Documenting the Effects of Annually Applied Green Waste and Manure Composts on Almond Tree Performance

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Many studies have shown that soil applications of composted green waste or manure can increase the diversity and activity of soil microorganisms, soil water holding capacity, soil nutrients such as potassium and nitrogen, humic acid, organic matter and carbon sequestration. Despite these published reports on improvements in "soil health", few if any data have demonstrated enhancements in orchard performance. Current costs for purchase, delivery and application of composted green waste in the Modesto area is approximately $27 per ton. Common application rates range between five & ten tons of compost per acre, representing a significant investment to the grower. It is important to determine if almond growers can improve tree performance and/or yield enough to recover such a substantial input cost.

Two replicated field trials were established in 2015 to document the effects of composted green waste and manure on the performance of new almond orchards. Orchard A is planted in a Hanford sandy loam soil that has not been previously farmed. The variety is Nonpareil on Nemaguard rootstock and is irrigated with full coverage sprinklers. Orchard B is planted in a loamy sand in a replant site following an almond orchard removed four months prior and is irrigated with microsprinklers. The variety is Independence on Nemaguard rootstock. In both locations, 5.2 tons of compost per acre were applied to the berms in a concentrated band ca. 4 feet wide and incorporated into the soil at planting. An additional 0.5 tons / acre was applied to the soil surface at the base of the new trees after one month of growth. Each subsequent spring (2016 – 2019), approximately 10 tons of composted green waste or manure has been applied to the soil surface in a band approximately six feet wide. Trees are periodically monitored for stem water potential (water stress), and annually for leaf nutrients, nematodes, growth and yield.

Composted green waste and manure significantly affected July leaf levels of some elements (Table 1). Nitrogen and chloride levels were higher in both compost treatments compared to the unamended controls ($P \geq 0.05$). Leaf calcium was lower in the compost treatments. Potassium was increased in the composted manure treatment but not the green waste treatment. No other significant changes in leaf nutrients occurred. To date, compost treatments have not affected tree canopy size as measured by photosynthetically active radiation (PAR) (Table 2) or yield (Table 3). Compost treatments have not affected pathogenic nematode numbers (Table 4).

<u>Conclusions:</u> After five years of study, the application of composted green waste or manure has not increased growth or yield of almond trees whether grown in excellent, first generation orchard soil or very sandy, second generation orchard soil. Stem water potential measurements indicated that compost-amended trees tended to be slightly more water stressed than trees growing in unamended soil. This is contradictory to what was expected, and the reason is unclear. It is possible that high chloride in the composts may have resulted in higher water stress.

Costs for purchase and application of composts at 10 tons / acre were approximately $265 annually, or $1,325 per acre over the five-year period. After five years of study, it does not appear that application of composted green waste or manure is an economically sound practice in conventionally farmed almond orchards. Composts may be more beneficial in orchards deprived of commercial fertilizers although at a substantially higher cost. It is also possible that benefits may be very long term and not observable in just five years.

Table 1. Leaf Nutrients in July-Sampled Leaves from 4th-Leaf Trees in Compost-Amended and Non-Amended Orchard Soil. Independence on Nemaguard; Loamy Sand Replant Site.					
	%N	%P	%K	%Ca	%Cl
Unamended	2.58 b	0.16 a	2.89 b	5.31 a	0.39 b
Green Waste	2.76 a	0.16 a	3.06 b	4.73 b	0.56 a
Manure	2.74 a	0.17 a	3.37 a	4.44 b	0.63 a
Additional Urea	2.58 b	0.15 a	3.12 b	5.33 a	0.39 b

Table 2. Photosynthetically Active Radiation (PAR) Measurements of 5th-Leaf Almond Trees Grown in Compost-Amended and Unamended Orchard Soil. July 2019		
	Sandy Loam, 1rst Generation Orchard; Nemaguard Rootstock	Loamy Sand, Replant Site; Nemaguard Rootstock
Unamended	74.4	
Green Waste	74.1	
Manure	72.2	
Additional Urea	70.1	
	n.s.	

Table 3. Yield of Almond Trees with and Without Annual Compost Applications				
	Yield (kernel pounds per acre)			
	3rd Leaf	4th Leaf	5th Leaf	Cumulative Yield
	Orchard A. Nonpareil on Nemaguard; 1rst generation orchard, Hanford sandy loam soil			
Untreated	568 a	2148 a	3154 a	5870 a
Green Waste Compost	559 a	1992 a	2898 a	5449 a
Manure Compost	602 a	1977 a	2909 a	5488 a
Slow Release Urea	600 a	2121 a	3015 a	5736 a
	Orchard B. Independence on Nemaguard; replant site with sandy loam soil			
Untreated	-	1987 a	1779 a	3766 a
Green Waste Compost	-	2256 a	1788 a	4044 a
Manure Compost	-	1990 a	1859 a	3849 a
Slow Release Urea	-	2018 a	1554 a	3572 a

Table 4. Nematode Numbers in Rhizosphere of 5th-Leaf Almond Trees Grown in Compost-Amended and Unamended Orchard Soil. January 2019.				
	Nematodes per 250 cc Soil			
	Sandy Loam, 1rst Generation Orchard; Nemaguard Rootstock		Loamy Sand, Replant Site; Nemaguard Rootstock	
	Ring	Root Lesion	Ring	Root Lesion
Unamended	0	0	73	118
Green Waste	0	0	180	136
Manure	0	38	316	137
Urea	0	0	44	162
	n.s.	n.s.	n.s.	n.s.