kill plants and reduce yields.

In 2025, similar studies should be conducted.

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