Nitrogen Fertility in Beans following Whole Orchard Recycling

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Whole Orchard Recycling (WOR) occurs after the productive life of an orchard and is the process of grinding or chipping trees, spreading the wood chips evenly over the soil surface, and then incorporating the biomass into the soil. WOR has become more common in recent years because air quality regulations restrict growers' ability to manage biomass by burning.

While the process of WOR came about due to biomass management restrictions, researchers have been evaluating the potential benefits for soil health and water management. This is because the practice incorporates large quantities of organic carbon (C) into the soil, and soil C influences other soil properties. There are tradeoffs, however. The woody biomass of the trees has a high carbon to nitrogen (C:N) ratio, which is the mass of C relative to the mass of N. The C:N is an important characteristic of soil amendments because it influences soil biological activity. When the C:N is high (>30:1), the N is primarily used for microbial energy and maintenance. In other words, the N can be 'tied up' by the microbes and not available for plants.

Our understanding of WOR is most advanced in almond sites replanted back to almond, where the UC recommendation is to double the N application in the first year after recycling. Our objectives for this trial were to evaluate soil properties and kidney bean yield following WOR compared to a non-WOR control, and to evaluate two N fertilizer rates. We hypothesized that bean yield might be reduced following WOR due to N immobilization but that higher fertilizer N might help to overcome the yield gap.

The trial took place in 2020 and 2021 on an approximately 35-acre site in San Joaquin County, following June 2019 walnut orchard recycling. At that time, three approximately 0.5-acre plots were kept without wood chips, as untreated controls. We identified three 0.5-acre WOR plots adjacent to each control plot. Nitrogen fertilizer treatments were 45-ft wide strips that ran the length of the field through the WOR and control plots. Soil samples were taken from 0-6 and 6-12 inches in June and October of both years.

Figure 1. Depth of walnut wood chips applied.

Figure 2. Walnut WOR incorporated approximately 70 tons of wood chips per acre.

N Treatment	2020 Standard* rate (Grower rate)	2020 Doubled sidedress rate	2021 Standard* rate	2021 Doubled sidedress rate (Grower rate)
Soil residual	18 lb	18lb	10 lb	10 lb
At-planting fertilizer	10 lb	10 lb	16 lb	16 lb
Sidedress fertilizer	88 lb	176 lb	71 lb	142 lb
Total	116 ab N/ac	204 lb N/ac	97 lb N/ac	168 lb N/ac

**Based on UC dry beans production manual which indicates that a 2000 lb/ac bean crop needs approximately 80-120 lb of N.*

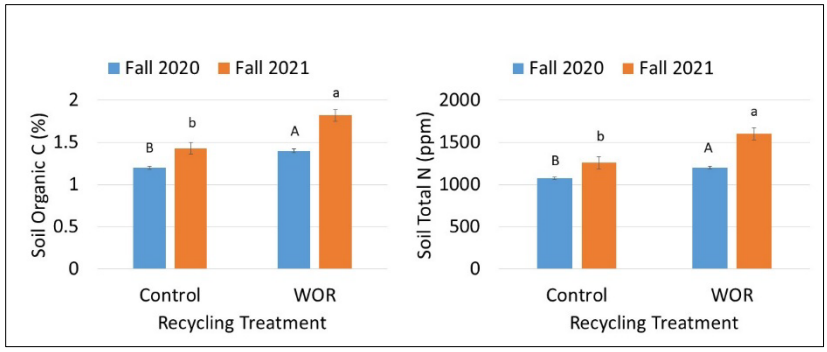

Fig. 3. Soil organic C and total N were enhanced with WOR.

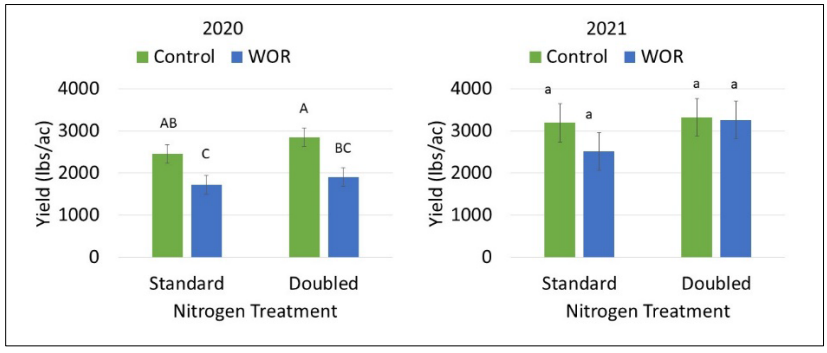

Fig. 4. There was a bean yield penalty with WOR, but it was mitigated with higher N fertilizer rates.

Figure 5. In August 2020, bean growth was visibly better in the control plots (right of pink flag).

Summary: Whole orchard recycling is a practice for managing orchard biomass. By incorporating a large quantity of organic C into the soil, WOR has the potential to improve soil health properties, but a tradeoff may be that N becomes limiting for subsequent crops. This project evaluated soil properties and kidney bean yield following walnut WOR. We found organic C and total N to increase with WOR, but plant-available nitrate was limiting in the first year (data not shown). Bean yield suffered as a result of WOR, but increasing the fertilizer N rate mitigated the yield penalty. To our knowledge, this trial was the first of its kind, and more research will be needed to develop N fertility guidelines in dry beans following WOR. Other tree and annual crops should also be studied.