Wood Chipping Almond Brush to Reduce Air Pollution and to Study the Effect of Wood Chips on Harvest, Soil Nutrients, Soil Aggregation, and the Microbial Community

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Interpretive Summary:

The wood chipping of almond prunings could provide an alternative to burning that would not contribute to air pollution and add valuable organic matter to soils. The success of wood chipping depends on whether or not the wood chips interfere with harvest or delete the soil of critical nutrients necessary for tree growth. An average of 600 pounds per acre of wet weight prunings were pruned in our orchard trial in the fall of 2005. Harvest wind-rows in the wood chipped treatments had significantly more (0.162 kg wood/22 ft row) wood debris than the wind-rows of nuts in treatments without wood chips (0.085 kg of wood/22 ft row). Ten-pound bulk in-shell almond samples taken from harvest carts harvested from both the wood chipped and non-wood chipped treatments were analyzed by the USDA with respect to foreign material consisting of wood debris. The wood chipped treatments averaged 1.62 % wood debris and were significantly greater than non-wood chipped treatments that averaged only 0.85 % wood debris. Woodchips and shreddings placed on the soil surface of an almond orchard decomposed for nearly 7 years before they were small enough to pass through a ¼ inch mess screen. Average individual size of shreddings was significantly larger than the wood chips but had a greater rate of decomposition.

Introduction:

In the San Joaquin Valley of California almond trees are usually pruned every year after harvest in the late fall or early winter. Prunings were typically removed from orchards with a "buck-rake" mounted on a tractor and placed on burn piles and usually burned green. In 2005 the San Joaquin Valley had 585,000 bearing acres of almonds. Preliminary studies have shown that between 1000-2000 lbs/ acre of prunings are removed annually. This would result in the burning of approximately 1 billion pounds of green almond prunings per year. The San Joaquin Valley Unified Air Pollution Control District restricts the burning of agricultural wastes and further restrictions have recently been approved (Senate Bill 700).

The wood chipping or shredding of almond prunings can provide an alternative to burning that will add valuable organic matter to San Joaquin Valley soils typically low in organic matter. If wood chips can be shown not to interfere with harvest or take valuable nutrients from trees then chipping and shredding could be a more environmentally friendly alternative to burning, especially if advantages to soil health and nutrition could also also be demonstrated. There are also a number of different shredders and wood chippers being used by the almond industry, and the shreddings and woodchips are quite variable in size. An experiment was established in 1997 to examine the rate of decomposition of wood chips (Brush Bandit Wood Chipper) compared to shreddings (Rears Pull Behind Shredder).

Materials and Methods:

Wood chipping orchard trial

Almond pruning was performed in October 2003-2005 in an almond orchard in Madera County. The pruning wet and dry weights were determined. The shredding trial was divided into two treatments, trees that received shredded prunings and trees that did not. Four quarter-mile Nonpareil rows received prunings while another four Nonpareil rows did not. The prunings from the rows that did not receive prunings were added to the rows that did. After the prunings were placed on the orchard floor they were shredded with a DiAnna Shredder in 2003 and a Rears Pull Behind Shredder in 2004 and 2005.

Wood debris in the orchard at harvest

After the almond nuts had been shaken to the ground, dried, and wind rowed, the amount of wood debris was determined per 22 feet of wind-row by sorting and weighing of the debris by hand. At harvest, five 10 pound sub samples were removed from harvest nut carts of both shredded and non-shredded treatments and sent to the USDA in Kerman, CA for a Federal State Inspection Certificate.

Woodchip/shredding decomposition experiment

Chippers and shredders have been used to chip or shred brush and their products can be quite variable in size and weight. The decomposition of chips from a Brush Bandit wood chipper was compared to shreddings from a Rears Shredder. Chips and shreddings (300g samples) were placed in nylon mesh sacks, with soil, and placed on the floor of an almond orchard in 1997 in order to examine their rate of decomposition.

There were 11 bags or replications per treatment that were removed at various intervals and replaced from 1998-2005. Soil was separated from wood debris by washing soil through a ¼ inch mess screen. If the wood chips or shreddings passed through the screen they were considered decomposed and not placed back on the orchard floor. If woodchips and shreddings did not pass through the screen the wood debris was weighed and 25 of the largest woodchips or shreddings per bag were measured (length, width, height) to determine their area (cubic mm), and individually weighed, then returned to the nylon sacks and soil and placed back on the orchard floor. Size, weight, and rate of decomposition (% reduction in weight) were examined.

Results:

Wood chipping orchard trial

Pruning wet and dry weights were determined in 2003, 2004, and 2005. The pruning wet weights for 12 randomly selected almond trees were determined. An average of 1,247, 502, and 610 pounds per acre of wet weight prunings were pruned in the trial in 2003, 2004, and 2005 respectively. After sub samples of prunings were dried down, weights averaged 791, 316, and 384 pounds of dried prunings per acre for 2003, 2004, and 2005, respectively. The grower considered the pruning performed in 2003-2005 to be "light" and speculated that on a "heavy" pruning year 3-5 times as much prunings could be removed.

Wood debris in the orchard at harvest

After the nuts had been shaken to the ground at harvest, dried, and wind rowed, the amount of wood debris were determined per 22 feet of wind-row by hand sorting and weighing. The wood debris (shredded) treatment averaged 0.136 kg of wood debris in 22 feet of wind-row and was significantly greater than the non-shredded treatment that averaged only 0.073 kg of wood debris (figure 1). 2006 results were similar to 2004 and 2005.

Sub samples from the harvest carts, after pick up from the orchard floor, were taken from both the shredded and non-shredded treatments and sent to the USDA for a Federal State Inspection Certificate. Ten-pound bulk in-shell almond samples harvested from both the shredded and non-shredded chipped treatments were analyzed with respect to foreign material consisting of wood debris. Ten pound bulk in-shell almond samples from the shredded treatments averaged 1.62 % wood debris and were significantly greater than non-shredded treatments that averaged only 0.85 % wood debris (figure 2). The 10 lb bulk in-shell almond samples from the shredded treatments averaged 0.3235 kg of wood debris and were significantly greater than the non-shredded treatments that averaged 0.1154 kg (figure 3).

Woodchip/shredding decomposition experiment

Chips and shreddings (300g samples) were placed in nylon mesh sacks, with soil, and placed on the floor of an almond orchard in order to examine their rate of decomposition. After 9 months total chip weight per sample average was reduced by 23.73% while total shreddings were reduced by 44.71% (figure 4). After 20 months total

chip weight was reduced by 34.43% while shreddings were reduced by 67.45%. After 2 years total chip weight was reduced 56.21% while shreddings were reduced 69.96 %. After 3 years on the orchard floor total woodchip weight was reduced by 80.85% while total shredding weight was reduced by 80.42%. After 4 years on the soil surface total woodchip weight was reduced by 87.61% while shreddings were reduced by 94.93 % . After 6 years total chip weight was reduced by 93.40 % while shreddings were reduced by 97.06 % (figure 4). Ultimately it took nearly 7 years for 100 % decomposition to take place, defined at when 100 % of the woodchips or shreddings passed through a ¼ inch mess screen.

At each sampling period, 25 of the largest woodchips and shreddings per sample bag were measured, (length, width, height) to determine their area (cubic mm), and weighed (g). Average individual wood chip weight was 0.683 ± 0.11 g while average individual shreddings were significantly larger at 3.63 ± 0.48 g dry weight (figure 5). After two years on the soil surface individual chip weight was reduced by only 28.25 % while the larger shreddings were reduced by 78.31 %. After 4 years on the soil surface individual chip weight was reduced by 63.69 % while the larger shreddings were reduced by 91.79%. After 6 years on the soil surface individual chip weight was reduced by 76.57 % while the larger shreddings were reduced by 96.91 % (figure 5). Again it took 7 years for the 100 % decomposition of the 25 largest individual woodchips and shreddings per sample bag to take place. Average individual area (cubic mm) of the woodchips were 2.1 ± 0.42 cm^3 while shreddings were significantly larger at 8.12 ± 1.83 cm^3 (figure 6). The area of the 25 largest wood chips and shreddings was proportional to their weight and showed a similar rate of decomposition (figure 6).

Conclusions:

Wood chipping or shredding of almond prunings and leaving them on orchard soils resulted in significantly more wood debris in the wind rows at harvest and in harvest carts with nuts after pick up. Woodchips and shreddings, in nylon bags, placed on the soil surface of an almond orchard took considerably longer than predicted to completely decompose. It took nearly 7 years on the orchard floor to decompose woodchips and shreddings to the point they would pass through a ¼ inch mess screen. The average size of the shreddings was significantly larger than the woodchips, that probably resulted in the shreddings having a greater rate of decomposition. The woodchips and shreddings were chipped and shredded in 1997 with a brush bandit wood chipper and a Rears pull behind shredder. These machines were not as efficient at reducing debris size as the ones in use today. This study does demonstrate however the long life of woody lignic materials on the soil surface of an orchard. We believe the more critical aspect of wood chipping or shredding is not the rate of decomposition of the woodchips or shreddings but whether the chips or shreddings become attached or bonded to the soil and are not picked up with the nuts at harvest. In several situations after a heavy pruning and shredding we have advised growers to lightly till or scratch the soil surface in order enhance wood debris contact with soil. We believe soil contact is more critical to holding wood debris in the orchard than the actual size of the wood debris or its decomposition rate. For wood debris that adheres to the soil surface and is not picked

up with nuts can be considered decomposed by the grower and the organic matter will benefit soil structure and nutrient availability.

Acknowledgements:

This study would have been impossible without the cooperation of Larry and Janice Lowder of LJL Farms, Madera, CA, and the L.D. James Ranches, Modesto, CA. This project was partially supported by the Almond Board of California.

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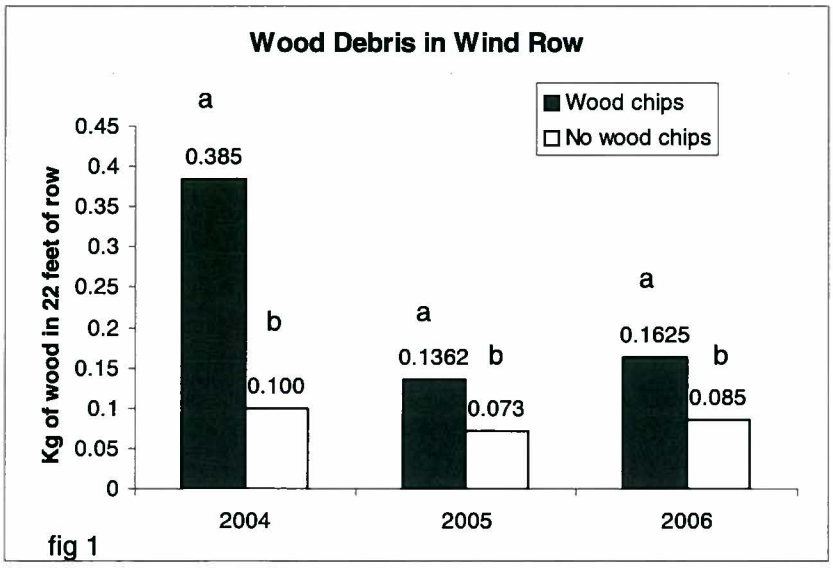

fig 1

figure 1. The amount of wood debris per 22 feet of wind-row at harvest. Paired columns with different letters were statistically different when compared in a Student's T-test (P # 0.05).

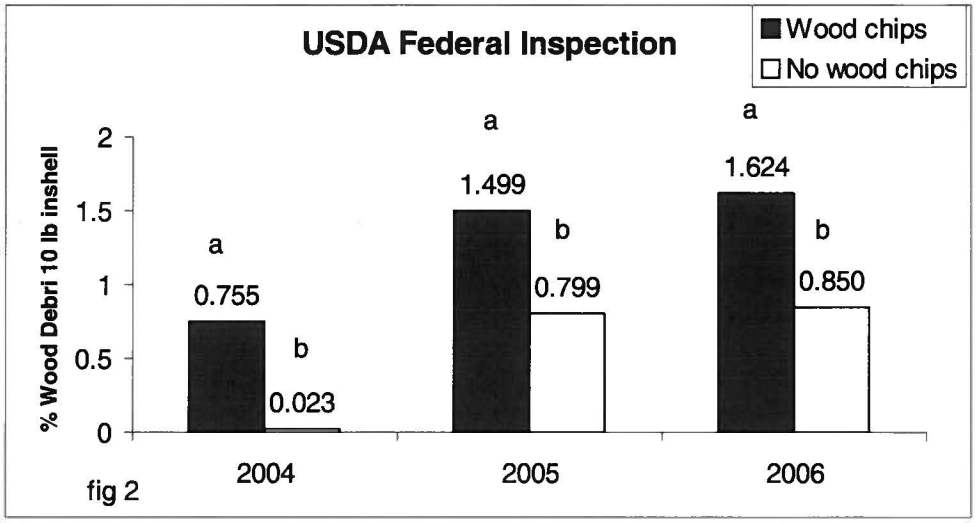

figure 2. Ten-pound bulk in-shell almond samples from wood chipped and non-wood chipped treatments were analyzed by the USDA and given Federal State Inspection Certificate with respect to foreign material consisting of wood debris. Paired columns with different letters were statistically different when compared in a Student's T-test (P # 0.05).

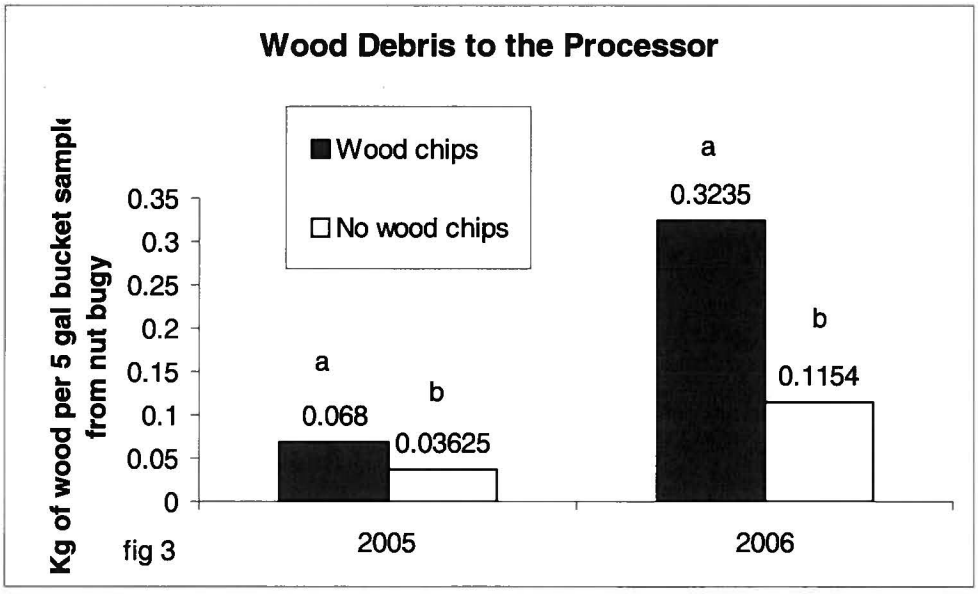

figure 3. The amount of wood debris per 5 gallon bucket bulk in-shell almond samples collected from the nut harvest bins from shredded and non-shredded treatments. Paired columns with different letters were statistically different when compared in a Student's T-test (P # 0.05).

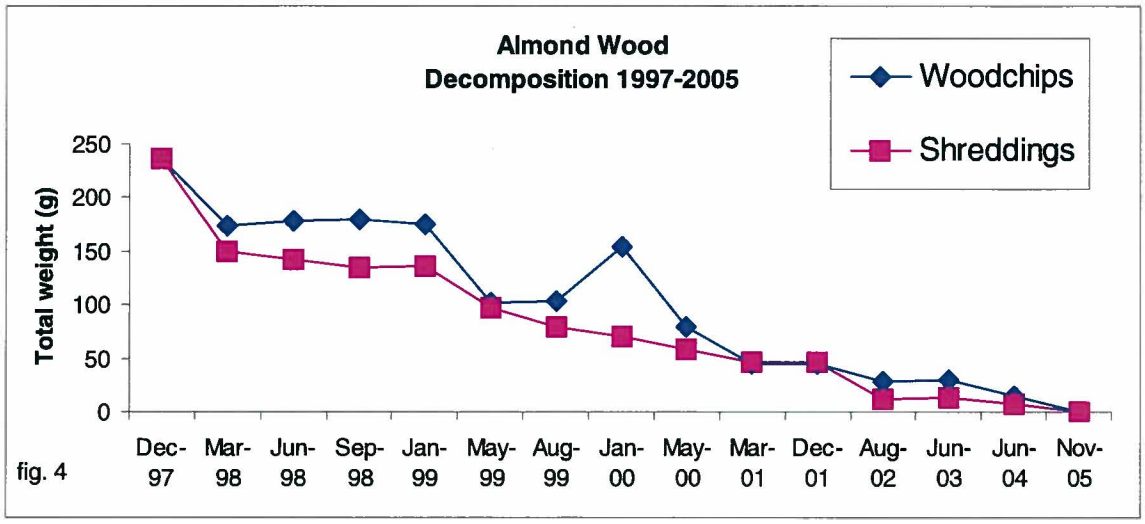

figure 4. 300 gram samples of woodchips and shreddings were placed in nylon mesh sacks with soil on the floor of an almond orchard in order to examine their rate of decomposition. Soil was separated from wood debris by washing soil through a ¼ inch mess screen. If wood chips or shreddings passed through the screen they were considered decomposed. If woodchips and shreddings did not pass through the screen they were weighed and returned to nylon sacks and the orchard floor. The percent decomposition (% reduction in weight) of the total 300 g sample was determined.

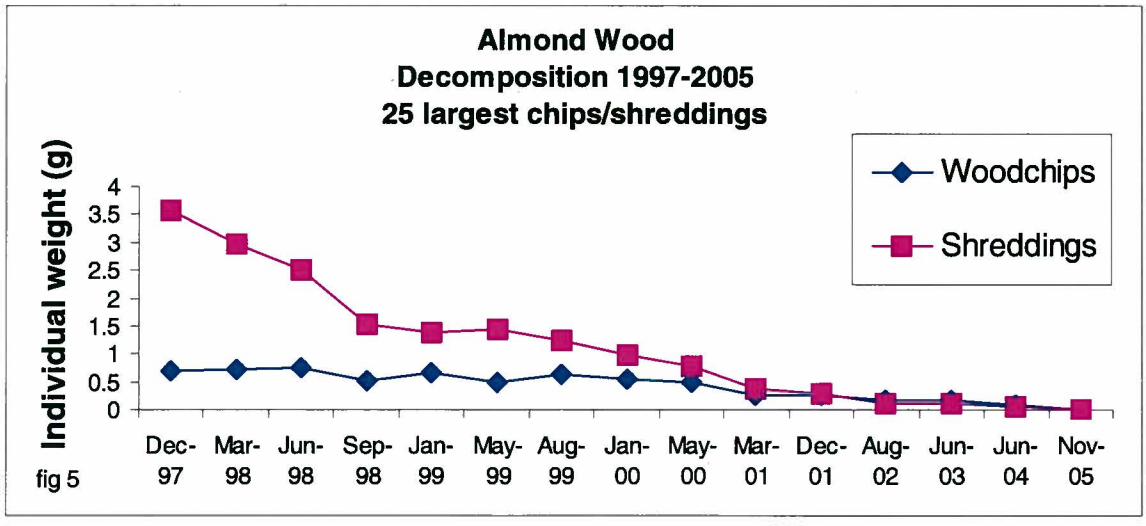

figure 5. 300 gram samples of woodchips and shreddings were placed in nylon mesh sacks with soil on the floor of an almond orchard in order to examine their rate of

decomposition. Soil was separated from wood debris by washing soil through a ¼ inch mess screen. If wood debris did not pass through the screen the 25 largest woodchips and shreddings per bag were weighed and returned to the nylon sacks and the orchard floor. The percent reduction in weight of the 25 largest woodchips and shreddings were determined.

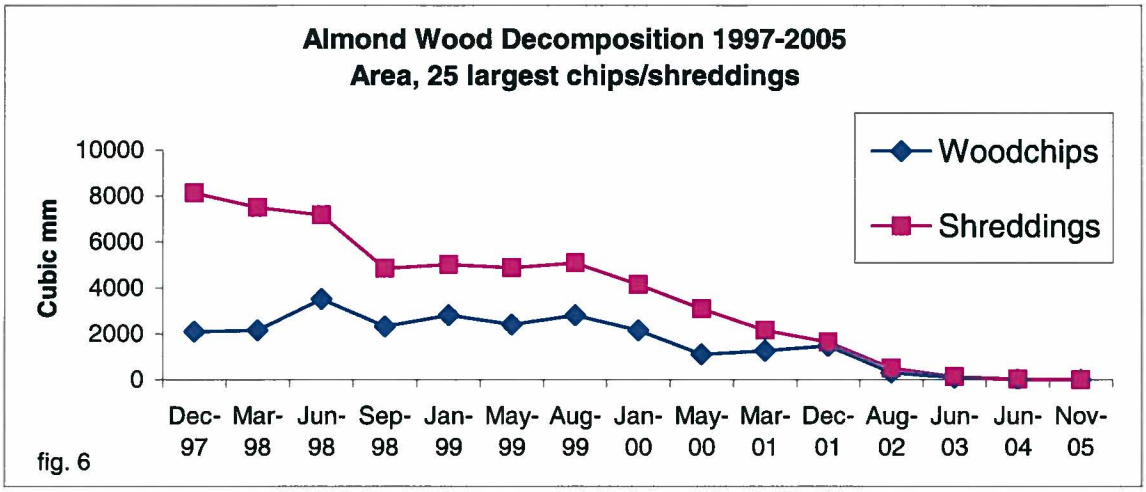

fig. 6

figure 6. 300 gram samples of woodchips and shreddings were placed in nylon mesh sacks with soil on the floor of an almond orchard in order to examine their rate of decomposition. Soil was separated from wood debris by washing soil through a ¼ inch mess screen. If wood chips or shreddings passed through the screen they were considered decomposed. If wood debris did not pass through the screen the 25 largest woodchips and shreddings per bag were measured (length, width, height) to determine area (cubic mm) and then returned to the nylon sacks and orchard floor. The percent reduction in area was examined.