

Longitudinal Almond Yield Response from Foliar Applied Mondo™ Programs with SureSeal™ Cuticle Supplement Technology in California's San Joaquin Valley

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Abstract: Trials were conducted in California's Central San Joaquin Valley to evaluate yield response of 3 to 13-year 'Nonpareil' almonds to foliar applied 1% v/v solutions of SureSeal™ Cuticle Supplement Technology formulation (Mondo™). In 2015, 12-year flood irrigated trees were treated with Mondo™ under two timing regimes (three monthly applications) starting either just after petal fall (spring) or in the first week of June (summer). 2015 trial data showed that Mondo™ increased the number of nuts in treated trees by as much as 57% (p=0.08). Both Mondo™ timing regimes produced greater individual nut weights even though the trees were retaining a greater number of nuts than the untreated trees. Estimated yields per acre were as much as 35% higher than the untreated (p<0.05). Due to the increased nut retention in Mondo treated trees, a repeat study was initiated on the same plots to determine if the increased nut retention would negatively affect the next season's yields and could the product continue to increase yields. In 2016, yield results showed a nut weights and nut retention were not different from the trees that had been untreated in 2015 and 2016. Two new first year trials were conducted in 2016 with one in 6-year sprinkler irrigated trees on sandy loam soil and another in young 3-year drip-irrigated trees on clay loam soil that only included the early post-petal fall application timing. Results on the 6-year sprinkler-irrigated trees were similar to the previous year's results with over 40% greater nut meat yields from the Mondo™ treated almonds than the untreated trees (p<0.07). In the 3-year old trees there was no significant increase in nut retention detected compared to the untreated trees. Even though yield increases were expected from Mondo treated trees in 2015 and 2016, grower irrigation and fertility programs were not augmented. In 2016 after the first applications were made DynaMax SapFlo™ meters and Sentek Diviner™ equipment were deployed to detect differences in water consumption at the new drip and sprinkler irrigated sites. Increased water consumption by Mondo™ treated trees appeared to be correspond with higher nut retention in 2016 trials and Volumetric Water Content below 30 cm soil depth. Only limited soil, irrigation and tissue sampling was performed in 2016, which did suggest there was some indication of excessive boron in 3-year drip irrigated trees. These findings, along with a known metabolic effect on plant cells, suggest SureSeal™ has potential to increase yields in properly irrigated and fertilized almonds and other stone fruits by increasing fruit retention shortly after petal fall and through harvest. The increase in nut retention does not appear to negatively affect individual nut weight. Future research should include monitoring flower set, early fruit set and pre-harvest fruit retention data, to evaluate the impact of Mondo™ applications on early fruit set. Additionally, extensive soil, irrigation water, and plant tissue sampling would be necessary to determine if there may be key nutritional deficiencies that exist or may occur in the year following the Mondo™ applications to optimize yield potential and successive year production.

| Trial Year | Site | Tree Age (year) | Irrigation | Soil |
|------------|-------------------|-----------------|----------------|------------|
| 2015-16 | Sanger - Belmont | >12 | Flood | Sandy Loam |
| 2016 | Huron | 3 | Drip | Clay Loam |
| 2016 | Sanger - McKinley | 6 | Microsprinkler | Sandy Loam |



Treatment: Mondo, a proprietary blend of phospholipids in a cellulose matrix, a SureSeal™ Cuticle Supplement, was applied by Tractor-mounted airblast sprayer (photo, left) at a rate of 1 gal/a. Treatments were applied monthly starting either in March (Applications A, B, & C) or starting in June (D, E, & F; 2015 only). Sanger-Belmont trials were conducted on the same trees both years.

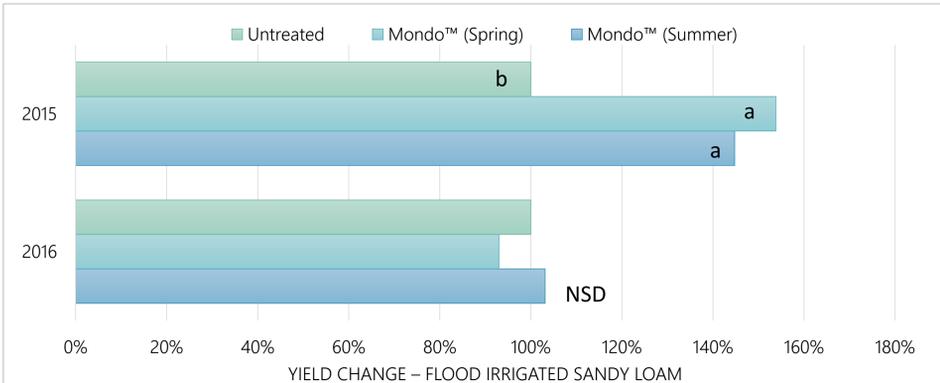


Figure 1. Yield Differences in 2015 and 2016. Almond yields were normalized based on terminal nut counts and average nut weights as full harvests were not possible. Given the increase in nut weight and nuts on branches (data not shown), compared to the untreated (normalized to 100%), there was a 54% increase in yield where Mondo™ was spring applied and a 45% increase where summer applied in 2015 (p=0.04). The following year, on the same trees, we saw a 7% decrease in yield compared to the untreated for the spring application and a 3% increase for the summer treatment, though results were not significantly different.

| Treatment (Timing) | 2016 Nut Drop | | |
|--------------------|---------------|-------|-----------|
| | Flood | Drip | Sprinkler |
| Untreated | 7.6% | 19.3% | 3.3% |
| Mondo™ (Spring) | 8.2% | 21.8% | 4.3% |
| Mondo™ (Summer) | 5.8% | | |

Figure 2. Terminal Nut Counts were taken in April and again, following nut drop, in July for all sites in 2016. There were no significant differences in percent nut drop at each site, and for trees in the flooded orchard in their second year from 4-6 weeks after petal until harvest only, we don't see a negative effect of a second year of Mondo™ applications but no additional yield.

| | Nutrient Analysis | | | |
|---------------------|----------------------|---------------------|----|--|
| | Soil - 13-Year Flood | Water - 3 Year Drip | | |
| + No problem | B -- | B | -- | |
| - Potential Problem | Fe - | Fe | NA | |
| -- Problems Likely | NO ₃ -N - | NO ₃ -N | + | |
| | Zn - | Zn | NA | |

Figure 3. Nutrient suitability in soil and water samples taken from the drip-irrigated site in Huron and flooded site in Sanger. Analytical evidence shows deficient or excessive amounts of key nutrients Boron, Iron, Nitrate Nitrogen and Zinc, which could have limited yield contributions from treated trees.

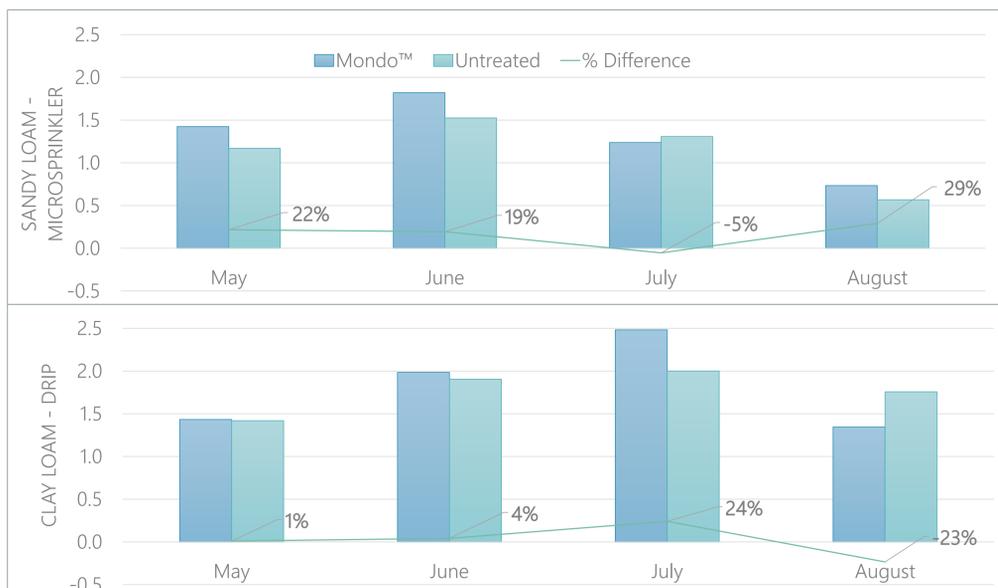


Figure 4. Sap flow was monitored using DynaMax SapFlo™ meters on the microsprinkler (Sanger - McKinley) and drip irrigated (Huron) sites. The line graph shows percentage difference in average sap flow by month. Average sap flow rates among the Mondo™-treated trees in May and June on the microsprinkler irrigated 6 year old trees was around 20% higher than the untreated trees. No consistent differences were detected in non-responsive trial in 3-year trees

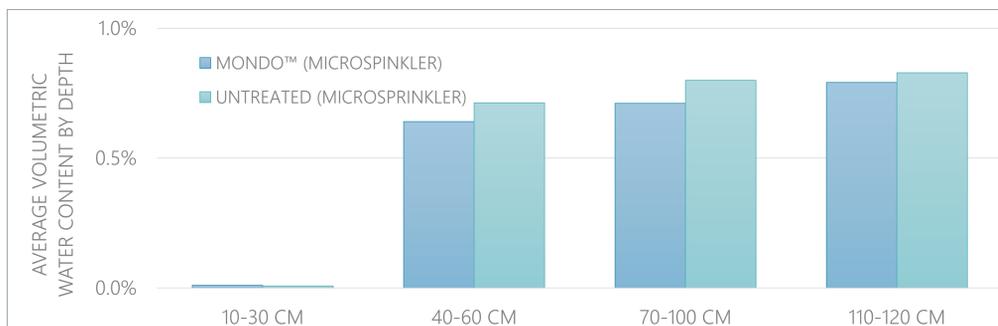


Figure 5. Soil Volumetric Water Content (VWC raw data from instrument not weighted) was monitored using Sentek Diviner™ equipment at the microsprinkler site in June and July. Water content averages in the sandy loam soil was lower as depth increased for the Mondo-treated trees, suggesting greater water uptake for increased fruit production.

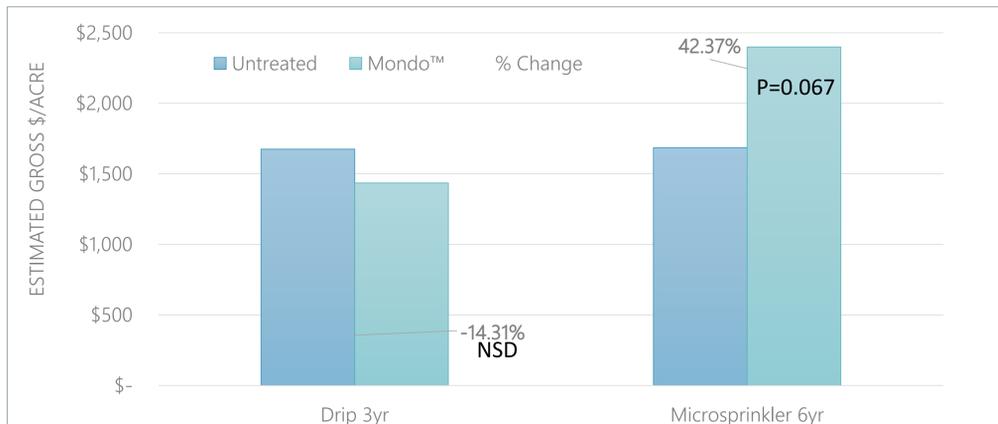


Figure 6. In 2016, terminal nut counts were multiplied by average single nut weights to normalize nut meat yield per acre for each treatment compared to the untreated trees. An average yield for nonpareil almonds was estimated at 600 pounds of nut meat per acre with an average almond nut meat price of \$2.81 per pound, totaling \$1,686 per acre of untreated trees. Drip irrigated trees had a 14% (NSD) decrease in estimated gross returns for the Mondo™-treatment while trees in the microsprinkler site had a 42% increase in returns, significant at p=0.067.

Conclusions: Sites that had 6-12 year old trees on sandy loam soil were able to significantly increase yields by as much as 54% on flooded 12-yr trees in 2015 (Fig. 1) and 43% on microsprinkler-irrigated 6-yr trees in 2016 (Fig. 6). There was no reduction in nut meat weights on average (they were 2-5% heavier in treated plots, numerically) but these trees did have an increase in count of nuts collected. This suggests productivity is not influencing nut size in a trade off when increasing nut counts. One site that had 3-year drip irrigated trees on clay loam did not show a significant improvement in yield. Additionally, in trees treated a second year, there were no significant decreases in productivity, but there was no increase in nut retention when the same Mondo treatment was applied a second year. This lack of repeat response is not understood but may be influenced by inadequate amendments to optimize fruiting bud production during a high production season. These findings support a hypothesis that Mondo™ enhances bud retention which returns greater yields without compromising fruit size, and will possibly provide the same effect on other stone fruit and other types of trees that typically produce many more flowers than they typically retain, such as cherry, plum, and some citrus.

