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Effect of Bifentrhin (Talstar®) on Mycorrhizal Colonization of California Native Plants in Containers©

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The insecticide bifenthrin (Talstar®) is a synthetic pyrethroid required by regulation for the production of nursery crops to suppress the red imported fire ant in Orange and Riverside Counties in California. However, there are no published studies on the consequences of the application of this chemical on the mycorrhizal symbiosis.

We've initiated research to determine the effects of bifenthrin on mycorrhizal colonization by *Glomus intraradices,* a vesicular arbuscular mycorrhizal fungi used to inoculate California native plant hosts at the Tree of Life Nursery. Greenhouse experiments were conducted with *Apium graveolens*, *Encelia californica*, and *Salvia apiana*. The percentage of mycorrhizal colonization was compared in plants grown without bifenthrin and with bifenthrin at different concentrations.

This study showed that the application of bifenthrin had no detrimental effects on root colonization by *Glomus intraradices* in the nursery practices at the Tree of Life Nursery.

INTRODUCTION

An assessment of the impact of pesticides on the functioning of mycorrhizas is crucial for the development of horticultural management practices. The symbiotic association of plants with arbuscular mycorrhizal (AM) fungi has been widely recognized for its beneficial effects on plant quality. Mycorrhizal colonization increases plant growth by enhancing nutrient uptake, increasing plant tolerance to drought, and salt stress and resistance to transplant shock and soil pathogens (Smith and Read, 1997). Inoculation with AM fungi has been shown to improve the growth response of California native plants that are grown for landscaping, revegetation, and ecological restoration at the Tree of Life Nursery (Louise Egerton-Warburton and Edith B. Allen, unpublished results). However, despite the increasing use of certain chemicals on horticultural practices, not much is known about their impact on the mycorrhizal symbiosis.

The effects of pesticides on mycorrhizal colonization vary from beneficial to detrimental. While several chemicals inhibit the mycorrhizal development, others do not affect the symbiosis and the use of certain pesticides stimulate root colonization by AM fungi and increase their sporulation (Menge, 1982; Pattinson et al., 1997; Trappe et al., 1984).

The insecticide bifenthrin (Talstar®) is a synthetic pyrethroid required by regulation for the production of nursery crops to suppress the red imported fire ant in Riverside and Orange Counties in California. However, there are no published studies on the consequences of the application of this chemical on the mycorrhizal symbiosis. We have initiated research to determine the effects of bifenthrin on mycorrhizal colonization by Glomus intraradices, a vesicular AM fungi used to inoculate California native plant hosts at the Tree of Life Nursery. Greenhouse experiments were conducted with three plant species grown in different media and with different rates of bifenthrin.

MATERIALS AND METHODS

Effects of Bifenthrin on the Propagation of *Glomus intraradices*. Celery plants (*Apium graveolens*) were grown in calcined clay, a growth medium used for the propagation of *G. intraradices*. Eight-day-old seedlings of celery were transplanted to 1-gal pots filled with calcined clay without bifenthrin and with granular bifenthrin at 5 and 10 ppm. The minimum rate required to protect crops against the red imported fire ant for 0 to 6 months is 10 ppm, but lower rates are also used for protection against other insects.

The different rates of bifenthrin were thoroughly mixed in a cement mixer with calcined clay and with the mycorrhizal inoculum. This inoculum consisted of dry pot culture material of spores, hyphae, and root fragments colonized by *G. intraradices*.

Fifteen replicates per treatment were distributed at random and watered as needed alternating distilled water and a nutrient solution without P that was modified from Sylvia and Hubbel (1986). Five randomly selected plants were harvested 4, 8, and 12 weeks after transplanting and the roots were cleared and stained with trypan blue (Koske and Gemma, 1989).

The percentage of mycorrhizal colonization was assessed under a compound microscope by the procedure of McGonigle et al. (1990). Arbuscular mycorrhizal colonization percentages were arcsine-square root transformed and analyzed by one-way ANOVA. Mean contrasts were performed using Fisher's protected least significant difference (PLSD) with $P < 0.05$ as the level of significance (Zar, 1996).

Effects of Bifenthrin on Mycorrhizal Colonization of Two California Native Plants. The effect of bifenthrin on mycorrhizal colonization was also studied in two California native plants: *Encelia californica* and *Salvia apiana*. Both species are found in Coastal sage scrub and chaparral, and are commonly used as ornamentals and for ecological restoration.

Plants were grown in a nursery potting soil composed by redwood, pine sawdust, sand and calcined clay (1 : 2 : 1 : 1, by volume). This potting mix was steam-pasteurized at 70°C for 1 h on 2 consecutive days. Granular Bifenthrin was mixed with the sterilized potting soil in a cement mixer as explained earlier but at higher rates because of the continuous protection requirement. Plants were grown without bifenthrin and with bifenthrin at 12 and 25 ppm. Plastic containers (656-ml, 25-cm-deep, 6.4-cm-diameter deepots, Steuwe and Sons, Corvallis, Oregon) were filled with the three different potting mixes (with 0, 12, and 25 ppm of bifenthrin) 9 cm from the top. At the moment of transplanting, a layer of mycorrhizal inoculum was added and covered by sterilized potting soil. Seven randomly selected replicates

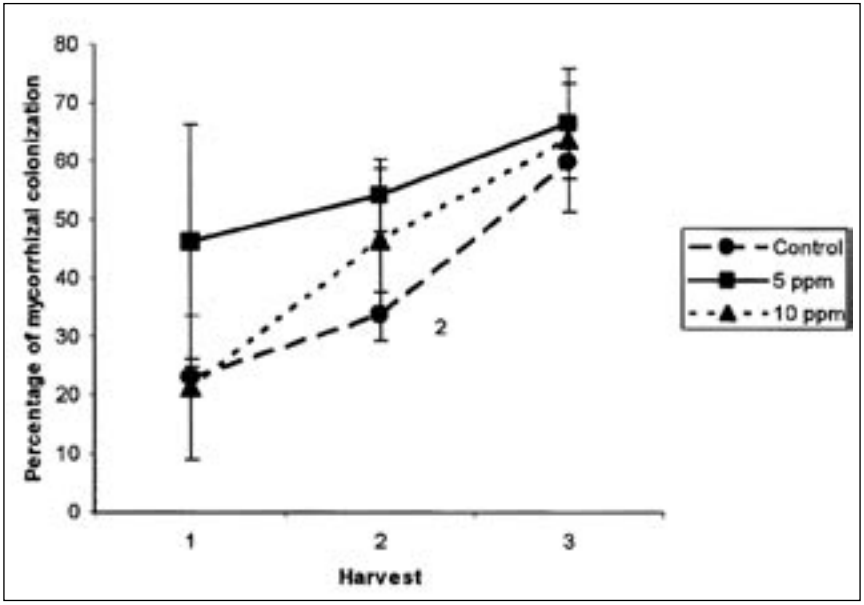

Figure 1. Effects of bifenthrin on mycorrhizal colonization of *Apium graveolens* at 4, 8, and 12 weeks after transplanting (first, second, and third harvest, respectively). Granular Talstar was applied at 0 (control), 5, and 10 ppm.

were harvested 9 weeks after transplanting. Fresh root pieces were processed as explained above and the percentage of mycorrhizal colonization was determined (McGonigle et al., 1990).

Data were also analyzed with one way ANOVA as previously explained.

RESULTS

There were no significant differences in the mycorrhizal colonization of celery plants grown without bifenthrin or with 5 and 10 ppm of bifenthrin 4, 8, and 12 weeks after transplanting (Fig. 1).

The application of 25 ppm of bifenthrin increased the mycorrhizal colonization in *Salvia apiana* (higher percentage of arbuscules and vesicles) (Fig. 2).

The difference in the total mycorrhizal colonization of *E. californica* was not statistically significant (15% of total mycorrhizal colonization was obtained in the plants grown without bifenthrin, and 5 and 10% total mycorrhizal colonization in the plants grown in 12 and 25 ppm respectively), however, plants of *E. californica* grown in 12 and 25 ppm of bifenthrin had significantly less arbuscules than those grown without Talstar® (Fig. 3).

DISCUSSION

Contrasting results have been reported on the effects of different synthetic pyrethroids on root colonization by AM fungi. While the application of Cypermethrin caused significant reduction on the percentage of mycorrhizal colonization by *Glomus* spp. in peanut (*Arachis hypogaea*), the use of high concentrations of Fenvalerate did not affect the symbiosis and the percentage of mycorrhizal colonization increased

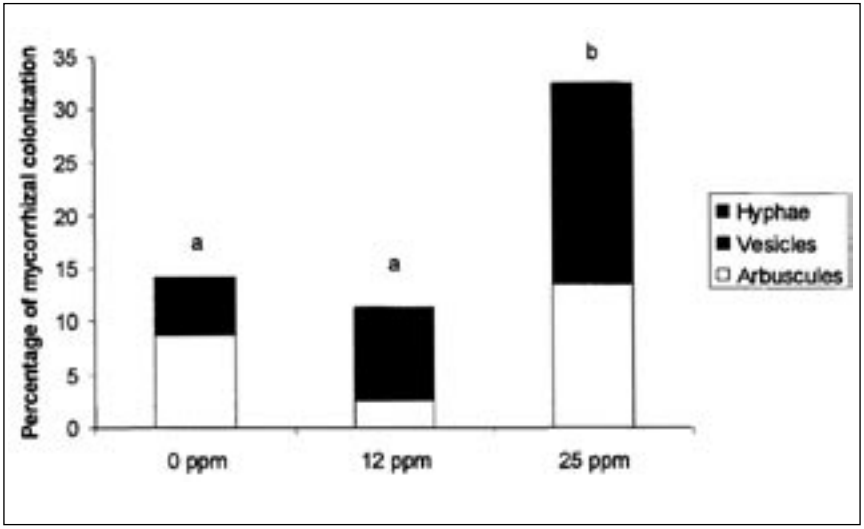

Figure 2. Effects of bifenthrin on the percentage of mycorrhizal colonization by arbuscules, vesicles and hyphae. Plants of *Salvia apiana* were grown with 0, 12, and 25 ppm of bifenthrin for 8 weeks. There were no statistically significant differences in the total percentages of mycorrhizal colonization obtained in the different treatments ($P<0.05$).

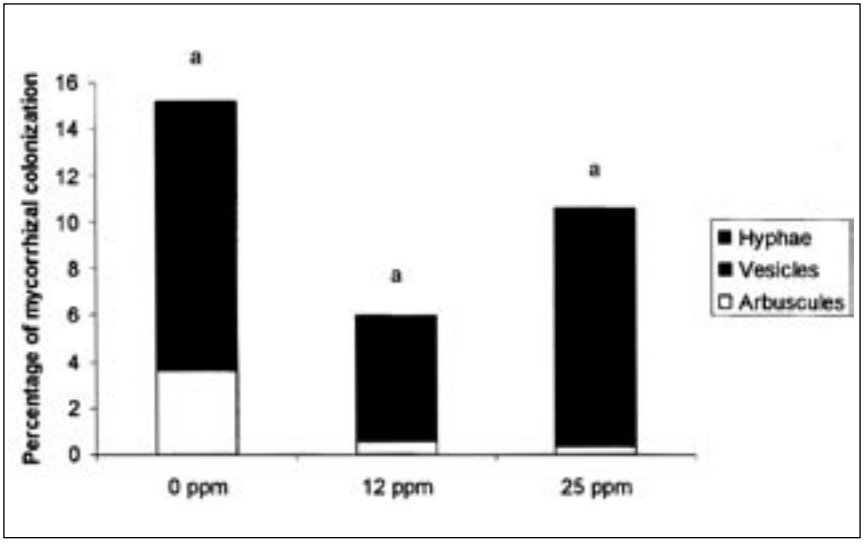

Figure 3. Effects of bifenthrin on the percentage of mycorrhizal colonization by arbuscules, vesicles and hyphae. Plants of *Encelia californica* were grown with 0, 12, and 25 ppm of bifenthrin for 8 weeks. Different letters denote statisticallly significant differences in the total percentage of mycorrhizal colonization($P<0.05$).

when it was applied at 5 and 10 ppm (Vijayalakshmi and Rao, 1993). Several studies have shown that the effects of pesticides on mycorrhizal colonization vary with the identity of the host plant, the AM fungal species, and the dose of application (Menendez et al., 1999; Spokes et al., 1981; Sreenivasa and Bagyaraj, 1989).

The low rates of bifenthrin applied to calcined clay for the propagation of *G. intraradices* at the Tree of Life Nursery did not alter the percentage of mycorrhizal colonization of celery plants. The higher rates of bifenthrin used in the nursery potting mix had no significant effect on the total mycorrhizal colonization of *E. californica* and stimulated the mycorrhizal colonization of *Salvia apiana.* To examine the effects of pesticides on mycorrhizal colonization it is also important to analyze its effects on plant growth (Pattison et al., 1997; Sukarno et al., 1993). We have observed that the application of bifenthrin does not affect the plant growth of mycorrhizal plants of *S. apiana*, but increases the growth of *E. californica* (Corkidi, et al., not published). This might explain the lower colonization percentages by arbuscules obtained in plants of *E. californica* grown with bifenthrin. However, further studies are needed to understand the effects of this insecticide on the correlation between mycorrhizal colonization and plant performance.

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