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TetraCURB™ Concentrate Effectively Controlled Spider Mite Infestation in High Tunnel Tomato Production Compared to Other Competitive Miticides

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Keywords: Third party university trial, Tetranychus urticae Koch, *spider mite, miticide, comparative competitive study.*

KEY CONCLUSIONS

- *TetraCURB Concentrate provided the best control of TSSM as compared to other commonly used commercial horticultural oils and microbial formulations evaluated.*
- *TetraCURB Concentrate is a valuable stand-alone contact miticide for commercial growers to include in rotation for IPM programs.*

INTRODUCTION

Two-spotted spider mites (TSSM), *Tetranychus urticae* Koch, are one of the most common pests and can be found on many crops such as fruit trees, vines, field-grown or greenhouse-grown berries, vegetables and ornamental plants. Spider mites are not insects but a member of the arachnid class along with spiders and ticks. They thrive in hot and dry weather; whereas colder and more humid conditions may slow down their reproductivity. TSSM use their piercing-sucking mouthparts to feed on the underside of a leaf, extracting the contents and fluid of its cells. Piercing the leaf surface causes plant injury with visible symptoms showing up as tiny white or yellow discoloration spots on the leaves called "stippling." As feeding continues, the leaves turn yellowish to bronze, dry up, and fall off. When heavily infested, large amounts of webbing cover the leaves, twigs, plant stems, and fruit. Even a minor spider mite infestation can have a significant impact on a plant's productivity and leading to crop yield loss.[1-4]

When it comes to pest management, prevention is crucial. Effective control of TSSM relies on an accurate field scouting program that gives the grower a good idea of a pest outbreak, the number of spider mites in the field, to anticipate the need for control before it's too late. Also, effective control often requires a good understanding of the biology of the pest, the ability to identify various life stages, as well as its natural enemies' and their activity.

Fortunately, to keep the populations under control, commercial growers have a plethora of miticides/insecticides available for both indoor and outdoor use to develop rotation programs based on using different modes of action to avoid the development of resistant mite populations. However, all commercially available miticides are not equal as they can vary in the target mites on the label, mode of action, mite stages controlled, quickness of knockdown, and longevity.[5]

The aim of this third-party university laboratory and field trial was to evaluate how effective TetraCURB™ Concentrate botanical oil-based contact miticide mitigates TSSM in high tunnel tomato production compared to four commonly used commercial biorational miticides/insecticides: Two microbial-based, one neem oil-based, and one mineral oil-based miticide/insecticide when applied as a stand-alone treatment (Table 1).

Table 1. Miticide treatments evaluated and their respective mode of action.

Insecticide Name	Insecticide Family	Active Ingredients	Mode of Action
TetraCURB™ Concentrate	Horticultural oil Botanical oil	Rosemary oil 50%	TetraCURB Concentrate is a blend of Kemin's proprietary rosemary oil, soap and emulsifier in the concentrate. TetraCURB Concentrate kills and repels pests on contact thanks to multiple modes of action: The rosemary oil targets the octopamine receptor in mites to disrupt their nervous system, causing avoidance behavior, paralysis, and suffocation. The emulsifier allows for uniform product contact across the plant surface. This provides maximum product efficacy with minimum phytotoxicity. The soap disrupts cuticular waxes of the insect, allowing rosemary oil to quickly penetrate and induce water loss in mites, resulting in desiccation and death.

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Competitor A	Horticultural oil Mineral oil	Mineral oil 80%	Horticultural oils contact miticides such as petroleum, paraffinic, or mineral oil as the active ingredient are used as a dormant and/or summer spray. They provide minimal to no residual activity once spray residues have dried. Thorough coverage of both the lower and upper leaf surfaces is critical when applying this type of product. They work with multiple modes of action by preventing normal gas exchange through the insect cuticle and interfere with water balance inside the egg, soften or dissolve the egg covering or interfere with hormone or enzyme activity. When used against larvae, nymphs, or adults, horticultural oils act using suffocation by blocking the breathing pores (spiracles).[6]
Competitor B	Horticultural oil Neem oil	Azadirachtin 3%	Neem oil based miticides contain the active ingredient Azadirachtin, that is a part of the complex structure of substances extracted only from the neem seed kernel. The primary mode of action is as an antifeedant, larvae and adult repellent, sterilant and oviposition inhibitor. It is an insect growth regulator that affects normal insect molting hormone, ecdysone. It disrupts the life cycle of the insect and causes death when molting into the next life stage and prevents the production of future generations.[7]
Competitor C	Microbial-based insecticide	*Chromobacterium subtsugae* 30%	Composed of naturally occurring bacteria, fungi, or protozoans that target-specific plant pests without resorting to the use of chemicals. Because they contain only natural substances, microbial pesticides are easily biodegradable and a less toxic alternative than chemical-based pesticides.[8]
Competitor D	Microbial-based insecticide	*Beauveria bassiana* 22%	

MATERIALS AND METHODS

BIOASSAY

Before conducting a field trial, bioassays were performed as a proof of concept to identify the potential positive effects of the evaluated miticides on TSSM.

- **Application:** A group of 10 single aged female *T. urticae* was sprayed with diluted test solutions using a direct contact toxicity method with an electronic micro-sprayer to mimic pesticide application practices in high tunnel tomato production. The sprayer was calibrated to deliver equivalent to 50 gallons/acre of spray solution.
- **Bioassay:** The sealed Petri dishes after application of the treatments were then placed in a growth chamber at 26±2ºC, 55-60% RH, and a photoperiod of 14:10 (L:D) h. Mites were considered dead if appendages did not move when probed with a fine paintbrush and mortality was recorded daily for 10 days after treatment. The experiments were repeated five times to ensure reproducibility of the results.
- **Data collection:** Mortality data were analyzed by ANOVA and means were separated with Tukey's honestly significant difference (HSD) test. Significant differences were established at the 95% confidence level ($P < 0.05$).

HIGH TUNNEL FIELD TRIAL

Tomato seedlings were raised in a greenhouse before being transplanted in high tunnels. Then, they were maintained using standard high tunnel tomato production practices.

- **Treatment plots:** Single row of tomato plants of 20 ft by 2.5 ft, with plants spaced 1 ft apart for a total of 20 plants per plot.
- **Treatments**: Arranged in a randomized complete block design, with four replicates. All miticides/insecticides were evaluated at label recommended rates, and each trial included an untreated control (Table 2).

Table 2. Miticide treatments evaluated.

Treatments	Label Recommended Rate (per acre in 100 gallons water)
TetraCURB™ Concentrate	2 gallons
Competitor A	2 gallons
Competitor B	10 ounces
Competitor C	3 pounds
Competitor D	1 quart

- **Application methods, rate and timing:** A weekly foliar application of the different treatments was made with a pressurized CO_2 sprayer calibrated to deliver equivalent to 50 gallons/acre. Sprays were performed starting from the onset of *T. urticae* activity in the field.
- **Data collection:** Plots were evaluated 24 hours after application by sampling five randomly selected leaves (one per plant) per plot for *T. urticae* nymph, and adults. The mean number of nymph and adult *T. urticae* was calculated for each treatment. Data were not normally distributed and thus were transformed by using the square-root ($\sqrt{x} + 0.5$) transformation method. Transformed data were analyzed for significant treatment effects using analysis of variance (ANOVA), with the replicates considered as blocks. Means were compared using the Tukey's HSD test. Significant differences were established at the 95% confidence level ($P < 0.05$).

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RESULTS – BIOASSAY

- At the field recommended rate, all treatments had a significant effect on the mortality of *T. urticae (P < 0.0001)* as early as 24 hours post exposure to the treatments.
- TetraCURB Concentrate was the most effective treatment with >65% mortality at day 1 and up to 90% mortality after 4 days, which was significantly higher than the other treatments or the untreated control *(P < 0.0001)*.
- By day 10, TetraCURB Concentrate was still the miticide that provided the highest mortality rate with a consistent performance during 5 consecutive days.
- By day 10, only Competitor A (70%) and Competitor C (42%) performed significantly better than the untreated negative control *(P < 0.0001*), whereas mortalities caused by Competitor B and Competitor D were not significantly different from the untreated negative control.

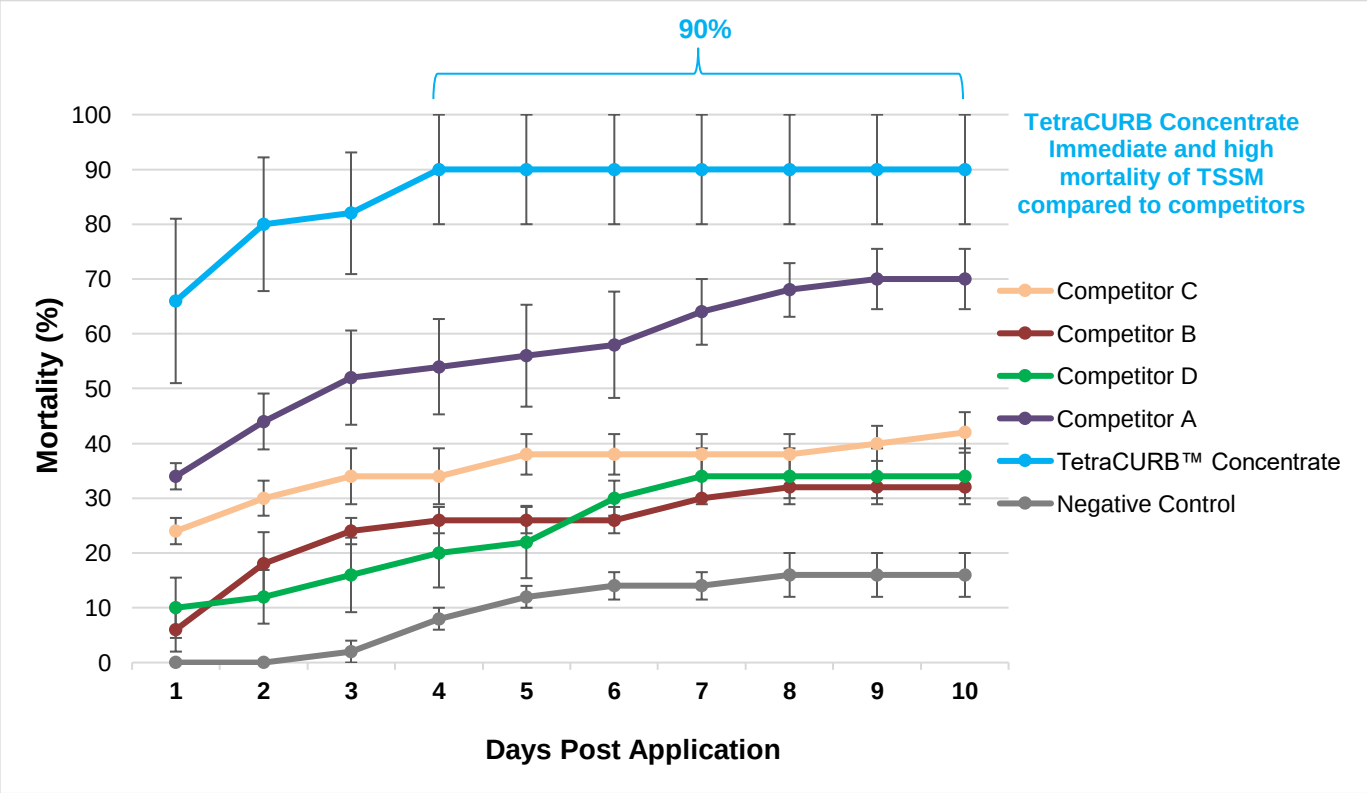

Figure 1. Percent mortality of commercial miticides/insecticides applied directly on *T. urticae* under laboratory conditions. Lines representing means ± standard error.

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RESULTS – HIGH TUNNEL FIELD TRIAL

- TetraCURB™ Concentrate performance in controlling adult and nymph TSSM in high tunnel tomato production impressively stood out over the untreated control plots and the plots treated with the other competitive miticides/insecticides (Fig. 2 and 3)
- TetraCURB Concentrate controlled nymph (Fig. 2) TSSM with a 56% reduction after 1 week (August 15) and 68% after 3 weeks (August 30) and adults (Fig. 3) by 57% and 65% after 1 and 3 weeks, respectively, compared to the negative control.

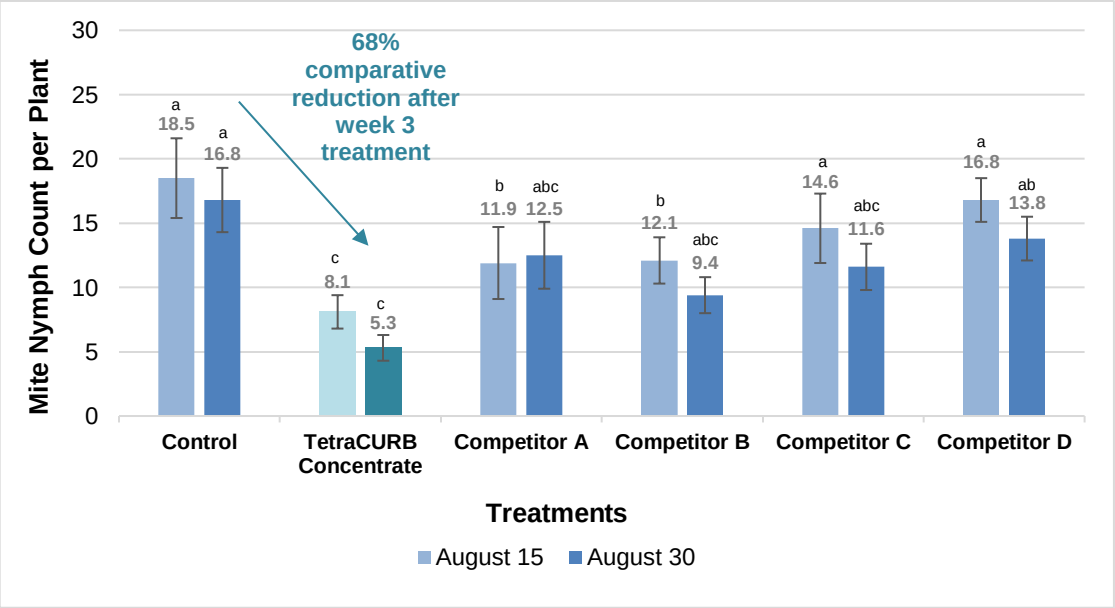

Figure 2. Mean ± standard error of *T. urticae* nymphs per plant treated with different biorational miticides/insecticides in high tunnel tomato production.

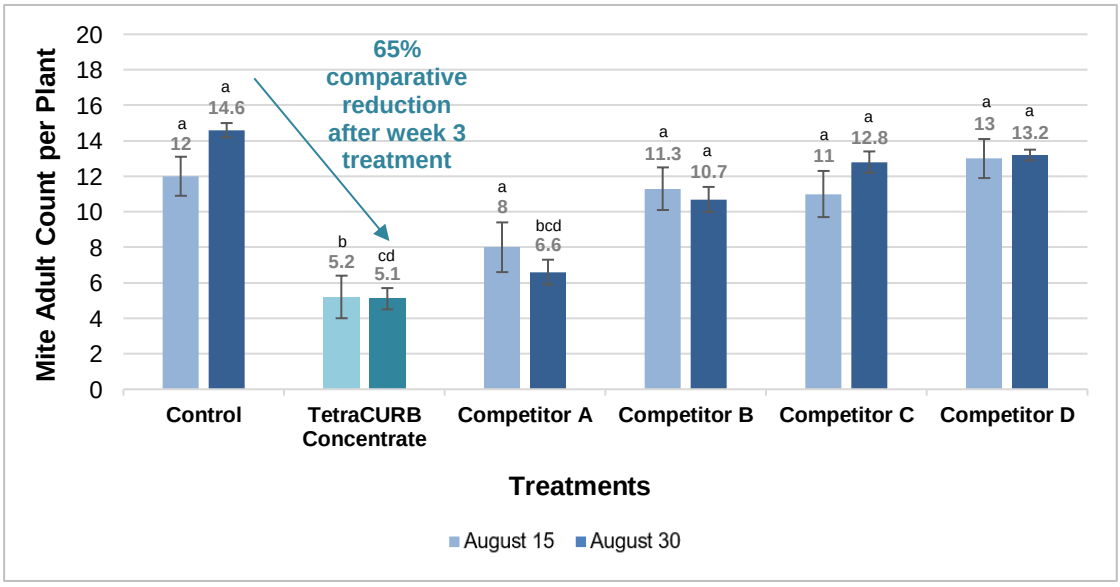

Figure 3. Mean ± standard error of adult *T. urticae* per plant treated with different biorational miticides/insecticides in high tunnel tomato production.

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CONCLUSION

This third-party university trial was designed to evaluate the performance of multiple types of commonly used commercial biorational miticides/insecticides and primarily to assess the efficacy of TetraCURB Concentrate, botanical oil-based miticide, to control as a stand-alone treatment TSSM (*T. urticae)* on high tunnel produced tomatoes.

Results showed that a weekly foliar spray of TetraCURB Concentrate for 3 weeks consistently performed very well in controlling *T. urticae* nymphs and adults by 68% and 65%, respectively, compared to the untreated plot and the four other competitive treatments when applied at label rates. Competitor C, a bacterial formulation of *Chromobacterium subtsugae*, showed some efficacy against *T. urticae* but did not sufficiently suppress the pest population. Whereas Competitor B, a botanical insecticide with azadirachtin as the active ingredient, and Competitor D, a microbial formulation containing fungus *Beauveria bassiana*, showed no efficacy against *T. urticae*. This trial showed that horticultural oil based miticides containing botanical oils such as TetraCURB Concentrate, performed better than other commonly used biorational options to control spider mites in high tunnel operations.

The trial was performed by spraying 50 gallons/acre of TetraCURB Concentrated diluted at 2 gallons into 100 gallons of water. We typically recommend growers to use TetraCURB Concentrate at a dilution rate of 64 fl oz per 100 gallons of water per acre when there is a predominant mite infestation in the operation.

In summary, we recommend growers use TetraCURB Concentrate in an IPM program to effectively mitigate *T. urticae* populations in high tunnel tomato production systems. TetraCURB Concentrate is a powerful stand-alone miticide, with competitive advantages as the formulation includes an adjuvant and an emulsifier for increased spreading and optimal coverage for higher performance and minimal phytotoxicity. Moreover, TetraCURB Concentrate is a safe option for workers with its zero-hour REI, and convenient for the grower with its zero-day PHI.

Always follow the pesticide label directions attached to the pesticide container you are using. Certain statements may not be applicable in all geographic regions. Product labeling and associated claims may differ based upon regulatory requirements. Consult with your regulatory representative for specific applications and labeling.

SOURCES:

1. University of California Agriculture and Natural Resources. How to Manage Pests, Pests in Gardens and Landscapes. (Link)
2. Arbico Organics. Spider Mites (Link)
3. The Center for agriculture, food and the environment. Two spotted Spider Mite. (Link)
4. Clemson.edu. College of Agriculture, Forestry and Life Sciences. Integrated Pest Management (I.P.M.) For Spider Mites.(Link)
5. Grower Talk.Seven Steps for Spider Mite IPM. (Link)
6. Greenhouse Management. Horticultural soaps and oils: an avenue for pest control? (Link)
7. GPN. Explaining Azadirachtin and Neem. (Link)
8. Maximum yield. Microbial Pesticide. (Link)

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