Metalosate®
Powered by Albion® Technology
Balchem® Plant Nutrition Research Paper

Nutritional Metalosate® Supplements with Calcium that Reduce Pest Pressure in Citrus Production

*by S.D. Nelson*1, M. Setamou2, D.E. Garza2, J. Melgoza2 and M. Esparza2*

1Texas A&M University-Kingsville, 700 Univ. Blvd., MSC 228, Kingsville, TX 78363
2 TAMU-Kingsville Citrus Center, 312 N. International Blvd, Weslaco, TX 78596

INTRODUCTION

The state of Texas is known to be the third largest citrus producing state within the United States (Nelson et al., 2012). The counties that produce the largest amount of citrus within Texas are Hidalgo, Cameron and Willacy and are located in the southern region of Texas known as the Lower Rio Grande Valley (LRGV). Grapefruit is the most common citrus grown in the LRGV as the "Rio Red" variety (Citrus paradisi Macfad. cv. Rio Red) which is well-known for its taste, red color, and size. The LRGV in Texas is occasionally affected by natural disasters such as hurricanes and freezes that periodically cause extensive damage to the Texas citrus industry. Nevertheless, the bigger and more persistent issues are not natural disasters, but pests and diseases such as the deadly bacterial disease (Candidatus Liberibacter asiaticus) called Huanglongbing (HLB). Symptoms of this disease include yellowing of flush shoots, mottling and yellow streaking of the leaves, misshapen or deformed fruit, aborting of seed, and a bitter taste in the fruit, and eventual tree starts to slowly die back (Capoor et al., 1967). This disease is currently affecting the three main citrus producing states in the U.S., Florida, California and Texas. HLB is transmitted by an insect vector called the Asian Citrus Psyllid (ACP) (Diaphorina citri Kuwayama). As an adult, D. citri feeds at a 45 degree angle on the citrus leaf surface and its lifecycle consists of approximately 17 days from the stages of egg through five instar nymph stages to adult (Fig. 1) in total of about 10-13 days (French et al., 2001). Sexual maturity for adults takes about 2-6 days, where females can lay up 900 eggs. D. citri population varies with the number of young flush shoots because adult females lay their eggs on the inner layer of young flush shoots. D. citri does induce slight direct damage to the leaves of citrus by its piercing mouth parts, but more importantly in doing so transmits the bacteria responsible for HLB. Currently there is no known cure for this disease, and the recommended strategy against this disease includes an intensive and systematic control of the vector together with the removal of infected trees.

Another management strategy that is gaining popularity among citrus producers that are combating HLB in Florida is through the adoption of improving citrus tree health through nutritional application. One grower in Florida has developed a citrus tree nutrient management program where he is able to maintain orange production despite having over 99% of his citrus trees with confirmed HLB symptoms. This nutritional approach program includes frequent sprays using foliar macro and micro nutrient supplements. Adequate nutrition is an important aspect of proper development and growth of citrus. Some researchers have considered that the use of natural products can reduce the amount of toxic substances in the environment while lowering potential harm to beneficial insect's populations. In a field trail performed in 2009-2010, Juan Raygoza observed the effects of nutrients and possible organic practices on D. citri dynamics to young citrus trees where it was found that an application of compost with high calcium levels led to increased calcium within citrus trees which consequently decreased D. citri-density (Raygoza, 2010). Follow up lab incubation studies were performed to determine the survivorship of D. citri adults on young flush sprayed with Ca resulting in significantly decreased ACP population survival curves as Ca treated foliage compared to water (control) treatments or K or Zn- Mn spray treatments. With these initial observations we hypothesized that by applying supplemental calcium sources to citrus we can increase calcium levels within the plant which will subsequently effect D. citri behavior, survival and development. Calcium (Ca) nutrients play an important role in a plants development and fruit quality (White and Broadley, 2003).

The main purpose of this research is to investigate if citrus mediated with Ca can effect population densities and behavior of D. citri in field trials and the impact of Ca on citrus fruit quality. Objective 1: Evaluate the impact of foliar- and soil-applied calcium sources on the survival and suppression of D. citri. Objective 2: Evaluate the impact of foliar applied macro- and micro-nutrient combinations with and without calcium sources on D. citri and its subsequent effect on citrus quality parameters.

MATERIALS AND METHODS

The two objectives were evaluated under two separate field studies using young three year old "Rio Red" grapefruit trees located at the Texas A&M University-Kingsville Citrus Center South Farm in Weslaco, TX.

Study # 1: Effects of foliar and soil calcium sources to D. *citri* infestation

A total of 100 trees were selected for this experiment with treatments arranged into a randomized block design, with five block rows (20 trees/block), and then split into five subplots (4 trees/subplot).Foliar and soil applied calcium sources were applied to a grapefruit orchard in March 2011, with evaluation of pest populations following treatment through November 2011 to evaluate the impact on D. citri survival and infestation. Four calcium sources were used for this experiment and compared against a control (water); two foliar applied (calcium Metalosate®and calcium thiosulfate) and two soil applied (calcium nitrate and calcium sulfate). Treatment products were obtained from the following sources: Calcium Metalosate® (Albion, Clearfield, UT, USA), calcium thiosulfate (CaTs®; Tessenderlo Kerley, Phoenix, AR, calcium nitrate (Southern Agricultural Insecticides, Inc., Palmetto, FL), and gypsum (Hoe-Down®; Temple-Inland, Fredericksburg, TX). Soil applied Ca treatments were incorporated under the tree canopy, while foliar Ca treatments were sprayed onto foliage at recommended application rates. ACP pest survey observations were performed weekly for D. citri eggs, nymphs and adults of each treatment using a 10x magnifying lens in the field.

Study # 2: Foliar applied nutrients with and without calcium on D. *citri* infestations

In this field trial, we focused on testing the impact that different nutrients have on D. citri populations in a RCB design containing 120 grapefruit trees, separated into 5 row blocks (24 trees/block) with 8 subplots per row (3 trees/subplot). Three different foliar spray fertilizers (Metalosate Calcium©, Metalosate Potassium©, and Metalosate Crop-Up© manufactured by Albion© Inc., Clearfield, UT, USA) were used to create eight different treatments. The Metalosate Ca had 6% chelated Ca, Metalosate K had a 24.0% soluble potash derived from potassium acetate, and Metalosate Crop-Up contained B as boric acid and chelated forms of Mg, Cu, Fe, Mn, and Zn. The eight foliar treatments were: 1) control (water only), 2) K, 3) Ca, 4) CropUp, 5) K+CropUp, 6) Ca+CropUp, 7) Ca+K, and 8) Ca+K+CropUp. Foliar treatments were applied twice on May 18 and August 20, 2011 in the morning at mid-range rates recommended by the manufacturer using a back-pack constant pressure sprayer. After spray treatment, ACP counts were monitored weekly from May through November 2011 as discussed previously. At the end of the season, grapefruits were harvested to determine treatment impacts on fruit quality parameters and yield.

Data Analysis:

The percentages of young flush shoots infested by any D. citri developmental stage were calculated per sampling date. To ensure normality, numbers of D. citri per flush shoot were log(x+1)-transformed and percentages were arcsine-transformed before analysis. Repeated measures analysis of variance was used to determine the effects of treatment, time and their interaction on D. citri infestation levels and densities using PROC MIXED of SAS. (SAS Institute 2008). Least square means of various treatments were compared using Tukey test. Correlation analysis was used to describe relationships between foliar nutrient content (macro- and micro-elements) and D. citri infestations.

RESULTS AND DISCUSSION

Study #1: Foliar and soil calcium application effects on D. *citri* infestation

The number of D. citri eggs, nymphs and adults observed in the percentage of flush shoots infested following Ca application varied significantly over time in the field ($P<0.0001$) as expected due to periodic flushing of leaves over the growing season . The effect of Ca treatments on D. citri infestation level was also significant above the 90% confidence level by repeated measure analysis (eggs: $P=0.07$; nymphs: $P=0.01$; and adults: $P=0.08$). Based on of LS means comparisons, both foliar and soil applied Ca sources significantly reduced numbers of D. citri for ACP eggs and nymphs (data not shown), and adults (Fig. 2) at the 95% confidence level and higher. The Ca application to citrus trees reduced the densities of D. citri eggs by 24-36%, nymphs by 35-56%, and adults by 20-44% compared to the control (data not shown).

Study # 2: Foliar applied nutrients with and without calcium on D. *citri* infestation

The number of D. citri counts in this field varied throughout the 2011 evaluation period with low population numbers from mid May until mid June when new shoot flush development occurred. Afterwhich, ACP densities followed closely to new leaf flush development until mid October 2011. Adult D. citri populations were significantly reduced by foliar application with Ca alone, whereas all foliar treatments containing K were not significantly different than that of the control (Fig. 3). Application of micronutrients by CropUp alone did reduce the number of ACP adults, but not significantly, whereas in the presence of calcium Ca+CropUp significantly lowered ACP adult numbers (Fig. 3).

During this study it was noticed that there was a very evident border-edge effect where ACP populations were present only on the windward eastern border row throughout the 2011 study. Since ACP counts were taken from all three trees per subplot, there was sufficient data and replication to focus on just the border rows trees that had ACP infestations. Pooling all treatments that had Ca application and comparing them to all trees without Ca application provided additional support to the role Ca plays at reducing ACP populations. The least square means comparison results from these trees showed that D. citri eggs ($t=2.55$, $df=72$, $P<0.01$) and adults ($t=2.22$, $df=72$, $P=0.03$) were significantly reduced in Ca vs. Non-Ca treated trees (Fig. 4).

This was not evident for nymph population counts ($P=0.59$), where significant differences is more challenging to observe in the field as nymphs are more prone to predators than that of eggs and adults. In all, foliar Ca application reduced ACP infestation by 36% for eggs and 44% for adults, suggesting that trees without supplemental Ca applications are prone to have 1.6 to 1.8 times more ACP egg and adult numbers.

The average reduction in ACP infestation on Rio Red grapefruit tree leaves is shown in Table 1. Comparisons between foliar macro- and micro-nutrient sprays using Albion Metalosate products with and without Ca additions, shows a repetitive trend of increased reduction in ACP infestations when Ca is applied to tree leaves.

Rio Red grapefruit were evaluated in 2011 for fruit quality indicators such as sugar and citric acid content. For 2011, juice sugar content as determined by degree Brix (°Bx) was the highest for Ca (10.95 °Bx) of all treatments and the control had the lowest (10.05 °Bx). Ca and Ca+CropUp also had the highest citric acid percentage with 1.67% and 1.52% compared to 1.02% citric acid for the control. Although these results are preliminary with only one year's data thus far, still the findings provide hope for improved yields in 2012 harvest season. The yield results from trees treated with foliar Ca-Metalosate applications were approximately 20% higher on average than trees receiving no Ca supplementations, despite having other types of macro- and micro- foliar Albion product nutrient applications (Fig. 5).

CONCLUSION

D. citri was discovered in South Texas in September 2001 and HLB disease was discovered in South Texas in January 2012. As evidenced in Florida, the spread of HLB could be devastating to the South Texas citrus industry if D. citri populations are not controlled (Batool, 2007). The most recommended method and best approach to controlling D. citri populations is via chemical control for reducing ACP populations (Childers and Rogers, 2005). However, this will be challenging to accomplish in organic farms that do not use conventional chemicals that have shown efficacy at controlling D. citri. The findings from two field trials have shown that in all treatments containing Ca there were lower numbers of D. citri infestation as compared to treatments without additional Ca, whether soil or foliarly applied. This is intriguing because south Texas soils are highly calcareous and yet supplemental Ca application whether led to the suppression of ACP populations in young citrus trees. The findings reported from these studies suggest that application of calcium sources to citrus can lead to the reduction of D. citri populations for a period of time. By applying calcium to citrus it shows that it may be a beneficial means of providing both as a macronutrient source required for plant growth while lowering the potential negative impact that D. citri can have on spreading the detrimental HLB disease. Calcium additions in tandem with good nutrient management and pest control plans can enhance both ACP pest control and may in turn enhance citrus health, yield and fruit quality.

Ackowledgements:

We would like to acknowledge the Texas Citrus Producers Board and USDA-NIFA Hispanic Serving Institutions grant program (Awards 2009-38422-20111 and 2011-38422-30826) for their financial support, and Albion® Plant Nutrition for supplying the foliar Metalosate® products. Special thanks to the graduate students and farm crew of the TAMU-Kingsville Citrus Center located in Weslaco, TX for their work.

REFERENCES

Batool, A. 2007. Citrus Greening Disease – A major cause of citrus decline in the world – A Review. Horticulture Science. (Prague). 34:159-166.

Capoor, S. P., D. G. Rao, and S. M. Viswanath, 1967. Diaphorina citri Kuway., a vector of the greening disease of citrus in India. Indian Journal of Agricultural Sciences. 37: 572-576.

Childers, C., and M. Rogers. 2005. Chemical Control and Management Approaches of the Asian Citrus Psyllid, Diaphorina citri Kuwayama (Homoptera:Psyllidae) in Florida Citrus. Proc. Fla. State Hort. Soc. 118:49-53.

French, J.V., C.J. Kahlke, and J.V. da Graca. 2001. First Record of the Asian Citrus Psylla, Diaphorina citri Kuwayama (Homoptera:Psyllidae) in Texas. Subtropical Plant Science. 53:14-15.

Mead, F. W., and T. R. Fasulo. August 2011 (EENY-033). University of Florida IFAS Extension. Asian Citrus Psyllid, Diaphorina citri Kuwayama (Insecta: Hemiptera: Psyllidae). <http://edis.ifas.ufl.edu/pdffiles/IN/IN16000.pdf>.

Raygoza, J.M., 2010. Effects of Organic Practices on Diaphorina Citri Dynamics and Nutrient Absorption of Citrus Trees. Thesis. Texas A&M University-Kingsville. May 2010.

SAS Institute, 2008. SAS Procedures Guide, Version 9.2. SAS Institute, Cary, NC, USA.

White, P.J., and M.R. Broadley, 2003. Calcium in Plants. Annals of Botany. 92:487-511.

FIGURES

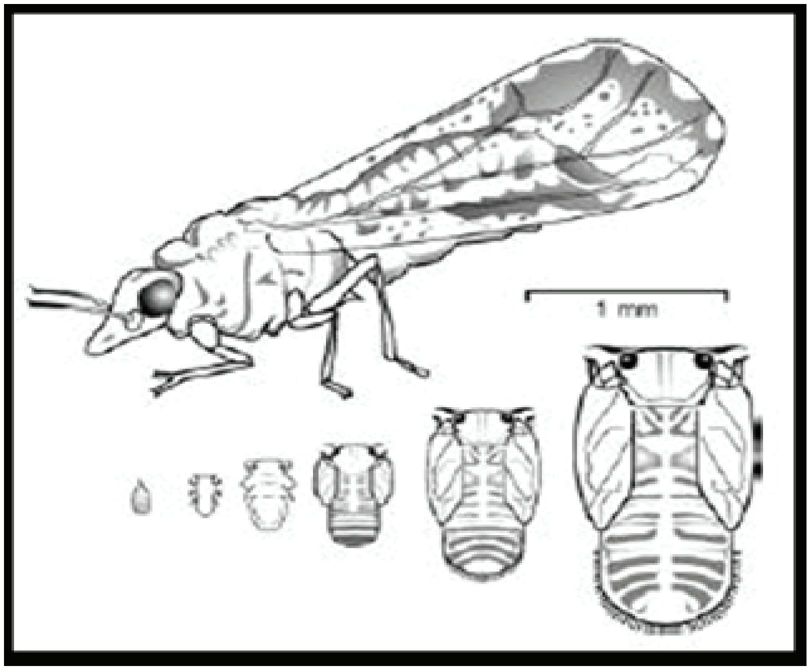

Fig. 1. Asian Citrus Psyllid; Life cycle from egg through 5 instar nymph stages to adult (Mead and Fasulo, 2011).

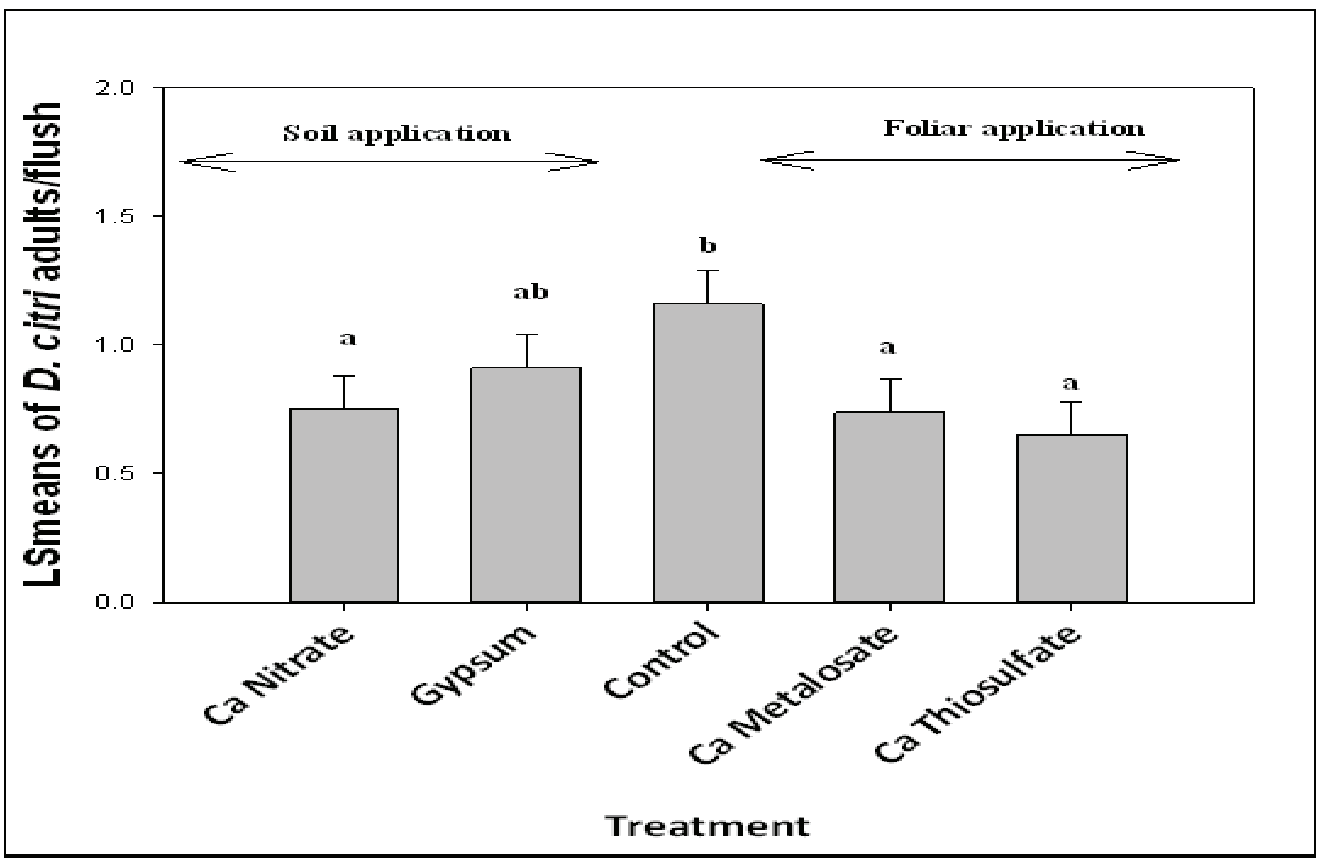

Fig. 2. Least square means of D. *citri* adult infestation per shoot flush after treatment.

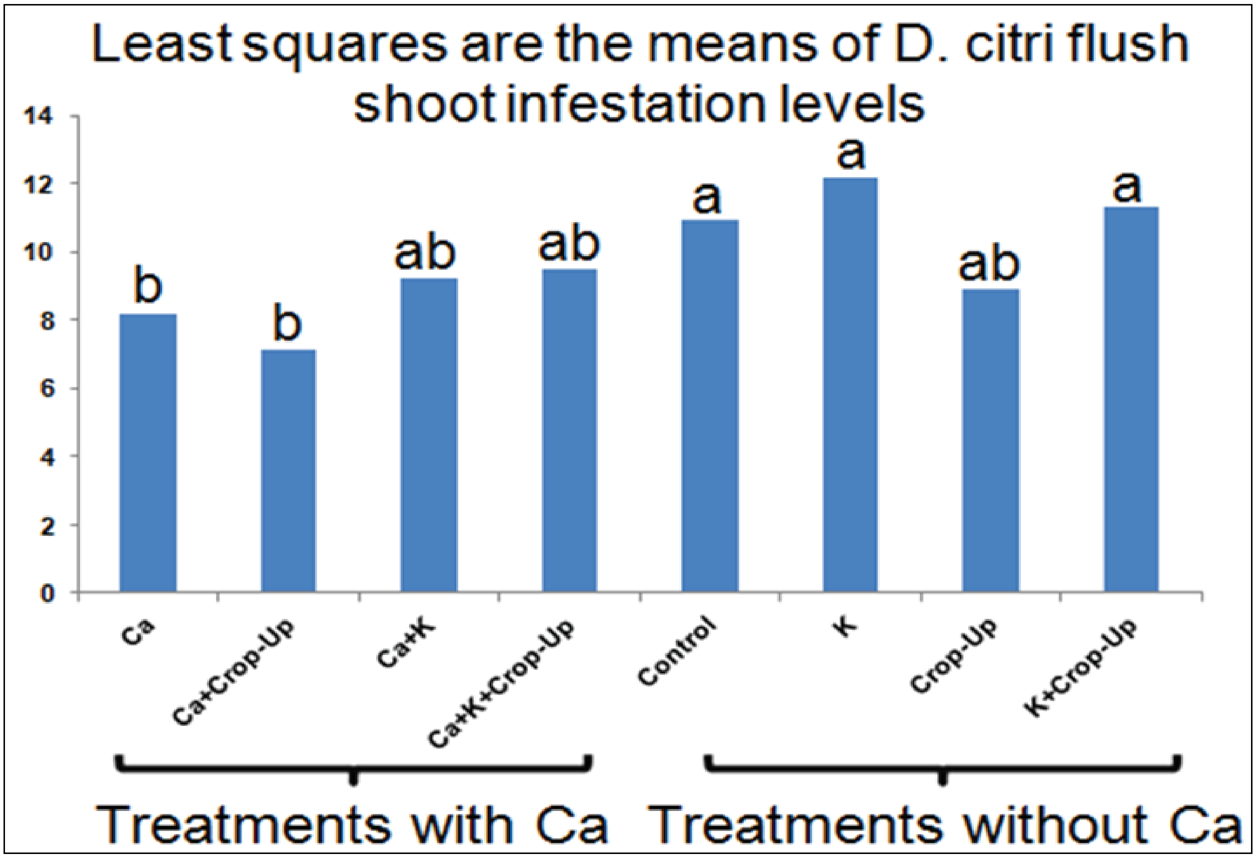

Fig. 3. Least squares means comparison of adult D. *citri* infestations for all foliar nutrient treatments with and without calcium.

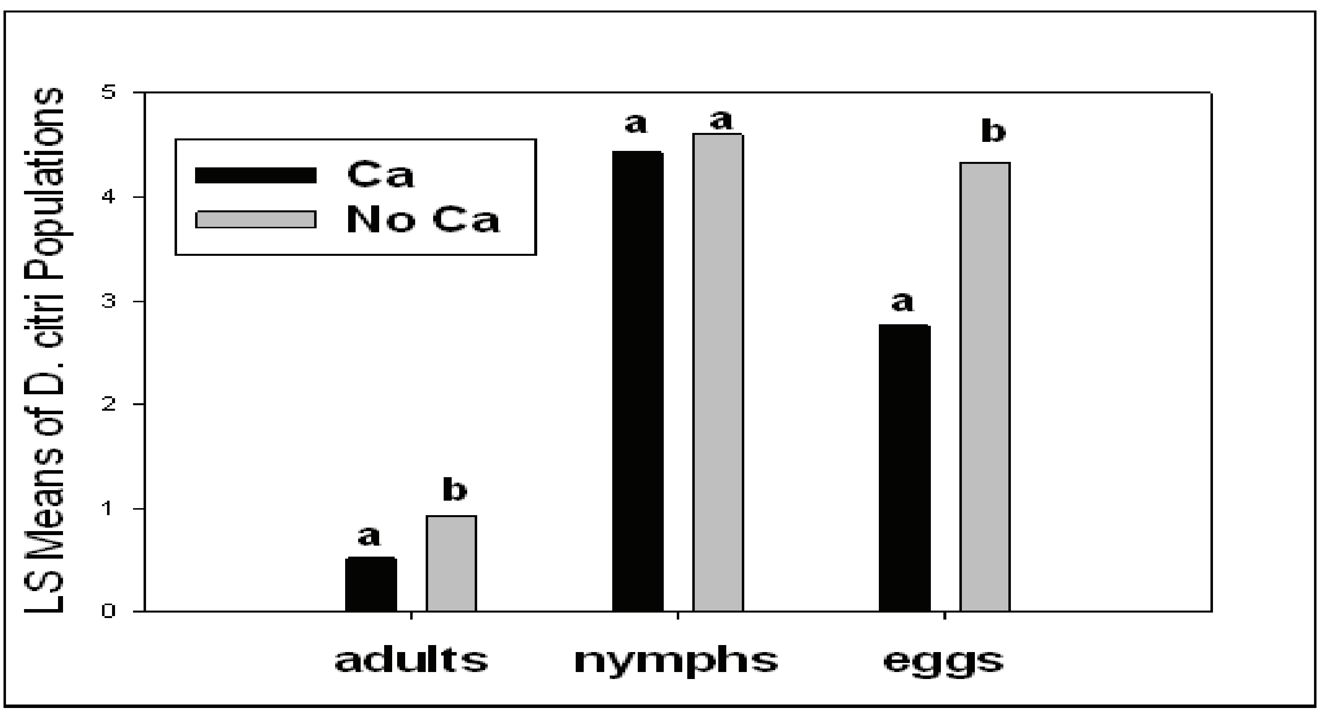

Fig. 4. Least square means of D. citri infestation per shoot flush, comparing all foliar nutrient treatments with calcium (Ca) versus treatments without calcium (No Ca).

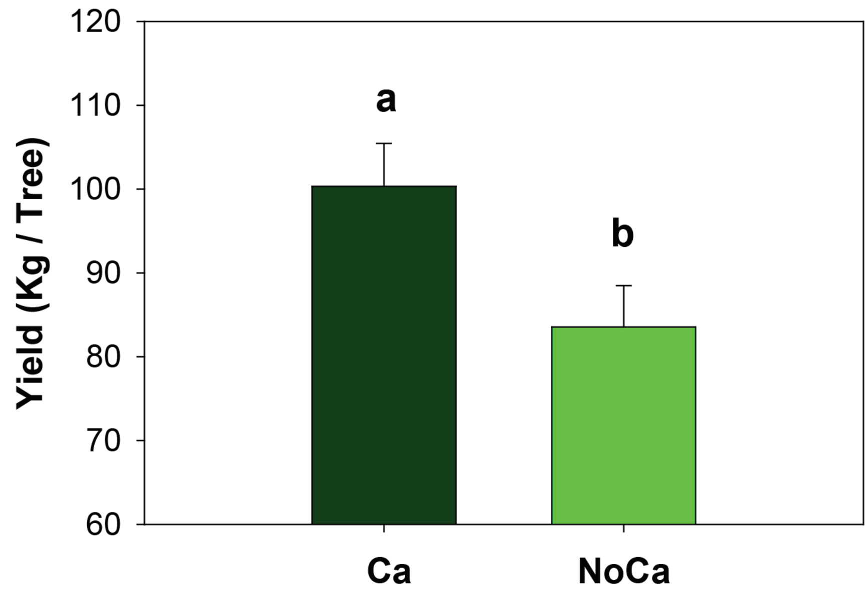

Fig. 5. Rio Red grapefruit yield comparisons among trees foliarly treated with Ca supplements vs. non-Ca supplemented trees.

Treatment Comparison	% ACP Infestation	% Reduction
Control Calcium –Metalosate (Ca)	10.9% 8.2%	24.8%
Crop-Up Ca + Crop-Up	8.9% 7.1%	20.2%
Potassium-Metalosate (K) Ca + K	12.2% 9.2%	24.6%
K + Crop Up Ca + K + Crop-Up	11.3% 9.5%	15.9%

Table 1. Effective reduction of Asian Citrus Pysllid infestations in grapefruit trees sprayed with Calcium-Metalosate® as compared to various Metalosate nutrient spray products.

balchem
PLANT NUTRITION
balchem.com/plant-nutrition