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Foliar Sprays for Frost Protection of Young Citrus and Avocado

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Abstract

Field and cold storage tests using four foliar anti-frost materials were evaluated on Hass avocado and Eureka lemon. Frost Guard®, water check, Kocide®, Frost Shield and Anti-Stress 2000® were applied at least one week prior to the cold event Without enough cold temperature for the field trials, the following two years the trials were moved into cold storage. With mild damage occurring in 1993, there were some treatment tendencies, but no significant differences. In 1994, even though trees were severely damaged, those that survived recovered equally well regardless of treatment.

1. Introduction

Many chemicals and some bacteria have been tested to induce frost tolerance of citrus, avocado and other horticultural crops. In some trials, protection of a few degrees has been achieved, but more commonly, the results have been variable or not commercially successful.
As the costs of conventional protection, such as wind machines, irrigation and orchard heaters have increased, a commercially acceptable chemical or biological method would be beneficial. The treatment must be non-toxic, easily applied and long-lasting.

In the past, materials acting as growth inhibitors, penetrating agents, antitranspirants, nutritional sprays, bactericides, and hormones have been used with some success in crops, such as pear, apple and peach. However, the variability in subtropical tree response to many of these materials has limited commercial acceptance.

For some years, it has been known that bacteria residing on cold-sensitive plants initiate ice formation. The ice formed in or on plants spreads rapidly, causing mechanical injury. Copper-containing sprays that are applied 10 days before cold weather, kill off these bacteria and allow enough time for their decomposition. By controlling the ice -nucleating bacteria, tests have shown temperatures may drop 2-4 ºF below critical levels without plants showing damage.

For the past four winters, we have been working with four materials that have shown promise in freeze trials on several crops in other states. To evaluate their relative efficacy, we have been applying Kocide, a copper spray which controls ice-nucleating bacteria; Anti- Stress 2000, a plastic film used as a antitranspirant; Frost Shield, another antitranspirant; and Frost Guard, a systemic/contact nutritional spray. Two field and two cold chamber trials have been monitored.

2. Materials and methods

2.1 Field Trials

On 19 December, 1991, 8A Lisbon lemon trees in the ground for six months were sprayed with the materials. Check trees were sprayed with water alone. Fifteen single-tree replicates were randomized throughout the plot. Frost Guard was applied to a light wetting, as directed; the other products were sprayed to runoff. Four days later, on 23 December, a frost hit with temperatures below 0ºC for four hours and two hours at -2º.

In order to ensure a site where colder temperatures would be obtained, the original site was expanded to two other orchards. During the first week of December 1992, the same experimental layout was done at each of the three sites.

2.2 Cold Storage Trials

On 27 January, 1993, Lisbon lemon and Hass avocado in liners were treated with the materials. On February 10, twenty trees of each treatment were loaded into picking bins and the root balls protected with wood chips. At dawn, the bins of trees were placed in a ready refrigerated trailer at -3ºC. Then every two hours, five trees of each treatment were removed, so that we had trees that had been at -3º for 2, 4, 6 and 8 hours. Trees were rated on rated on a Damage Severity Index (DSI) visual rating on 15 February.

The following 3 February, we went through the same procedure as in 1993. This time we put the trees into the commercial cold storage room. We had a little better temperature control here and we lowered the temperature so that it varied between -4 and -3º. After 1 hour we began removing some trees because it was evident there was a cold effect. We removed trees after 1, 2, 4 and 8 hours in the cooler. The trees were rated for DSI on 10 March.

3. Results and Conclusions

For the field trial of 1991, the trees were evaluated for damage two weeks after the cold period (data not shown). Only the trees sprayed with Anti-Stress 2000 showed any significant protection over the water-only treatment; other products showed no aid in cold tolerance. Damage was minimal however, and two months after the 23 December cold spell, there was no difference in the appearance of the trees. Why the copper product showed no effect may be due to the fact that there was such a short period between application and the onset of cold temperatures.

In 1992, again there was only a short time below 0ºC at two of the sites and no damage was noted on any trees.

In the cold storage trial of 1993, the trees were evaluated for damage a week after the cold treatment. The lemon and avocado at all lengths of exposure to the cold showed more severe damage than in the field trials, however even at 8 hours of -3º, only the new leaves had been burned (figures 1 and 2). Contrary to the field trial of 1991, the Anti-Stress 2000 did not seem to

confer any frost protection on lemon, while the copper on both crops and Frost Shield on avocado did seem to offer some protection. Trees showed no effects of the cold treatment two months later.

In 1994, all scion were killed on all avocado and lemon at 4 and 8 hours of cold and the whole tree in some cases. There was much more significant leaf loss during this trial than all previous ones, however, there were no effects of the various treatments on the 1 and 2 hour periods of cold (figures 3 and 4). We continued to follow the recovery of the trees. By May 3, citrus and avocado recovery was uniform. By June 7 there was no difference amongst the trees that had survived.

This is the tale of frost studies - variability. In the field, you're dealing with the weather - it gets cold or it doesn't. But even in the controlled environment, there is the tree variability - its age and stage of growth, crop load, and how acclimated the tree. We know clearly that tree health is an important factor in resistance to frost. This is shown by the classic case of two neighbors, one with trees destroyed by frost and the other untouched. What was the difference? Better irrigation practices, no root rot, denser canopies, no thrips, anything that improves the tree's strength is going to make it more tolerant to a freeze.

Bob Burns, Ventura Farm Advisor, made studies of numerous chemicals during the 60's and 70's. His conclusion was that although his tests "failed to provide the hoped for cold protection, there is reason to believe that a chemical will be found." This may be true, but what we do know is that there is no substitute for proper management and relying on a chemical protection is the icing on the cake.

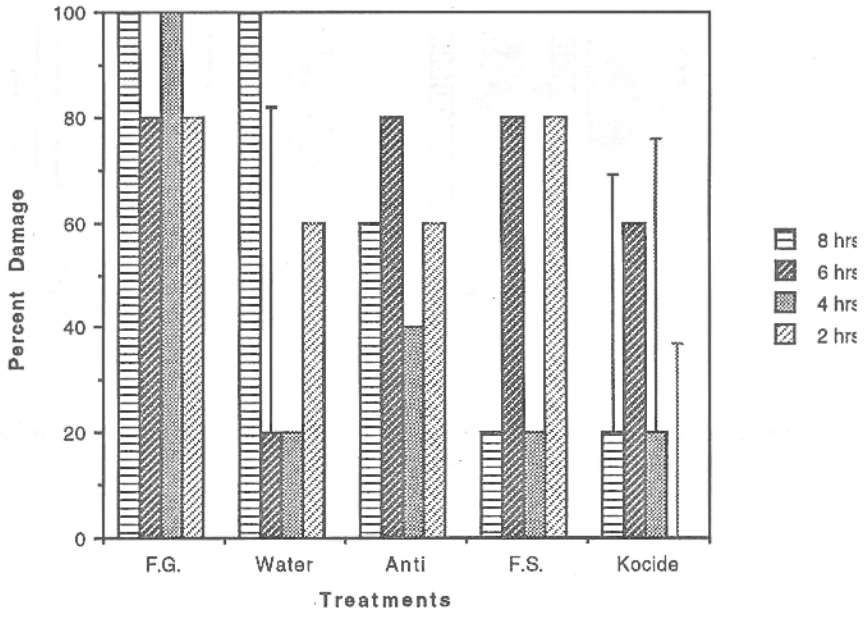

Figure 1. Percentage damage to Hass avocado after different periods exposed to -3°C in 1993. Error bars represent PLSD, P<0.05.

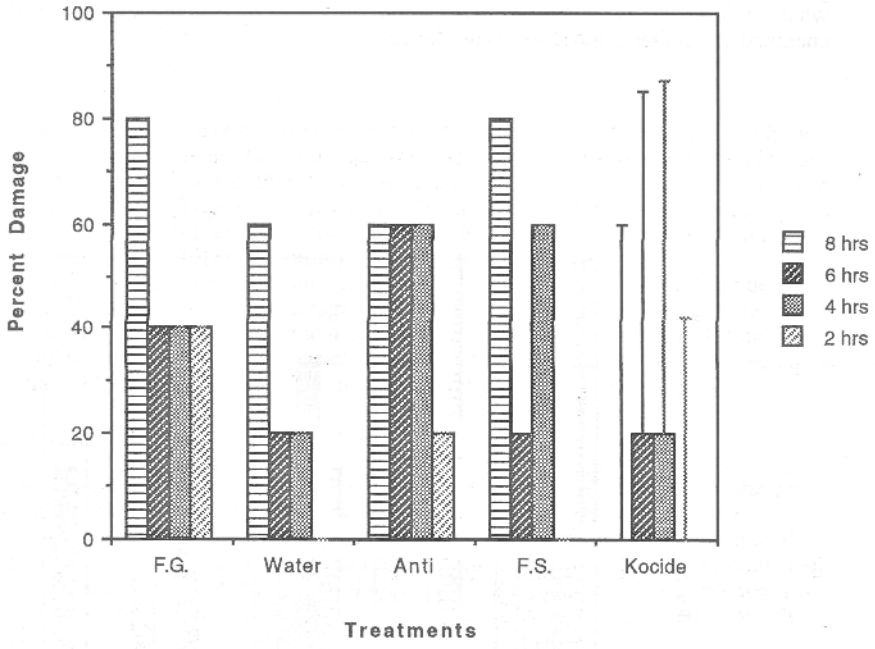

Figure 2. Percentage damage to Eureka lemon trees after different periods exposed to -3°C in 1993. Error bars represent according to PLSD, P<0.05

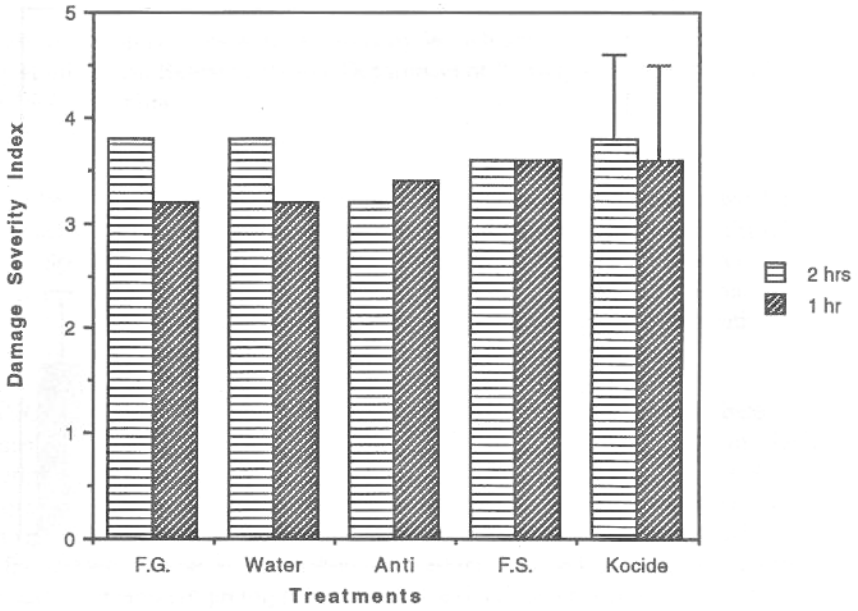

Figure 3. Damage Severity Index of Hass avocado exposed to -4°C for different periods of time in 1994. DSI: 1=healthy; 5 =dead. Error bars represent PLSD, P<0.05.

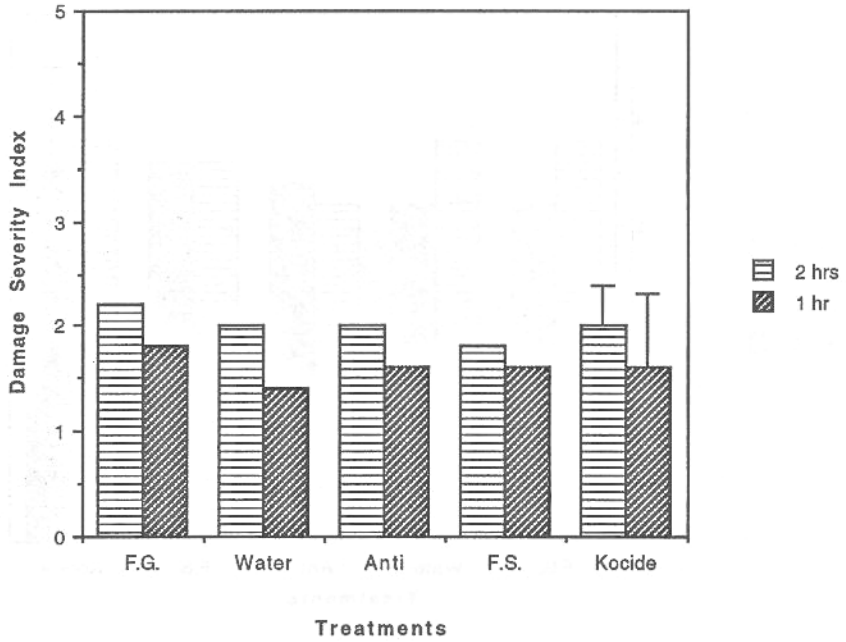

Figure 4. Damage Severity Index of Eureka lemon exposed to -4°C for different periods of time in 1994. DSI: 1=healthy, 5=Dead. Error bars represent PLSD, P<0.05.