

## **Avocado Growers Can Reduce Nitrate Groundwater Pollution and Increase Yield and Profit**

### **Project Leader:**

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### **Project Objectives:**

The goal of the proposed research is to reduce the amount of nitrate entering the groundwater and the amount of boron added to soils from avocado production by providing avocado growers with an economically viable alternative to the use of soil applied nitrate and/or boron.

The specific objectives are: (i) to test in a well replicated field trial the results of preliminary research suggesting that a single application of urea to the canopy during early bloom will increase yield and net return to the grower over untreated control trees at the 5% level and will increase yield significantly better than trees receiving canopy applications of boron; (ii) to determine if nitrogen applied to the canopy during expansion of the spring flush leaves (approximately May 30) increases yield alone and/or in combination with the bloom canopy application of urea; (iii) to determine if canopy applications of urea during bloom or during leaf expansion of the spring flush can replace part of the nitrogen annually applied to the soil in avocado production; and (iv) to disseminate the results of this research to avocado growers through talks to growers and publications in grower magazines and the California Avocado Society Yearbook.

### **Executive Summary:**

Canopy applications of boron or low-biuret urea were made during early inflorescence development and/or during leaf expansion of the spring flush (May). Unocal PLUS, zero biuret urea, was applied at a rate of 0.15 kg N per tree and Solubor, 20.5% boron, at 30 g per tree in 15 liters (4 gallons) of water to give full canopy coverage. In year 1, an "on" year, there were no statistically significant differences in kg fruit per tree as a result of any treatment. The bloom application of low-biuret urea increased the number of larger-sized fruit, packinghouse sizes 40 and 36, over all other treatments and the control at  $P=0.06$ . This increase in the number of larger-sized fruit was not due to any reduction in yield. Trees receiving the bloom application of low-biuret urea yielded 189 kg per tree, the control trees 187. While not statistically significant even at the 5% level, it is worth noting that trees receiving both the bloom and May spring flush applications of low-biuret averaged 223 kg fruit per tree, which was 36 kg (80 lbs) more fruit per tree than the control. Trees receiving only the May spring flush application of low-biuret averaged 11 kg (24 lbs) more fruit per tree than the control. In contrast, the harvest for year 2 represented an "off" year: compare

63.5 kg fruit per control tree in year two to 187 kg fruit per control tree for the previous harvest in year one of the experiment. No treatment significantly increased the total kg of fruit per tree at the 5% level. Consistent with the alternate bearing habit of the 'Hass' avocado in California, the treatment which increased yield the most in year 1 (foliar application of low-biuret urea at bloom followed by a second application to the spring flush in May) had the lowest yield in year two. Similarly, the control, which had a low yield in year one, had a high yield in year two. In year two, the control trees averaged 47 kg (103 lbs) more fruit per tree than the trees receiving the two urea sprays. Trees receiving boron sprays at bloom produced yields lower than the control trees for both years of the study. Despite differences in yield, there were no significant differences in the number of fruit in any size category.

Our research is the first to report the effects of using foliar nitrogen in the production of the 'Hass' avocado. The research requires additional years of replication due to alternate bearing in order to obtain results for several "on" and "off" crop years for statistical analyses. Due to alternate bearing there was no cumulative yield or economic benefit from any of the treatments. The results thus far provide evidence that urea applied to the canopy at bloom and again during the spring flush can increase yield. The results suggest, however, that this treatment should be initiated and/or used only when an orchard is going into an "off" year. This interpretation needs to be tested.

#### **Work Description:**

#### **TASK 1: Effect of Early Bloom Canopy Applications of Boron or Urea and/or a Later Spring Flush Application (May) on Yield of 'Hass' Avocado**

The purpose of this task is to test in a well replicated field trial the results of our preliminary research which provided evidence that a single application of urea to the canopy during early bloom increases yield and net return to the grower over untreated control trees or trees receiving a single early bloom spray of boron. The completion of this task will provide answers to two additional questions: (1) whether a single application of nitrogen to the developing spring flush foliage will increase yield; and (2) whether the early bloom and/or the spring flush applications can replace part of the nitrogen applied to the soil annually in avocado production. The product of this task will be a report summarizing the results of the completed task, including a cost benefit analysis of each treatment.

#### **Subtask 1.1: Application of treatments to 16 individual tree replicates/treatment in a randomized block design.**

The trees are mature, healthy commercially-producing 'Hass' avocados on Duke 7 rootstocks owned by Limoneira Co. and located in Santa Paula, CA. During the preliminary study, voucher specimens were collected to insure that trees could be treated at the same stage of flower development in each subsequent year. At early bloom, trees received a canopy spray of 30 g Solubor in 4 gallons of water/tree (all 4 gallons were applied to the bloom and foliage to thoroughly cover the tree) or 475 ml Unocal PLUS in 4 gallons of water/tree and/or at the time the leaves of the spring flush have been shown to optimally take up urea (approximately May 30), 475 ml Unocal PLUS in 4 gallons of water/tree was applied to the canopy. The concentration used for the boron canopy spray was that of Robbertse et al. (1990, Acta. Hort. 2:587-594) and the low biuret urea was the rate used in citrus production.

#### **Subtask 1.2: Collection of leaf samples for mineral nutrient analyses.**

Forty spring flush leaves from non-fruiting terminals were collected at chest height around each data tree in September. The leaves were immediately stored on ice, taken to UCR, washed, dried, ground and sent to Albion Laboratories for analysis of total nitrogen and boron.

### **Subtask 1.3: Harvest.**

During harvest on May 31 and June 1 in year 1 and on June 18 in year 2, total kg fruit/tree and the weight of 100 randomly selected individual fruit/tree were determined and subsequently used to calculate packout/tree.

### **Subtask 1.4: Submit Interpretive Summary.**

### **Subtask 1.5: Submit Interim Report**

### **Subtask 1.6: Final report, including cost/benefit analysis of each treatment.**

### **Results:**

For year 1, an "on" year, no treatment significantly increased the total weight of fruit per tree at the 5% level. The bloom spray of low-biuret urea increased the number of larger fruit, those of packinghouse sizes 40 and 36, compared to all other treatments at  $P=0.06$ . There were no significant differences in the number of fruit in any other size category. While not statistically different at the 5% level, foliar application of urea to the canopy at bloom in combination with a second application to the spring flush (May) resulted in an average of 3 additional packing cartons (10.9 kg or 24 lbs of fruit per carton) of fruit per tree: compare 223 kg fruit per tree to 187 for the control. Application of low-biuret urea to only the spring flush increased yield by 11 kg fruit per tree compared to the control. The boron spray at bloom resulted in the lowest yield, 164 kg fruit per tree. There were no negative effects from any treatment on internal fruit quality. Leaf boron and nitrogen concentrations increased one week after application at bloom for boron and after the May application for nitrogen, but there were no significant differences in the concentrations of either nutrient in September.

For year 2, the harvest represented an "off" year: compare 63.5 kg fruit per control tree in year two to 187 kg fruit per control tree for the previous harvest in year one of the experiment. No treatment significantly increased the total kg of fruit per tree at the 5% level. Consistent with alternate bearing habit of the 'Hass' avocado in California, the treatment which increased yield the most in year 1 (foliar application of low-biuret urea at bloom followed by a second application to the spring flush in May) had the lowest yield in year two. Similarly, the control, which had a low yield in year one, had a high yield in year two. In year two, the control trees averaged 47 kg more fruit per tree than the trees receiving the two urea sprays. However, trees receiving a foliar application of boron at bloom produced yields that were lower than the control in both years of the study. Despite differences in yield, there were no significant differences in the number of fruit in any size category. Leaf analyses for year 2 have not yet been completed by Albion Laboratories. There were no negative effects from any treatment on internal fruit quality.

### **Discussion:**

Our research is the first to report the effects of using foliar nitrogen in the production of the 'Hass' avocado. The research requires additional years of replication due to

alternate bearing in order to obtain yield results for several "on" and "off" crop years for statistical analyses. Due to alternate bearing, there was no cumulative yield or economic benefit from any of the treatments. It remains to be determined whether or not the treatment combining the bloom and May spring flush applications of low-biuret urea will yield statistically significant results in future years. In year 1, the trend toward 3 additional packing cartons per tree for this treatment was worth approximately \$4,500 per acre (24 lbs fruit/carton X \$0.60/lb X 96 trees/acre; Unocal PLUS cost \$1/gallon X 12 gallons/acre X 2 applications + \$15-35/acre cost of application X 2 applications). However, in year 2, this treatment yielded 4.3 packing cartons less than the control. The value of the fruit harvested on June 18, 1996, was coincidentally \$0.60/lb, so this treatment actually lost \$2,000 per acre over the two year period. The boron treatment reduced production by 2.1 and 1.7 packing cartons compared to the control for years 1 and 2, respectively. This represented a cumulative loss of \$5,200 per acre for the two years. The results provide strong evidence that boron applied at bloom to the foliage of trees having high concentrations of boron (>180 ppm) has a negative impact on year.

### **Conclusions:**

Few conclusions can be drawn at this time. The research needs to be replicated for several years to have yield data for a minimum of two "on" and two "off" years. The potential of bloom and/or foliar applications of nitrogen to increase yield and/or size is promising but requires further investigation. At this point, only the increase in the number of larger-sized fruit (packinghouse sizes 40 and 36) with the bloom application of low-biuret urea approaches statistical significance ( $P=0.06$ ). At present the data are consistent with foliar applications of nitrogen having a beneficial effect on yield over treatment with boron and the control. The results suggest, however, that urea treatments should be initiated and/or used only when an orchard is going into an "off" year. This interpretation needs to be tested further, but is consistent with the increased yield obtained in an earlier preliminary experiment conducted in an "off" year. A firm conclusion can be drawn regarding the effect of foliar application of boron at bloom to orchards having high concentrations of boron in the trees (>180 ppm in spring flush leaves collected from non-fruiting terminals in September and commercially analyzed). This treatment reduced yield in both "on" and "off" production years and should not be recommended for such orchards.