Acknowledgments

This research has been supported, in part, by a grant from the Florida Citrus Production Research Advisory Council.

Literature Cited

Bowman, K. D. 1990. Unexploited germplasm, natural, mutations, and selected in vitro techniques for citrus cultivar improvement. PhD Dissertation, University of Florida. 217 pgs.

Bowman, K. D., F. G. Gmitter, Jr., G. A. Moore, and R. L. Rouseff. 1991. Citrus fruit sector chimeras as a genetic resource for cultivar improvement. J. Amer. Soc. Hort. Sci. 116:888-893.

Castle, W. S., R. R. Pelosi, C. O. Youtsey, F. G. Gmitter, Jr., R. F. Lee, C. A. Powell, and X. Hu. 1992. Rootstocks similar to sour orange for Florida citrus trees. Proc. Fla. State Hort. Soc. 105:56-60.

Grimm, G. R. and S. M. Garnsey. 1968. Foot rot and tristeza tolerance of smooth seville orange from two sources. Proc. Fla. State Hort. Soc. 81:84-90.

Grosser, J. W., J. L. Chandler, R. R. Pelosi, and M. Cohen. 1993. In-vitro micropropagation of seedless 'Cohen' citrange. Proc. Fla. State Hort. Soc. 106:57-60.

Grosser, J. W. and F. G. Gmitter, Jr. 1990. Protoplast fusion and citrus improvement. Plant Breeding Rev. 8:339-374.

Grosser, J. W., G. A. Moore, and F. G. Gmitter, Jr. 1989. Interspecific somatic hybrid plants from the fusion of 'Key' lime (*Citrus aurantifolia*) with 'Valencia' sweet orange (*Citrus sinensis*) protoplasts. Scientia Horti. 39:23-29.

Hutchison, D. J., C. J. Hearn, and F. W. Bistline. 1992. The performance of 'Valencia' orange trees on 21 rootstocks in the Florida flatwoods. Proc. Fla. State Hort. Soc. 105:60-63.

Moore, G. A. 1986. In vitro propagation of Citrus rootstocks. HortScience 21:300-301.

Murashige, T. and D. P. H. Tucker. 1969. Growth factor requirements of citrus tissue culture. Proc. First Int. Citrus Symp. 3:1155-1161.

Singh, S., B. K. Ray, S. Bhattacharyya, and P. C. Deka. 1994. In vitro propagation of *Citrus reticulata* Blanco and *Citrus limon* Burm.f. HortScience 29(3):214-216.

Proc. Fla. State Hort. Soc. 107:18-20. 1994.

CONTROLLING CITRUS ROOTSTOCK SPROUTING IN THE NURSERY USING TRE-HOLD®

ROBERT E. ROUSE
University of Florida, IFAS
Southwest Florida Research and Education Center
P.O. Drawer 5127
Immokalee, FL 33934

Additional index words. NAA, growth regulator, bud inhibitor

Abstract. **Tests were conducted to determine whether Tre-Hold®, a commercially available sprout inhibitor for newly planted trees in citrus groves, could be used to prevent axillary bud growth on citrus rootstock seedlings in the nursery. Tre-Hold® was applied at formulated concentration (1X), one-half (1/2X), and one-fourth (1/4X) to container-grown greenhouse seedlings before budding and full concentration (1X), three-fourths (3/4X), and one-half (1/2X) to field-grown seedlings after budding. When Tre-Hold® was applied to green citrus tissue, no phytotoxicity occurred. It was possible to control dormancy of individual buds without affecting adjacent buds. Full and 1/2X concentrations of the formulated product prevented rootstock sprouting of container trees and 1X, 3/4X, and 1/2X prevented sprouting on field-grown trees. Full concentration of Tre-Hold® was found to prevent scion bud healing of container-grown trees when the seedling was treated before budding. Application a few days before unwrapping and after the scion bud had healed did not affect bud healing or budling growth in the field nursery.**

In Florida, over 95% of commercial citrus trees are budded. Budding has many advantages such as early fruiting, trueness to type, few or no thorns associated with juvenility, uniform fruit season and quality, less alternate bearing, a root system better adapted to soil conditions, and greater resistance to soil pests (Jackson, 1991).

A common nursery practice to force growth of the scion bud is to remove the rootstock seedling stem above the scion bud, which contains the terminal bud (apical meristem) of the rootstock. Terminal buds produce IAA (indoleacetic acid) which is a naturally occurring growth hormone found in unfolding terminal buds, growing leaves, and shoot apexes (Stowe, Thimann, and Kefford, 1956). A similar synthetic material, napthalenecetic acid or NAA, is not naturally occurring in plants, but can be even more effective and is sometimes used in commercial products (Hartman and Kester, 1983).

Although it is known as a growth hormone, IAA may also act as a growth inhibitor (Wilson and Loomis, 1967). While involved in tissue differentiation and growth of the terminal bud, IAA also inhibits the growth of lateral and basal buds, and the farther away from the terminal bud the greater the chance of slow development. This process is known as apical dominance.

After budding, the scion bud is stimulated to grow by removal of the seedling rootstock above the inserted bud. When the rootstock top is removed, not only does it allow growth in the scion bud but it also allows growth of the lateral and sometimes basal buds of the rootstock (Wilson and Loomis, 1967). These lateral and basal rootstock buds take valuable nutrients away from the developing scion bud. In commercial citrus nurseries that bud trees for planting groves, it is common to remove these lateral and basal buds by hand. This practice is time consuming and costly.

Tre-Hold® (Amvac Chemical Corp. Los Angeles, CA) a commercial product that contains ethyl-naphthaleneacetate or NAA, acts as a sprout inhibitor for citrus. Tre-Hold® is used on the trunks of newly planted trees in grove sites to reduce sprouting from pruning cuts and rootstocks during the first year after field planting. The label cautions that green tissue or buds and leaves should not be allowed to come in contact with the Tre-Hold® solution during application because it may have phytotoxic (chemical burn) effects.

The objectives of this study were to determine whether Tre-Hold®: (1) would be phytotoxic to seedling green stem tissue in the nursery; (2) could be used to control individual lateral bud growth without affecting other untreated lateral buds or the inserted scion bud; (3) could be used to pre-treat

Florida Agricultural Experiment Station Journal Series No. N-00985.

budded seedlings to inhibit the development and growth of the rootstock buds without affecting scion bud healing; and (4) could be used to treat budded seedlings prior to unwrapping and forcing without retarding the bud forcing process and subsequent growth of the scion bud shoot.

Materials and Methods

In the greenhouse nursery, 50, 4-month-old Cleopatra mandarin (*Citrus reshni* Hort. ex Tan.) and 50, 6-month-old Smooth Flat Seville (*Citrus aurantium*? hybrid) seedling liners were planted in 4x4x14 inch containers with Metro-Mix 500 potting medium (Grace Sierra Horticultural Products Company, Milpitas, CA). A 16 ounce spray bottle was used to apply Tre-Hold® at 3 different concentrations. The active ingredient in Tre-Hold® is NAA at 1.15%. The applied concentration rates were: 1X (full strength formulated product); ½ X (half concentration); ¼ X (quarter concentration). Nutrition for the trees was supplied by Osmocote Florida Citrus Mix 17-6-9 Plus Minors (Grace Sierra Horticultural Products, Milpitas, CA) on June 30; the Smooth Flat Seville received 12 grams and the Cleopatra mandarins received 9 grams per container.

Budding method was the standard inverted T shield bud procedure described in the third edition "Citrus Growing in Florida" by Jackson, 1991. Budwood of 'Ruby Red' grapefruit (*Citrus paradisi* Macf.) was obtained from the Budwood Foundation Grove at the Southwest Florida Research and Education Center, Immokalee.

To determine phytotoxicity, 20 Cleopatra mandarin seedling liners were divided into 4 groups of 5 plants. These groups each received concentrations of 1X, ½ X, and ¼ X, respectively. The fourth group was an untreated control. Each group was treated in the same manner using a spray bottle to apply Tre-Hold® directly to the top (apical) of the plant stem. It was allowed to run down the stem, thereby coating the entire stem area.

These 20 seedling liners were topped 1 day after treatment to force axillary buds. Four days after treatment, the seedlings were examined for any signs of phytotoxicity. Twelve days after treatment, leaves were removed to further stimulate and force axillary bud growth. Twenty-five days after treatment, the first 10 healthy buds below the apex were examined for bud break and shoot growth.

To determine the effect of Tre-Hold® on untreated buds adjacent to treated buds, 24 Cleopatra Mandarin seedling liners of uniform height and stem diameter were divided into 4 groups of 6 plants. Each seedling was topped at 24 leaves above the cotyledons. All leaves were removed and the 4 groups received 1X, ½ X, and ¼ X concentration and no treatment, respectively. A sponge tipped paintbrush was used to apply the Tre-Hold® to buds, but not the stems. Starting at the seedling apex, nodes were divided into groups of 3, and treatment was made to the odd numbered groups of 3 adjacent buds. This process continued down the stem. From each group of 6 trees that received the same treatment concentration, 3 plants were positioned on their side, while the others remained upright. This was to determine if the lateral flow of material within the plant transported the chemical to neighboring buds, preventing untreated bud growth.

Twenty-one days after treatment, the number of buds that had initiated growth were counted from each group of 3 buds. Notations were made as to whether the middle buds had forced.

To determine the effects on Tre-Hold® on bud healing, 40 Smooth Flat Seville seedling liners suitable for budding were randomly separated into 4 groups of 10. The 4 groups of seedlings were treated with Tre-Hold® at concentrations of 1X, ½ X, and ¼ X, and 0. Application was made with a spray bottle and allowed to run to the base of the tree.

After allowing the chemical to dry, seedlings were budded with 'Ruby Red' Grapefruit. Twenty-one days after budding, buds were unwrapped and healing evaluated.

To overcome inhibitory effects on bud healing and evaluate bud forcing and application to field nursery conditions, 200 budded liners of Swingle citrumelo (*Citrus sinensis* x *Poncirus trifoliata*) budded with 'Valencia' sweet orange (*C. sinensis* L. Osbeck) were selected in a commercial field bare-root nursery. Four groups of 50 budded liners ready to be unwrapped were treated with Tre-Hold® at concentrations of 1X, ½ X, ¼ X, and an untreated control, respectively. Application was made to both sides of the nursery tree row with a standard hand-pumped, compressed-air sprayer. Scion bud break and number of rootstock sprouts were evaluated at 30, 60, and 90 days after bud unwrapping.

All data were analyzed using the General Linear Model procedure (SAS Institute, 1988) and the means were separated using least significant difference (LSD).

Results and Discussion

The 20 Cleopatra mandarin seedlings observed at 4 and 25 days after treatment for phytotoxic effects from Tre-Hold®, showed no evidence of phytotoxicity. When evaluated for axillary bud force at each treatment concentration, it was found that the untreated control group had the highest bud force percentage of sprouts (Figure 1), followed in descending order by increasing concentration of Tre-Hold®.

Tre-Hold® had a significant effect on the number of buds that forced on the seedlings. It was concluded that Tre-Hold® was not phytotoxic to green citrus tissue in this experiment, and a 1X and ½ X concentration did prevent axillary bud initiation.

Evaluation of treated and untreated adjacent buds for growth inhibition showed Tre-Hold® could be used to effec-

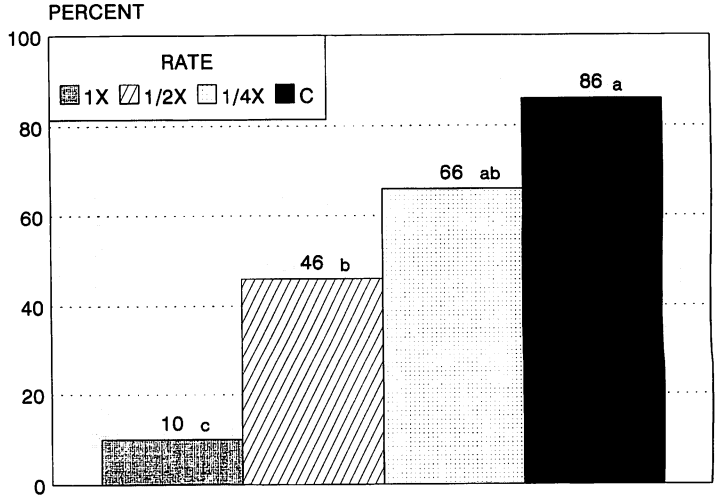

Figure 1. Percentage of axillary buds sprouted on citrus seedlings 25 days after treatment with Tre-Hold® at concentrations of 1X, ½ X, ¼ X, and 0 (control).

tively control individual buds. After 21 days the control group had the highest number of total buds and middle buds (center bud of 3 adjacent buds) forced, followed by decreased sprouting with treatment of Tre-Hold® (Figure 2). Among the 3 concentrations of Tre-Hold® the position of the trees, whether standing vertical or laying horizontally, made no difference in the number of middle buds that forced or in the number of buds that forced overall. The exception was the control group which showed trees standing vertical had a significantly higher number of buds forced than the horizontal trees.

The 1X and ½ X concentration had a significant effect on the number of axillary buds that grew, but the ¼ X and the control groups showed no significant differences. It was concluded that the tree position (horizontal or vertical) had no effect on axillary bud forcing, and Tre-Hold® at concentrations of 1X and ½ X reduced the number of axillary buds that grew, while ¼ X was not different than the untreated control.

Pretreating seedling stems prior to budding inhibited scion bud healing. A statistically significant difference was found between all 3 concentrations of Tre-Hold® and the untreated controls. In the 1X group, 100% of the scion buds were dead at unwrapping and none were healed to the rootstock. In the control group, 90% of the buds were successful (Figure 3). The ½ X and ¼ X were intermediary in effect on bud healing. Evidence had shown that ¼ X was not strong enough to inhibit rootstock sprouting and ½ X might be marginal on inhibiting rootstock sprouts and too strong inhibiting scion healing. The conclusions were that high concentrations had a significant negative effect on scion bud healing compared to untreated controls, and further testing was needed combining alternative application times with concentrations lower than 1X, but higher than ½ X that might be effective at inhibiting sprouting without affecting the bud healing process.

Results of the field nursery experiment showed that concentrations of 1X, ¾ X, and ½ X were effective at inhibiting rootstock sprouting without affecting scion bud healing (Figure 4) if applied afew days before bud unwrapping and after bud healing was assured. The 1X concentration eliminated all rootstock sprouts below the bud wrapping tape. The ¾ X and

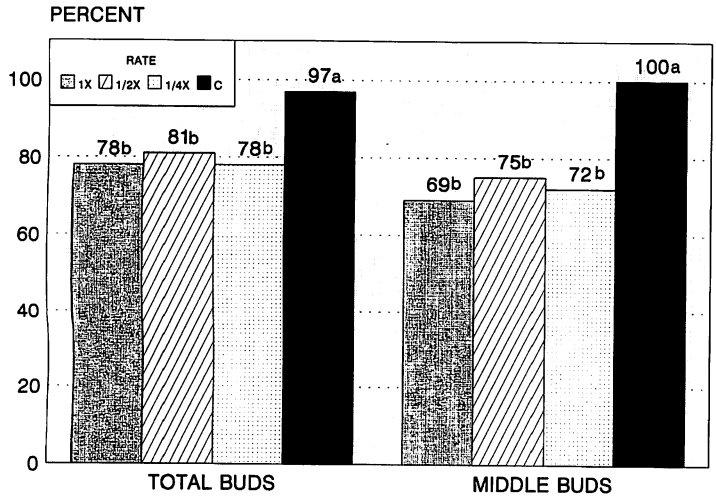

Figure 2. Percentage of total and middle axillary buds sprouted after 21 days in groups of 3 adjacent untreated buds between 3 adjacent treated buds on citrus seedlings receiving Tre-Hold® at concentrations of 1X, ½ X, ¼ X, and 0 (control).

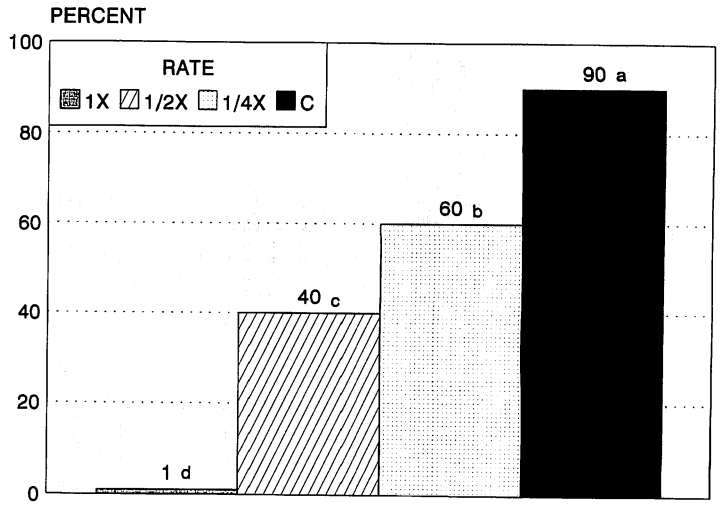

Figure 3. Percentage survival of scion buds when "T" budded into citrus rootstock seedlings after application of Tre-Hold® at concentrations of 1X, ½ X, ¼X, and 0 (control).

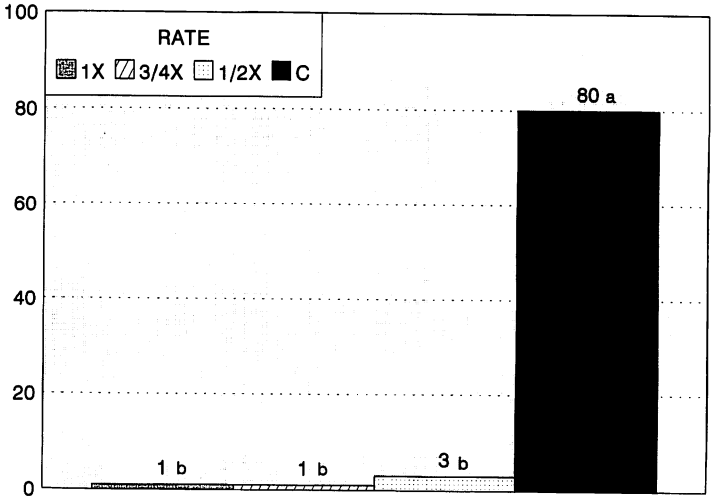

Figure 4. Number of rootstock sprouts per 10 budded seedlings in a field citrus nursery treated with Tre-Hold® at concentrations of 1X, ¾ X, ½ X, and 0 (control) after scion bud healing and before unwrapping.

½ X concentrations reduced sprouts to 1 per 10 treated trees. All 3 concentrations were effective for the 90 days evaluated. Scion bud forcing was not delayed or reduced compared to untreated controls or other similar trees in the commercial nursery.

It was concluded that in the field nursery, all 3 concentrations of Tre-Hold® inhibited rootstock sprouting to effectively reduce or eliminate hand sprouting without inhibiting bud healing or scion bud growth. Tre-Hold® may be an effective means to control rootstock sprouting in citrus nursery trees.

Literature Cited

Hartman, H. T. and D. E. Kester. 1983. Plant propagation. 4th ed. Prentice Hall Inc. New Jersey.

Jackson, L. K. 1991. Citrus growing in Florida. 3rd ed. Univ. of Fla. Gainesville.

Stowe, B. B., K. V. Thimann, and N. P. Kefford. 1956. Further studies of some plant indoles and auxins by paper chromatography. Plant physiol. 31:162-65

Wilson, C. L. and W. E. Loomis. 1967. Botany. 4th ed. Holt, Rinehart, and Winston. Chicago.