

Whole orchard recycling and nitrogen considerations in second generation almond orchards

by

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Can we return this organic matter to our orchard soils without negatively effecting the next orchard that will be planted?

Can whole orchards be incorporated into the soil when they are removed and not burned in the field or in a co-generation plant?





- When we remove an orchard we grind up 25-30 years worth of photosynthesis and carbon and nutrient accumulation and haul it away. 25-30 years of organic matter is lost from our system, estimated at 60 tons per acre for almond.



The Iron Wolf

[http://ucanr.edu/?blogpost=16603
&blogasset=74534](http://ucanr.edu/?blogpost=16603&blogasset=74534)



The Iron Wolf
a 100,000 lb (45,000 kg)
rototiller





The Iron Wolf

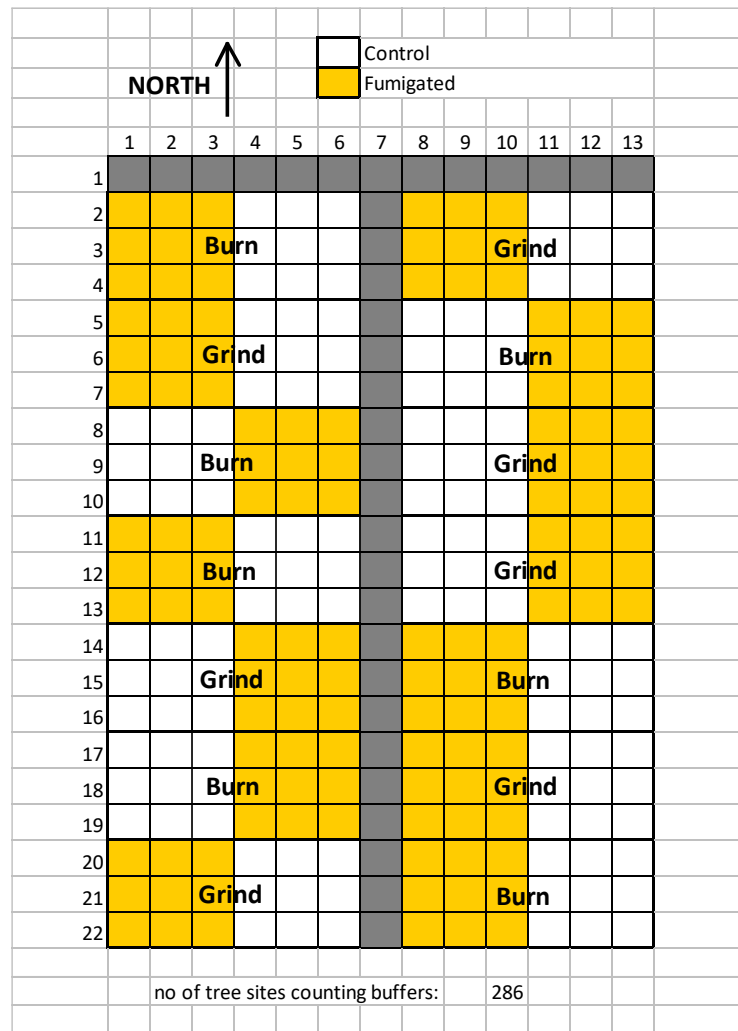
Two Treatments:
Orchard Grinding with Iron Wolf
Pushing and Burning Trees





In a natural forest system— Tree nutrients come from either decomposing logs or ashes from forest fires.







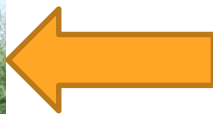
2009 First leaf trees growing in grinding plot

2010 Second leaf trees

No difference in tree
circumference

The Grinding did not stunt the
second generation orchard





2011 Third leaf trees growing
in grinding plot

2012 Fourth leaf trees
growing in grinding plot



Soil Analysis

	<u>2010</u>		<u>2011</u>		<u>2012</u>	
	Grind	Burn	Grind	Burn	Grind	Burn
Ca (meq/L)	4.06 a	4.40 b	2.93 a	3.82 b	4.27 a	3.17 b
Na (ppm)	19.43 a	28.14 b	13.00 a	11.33 b	11.67 a	12.67 a
Mn (ppm)	11.83 a	8.86 b	12.78 a	9.19 b	29.82 a	15.82 b
Fe (ppm)	32.47 a	26.59 b	27.78 a	22.82 b	62.48 a	36.17 b
Mg (ppm)	0.76 a	1.52 b	1.34 a	1.66 a	2.05 a	1.46 b
B (mg/L)	0.08 a	0.07 a	0.08 a	0.08 a	0.08 a	0.05 b
NO ₃ -N (ppm)	3.90 a	14.34 b	8.99 a	11.60 a	19.97 a	10.80 b
NH ₄ -N (ppm)	1.03 a	1.06 a	2.68 a	2.28 a	1.09 a	1.06 a
pH	7.41	7.36	6.96 a	7.15 b	6.78 a	7.12 b
EC (dS/m)	0.33 a	0.64 b	0.53	0.64	0.82 a	0.59 b
CEC(meq/100g)	7.40 a	8.47 b	8.04	7.88	5.34	5.32
OM %	1.22 a	1.38 b	1.24	1.20	1.50 a	1.18 b
C (total) %	0.73 a	0.81 a	0.79 a	0.73 a	0.81 a	0.63 b
C-Org-LOI	0.71 a	0.80 b	0.72	0.70	0.87 a	0.68 b
Cu (ppm)	6.94 a	6.99 a	7.94 a	7.54 a	8.87 a	7.92 b

Blue Pair = grinding significantly less than burning

Yellow pair = grinding significantly greater than burning

Soil Analysis

	2013		2014		2015	
	<u>Grind</u>	<u>Burn</u>	<u>Grind</u>	<u>Burn</u>	<u>Grind</u>	<u>Burn</u>
Ca (meq/L)	3.78 a	3.25 b	7.55 a	5.45 b	4.02 a	1.36 b
Na (ppm)	2.74 a	1.90 b	3.41 a	2.34 b	2.32 a	1.21 b
Mn (ppm)	26.35 a	5.71 b	14.46 a	10.65 b	7.31 a	4.67 b
Fe (ppm)	32.56 a	20.38 b	38.58 a	29.30 b	24.29 a	17.21 b
Mg (ppm)	2.15 a	1.20 b	3.61 a	2.57 b	2.01 a	0.68 b
B (mg/L)	0.06	0.07	0.07 a	0.10 b	0.05 a	0.07 b
NO ₃ -N (ppm)	20.11	12.27	26.53 a	18.89 b	20.64 a	5.23 b
NH ₄ -N (ppm)	0.37	0.33	1.59 a	1.36 b	0.89 a	0.65 b
K (mg/L)	94.50	84.88	28.50 a	13.60 b	19.76 a	16.97 b
pH	7.39 a	7.53 b	6.95	7.06	7.27 a	7.60 b
EC (dS/m)	0.91 a	0.68 b	1.54 a	1.08 b	0.90 a	0.38 b
CEC(meq/100g)	9.54	10.16	7.78	8.30	5.16	5.14
OM %	1.55 a	1.06 b	1.21 a	0.93 b	1.37 a	1.08 b
C (total) %	0.87 a	0.51 b	0.71 a	0.54 b	0.66 a	0.50 b
C-Org-LOI	0.87 a	0.61 b	0.70 a	0.54 b	0.79 a	0.62 b
Cu (ppm)	8.26 a	7.11 b	8.03	7.73	7.51 a	7.03 b

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Yellow pair = grinding significantly greater than burning

Soil Analysis

	2016		2017		2018	
	<u>Grind</u>	<u>Burn</u>	<u>Grind</u>	<u>Burn</u>	<u>Grind</u>	<u>Burn</u>
Ca (meq/L)	5.53 a	2.66 b	3.02	3.05		
Na (ppm)	1.50 a	1.20 b	0.89 a	0.72 b		
Mn (ppm)	10.86 a	7.66 b	9.03 a	6.79 b		
Fe (ppm)	30.25 a	23.15 b	33.23 a	28.01 b		
Mg (ppm)	2.60 a	1.29 b	1.46	1.43		
B (mg/L)	<0.05	<0.05	0.30	0.31		
NO ₃ -N (ppm)	13.87 a	10.50 b	11.93	12.66		
NH ₄ -N (ppm)	1.15 a	0.98 b	1.39	1.31		
K (mg/L)	54.78 a	11.33 b	11.06	11.68		
pH	7.20 a	7.37 b	6.94	7.02		
EC (dS/m)	1.21 a	0.56 b	0.57	0.58		
CEC(meq/100g)	8.35	9.25	8.23	7.78		
OM %	1.41 a	1.10 b	1.52 a	1.07 b		
C (total) %	0.82 a	0.55 b	0.79 a	0.55 b		
C-Org-LOI	0.82 a	0.64 b	0.88 a	0.62 b		
Cu (ppm)	8.43	8.20	9.25	9.25		

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Leaf Analysis

	<u>Nitrogen %</u>		<u>Phosphorus %</u>		<u>Potassium %</u>		<u>Magnesium %</u>		<u>Manganese ppm</u>		<u>Iron ppm</u>		<u>Sodium ppm</u>	
	Grind	Burn	Grind	Burn	Grind	Burn	Grind	Burn	Grind	Burn	Grind	Burn	Grind	Burn
2010	2.40 a	2.33 b	0.11 a	0.10 b	1.76 a	1.44 b	0.98 a	1.03 b	23.63 a	17.44 b	102.5	104.3	340.5 a	455.5 b
2011	2.58	2.58	0.14	0.14	1.92 a	1.67 b	0.66 a	0.71 b	25.70	24.91	91.34	93.75	19.38 a	54.00 b
2012	2.46	2.44	0.13	0.13	1.14 a	1.02 b	0.87	0.90	20.13	19.13	84.84	83.95	24.88 a	49.50 b
2013	2.57 a	2.49 b	0.112 a	0.106 b	0.94 a	0.73 b	1.04 a	1.12 b	27.83 a	23.25 b	113.59 a	102.79 b	634.6 a	957.5 b
2014	2.40 a	2.33 b	0.11 a	0.10 b	1.76 a	1.44 b	0.98 a	1.03 b	23.63 a	17.44 b	102.5	104.0	340.5 a	455.5 b
2015	2.42	2.39	0.12	0.11	1.66 a	1.43 b	0.97	1.01	23.96 a	17.88 b	142.5	148.22	243.8 a	358.22 b
2016	2.77	2.75	0.14	0.14	1.35 a	1.16 b	0.93	0.97	24.46 a	21.58 b	97.09 a	88.20 b	207.1 a	335.38 b
2017	2.57 a	2.50 b	0.12	0.12	1.28	1.20	1.09	1.09	29.23 a	27.11 b	199.50 a	225.63 b	353.50	392.88

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Yellow pair = grinding significantly greater than burning

Trunk Diameter

Butte Variety (cm)

Year	Grind	Burn	P value
2009	4.87	4.96	P= 0.19
2010	14.56	15.22	P=0.07
2011	22.39	22.72	P=0.38
2012	30.53	30.23	P=0.18
2013	38.52	37.73	P=0.09
2014	46.50 a	45.24 b	P=0.01
2015	55.71 a	53.79 b	P=0.01
2016	63.15 a	60.58 b	P=0.007
2017			

Butte Variety, Kernel pounds/acre

Year	Grind	Burn	Difference
2011	687.40 lbs/ac	687.37 lbs/ac	0.03 lbs/ac (P= 0.49)
2012	1,472.40 lbs/ac	1,379.42 lbs/ac	92.98 lbs/ac (P=0.19)
2013	1909.64 lbs/ac	1667.91 lbs/ac	241.73 lbs/ac (P=0.05)
2014	2272.11 lbs/ac	1767.25 lbs/ac	504.86 lbs/ac (P=0.12)
2015	1,072.90 lbs/ac	877.54 lbs/ac	195.36 lbs/ac (P=0.11)
2016	1,341.97 lbs/ac	1,206.96 lbs/ac	135.01 lbs/ac (P=0.14)
2017	1956.01 lbs/ac	1539.17 lbs/ac	416.84 lbs/ac (P=0.07)
Total	10,712.43 lbs/ac	9,125.62 lbs/ac	1,586.81 lbs/ac

Nonpareil Variety, Kernel pounds/acre

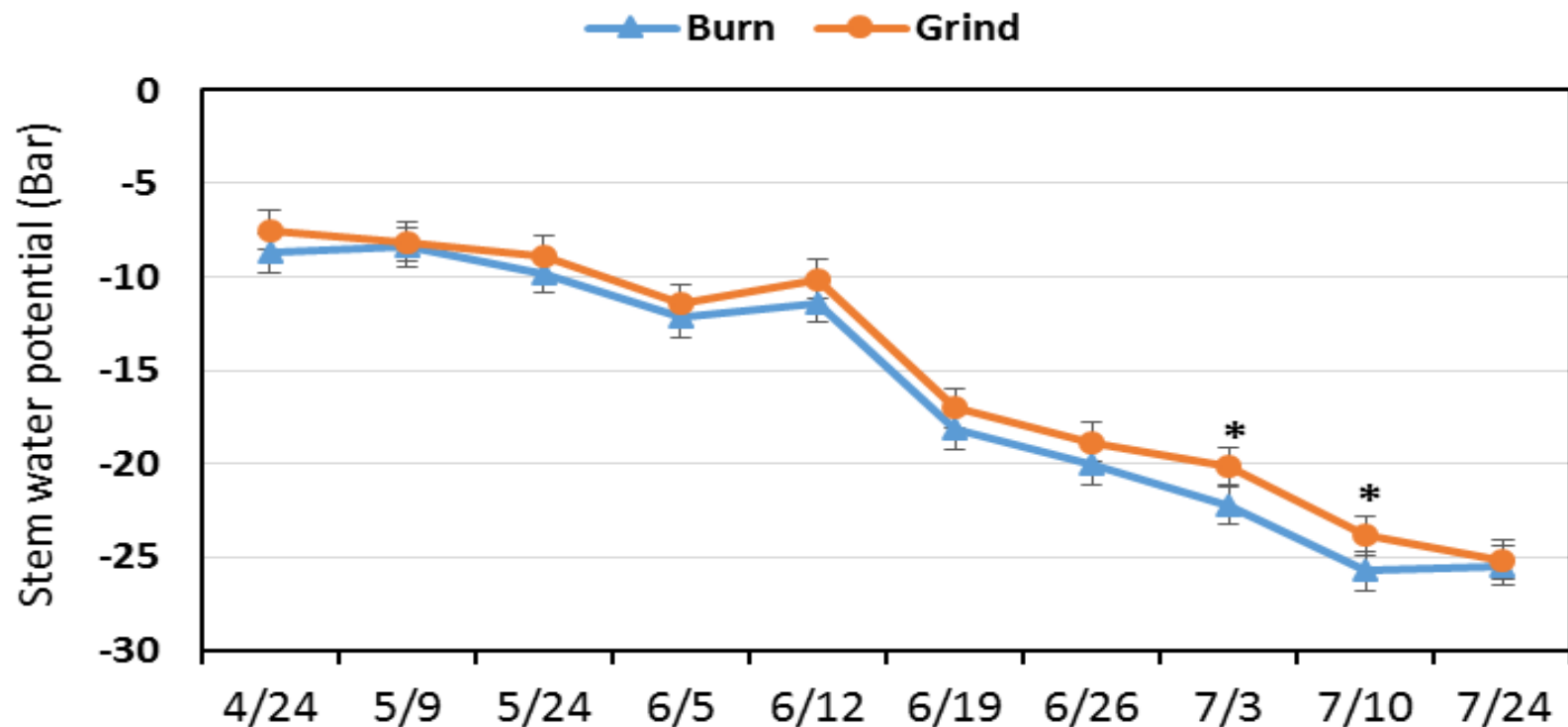
Year	Grind	Burn	Difference
2014	2,147.02 lbs/ac	1,957.97 lbs/ac	189.05 lbs/ac (P=0.02)
2016	2,821.86 lbs/ac	2,386.02 lbs/ac	435.84 lbs/ac (P=0.03)
2017	2,246.66 lbs/ac	1,871.86 lbs/ac	374.80 lbs/ac (P=0.01)
Total	7,215.54 lbs/ac	6,966.98 lbs/ac	999.69 lbs/ac



% photosynthetically
Active radiation
(PAR) light interception

Date	Variety	Treatment	PAR(%)	Yield (kernel lbs/ac)	Yield per unit PAR intercepted
10/16/17	Butte	Grind	56.8 a	2025 a	35.1 a
		Burn	54.3 a	1590 a	29.1 a
10/16/16	Nonpareil	Grind	66.0 a	2268 a	34.3 a
		Burn	61.4 a	1868 a	30.7 a

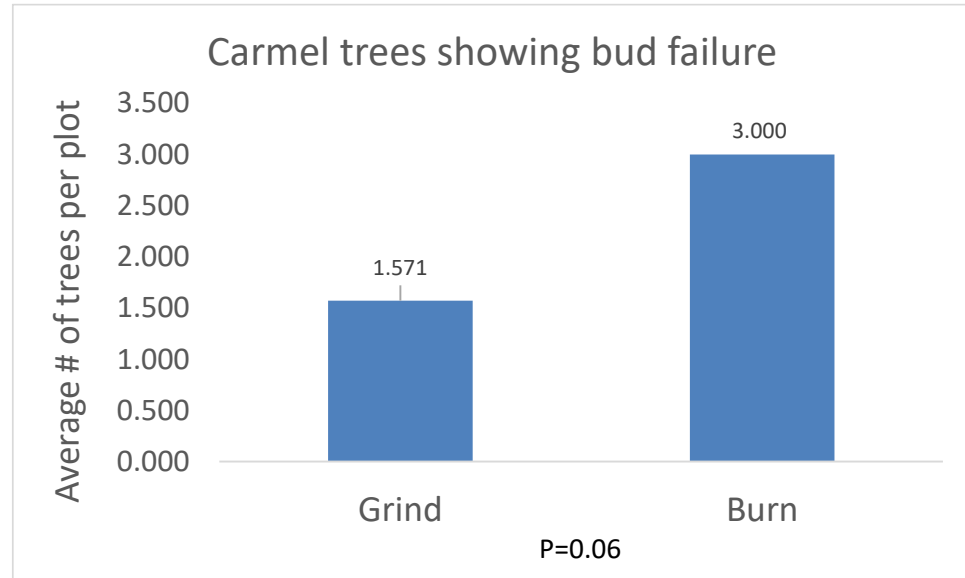
Stem Water Potential (Grind vs Burn)

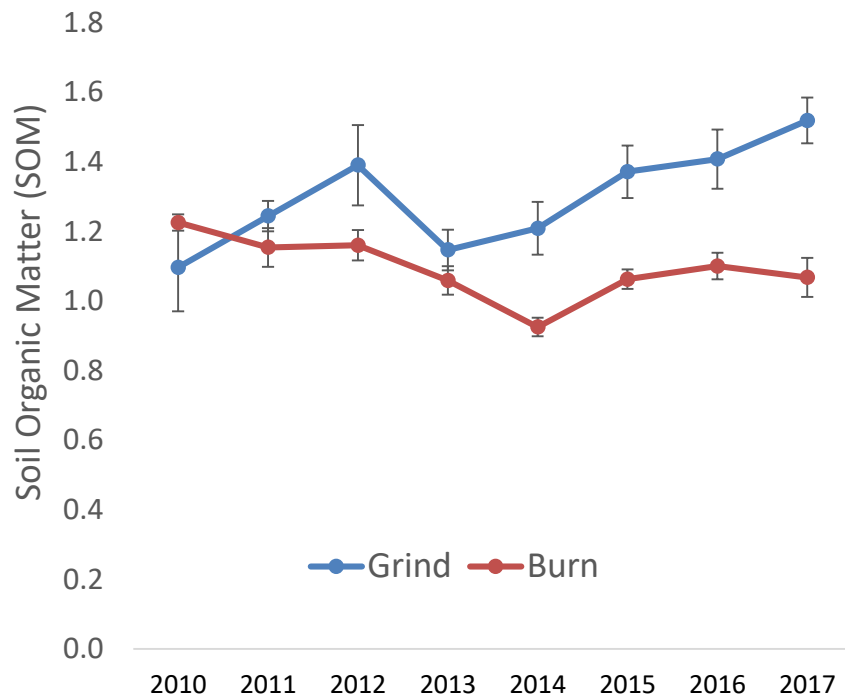
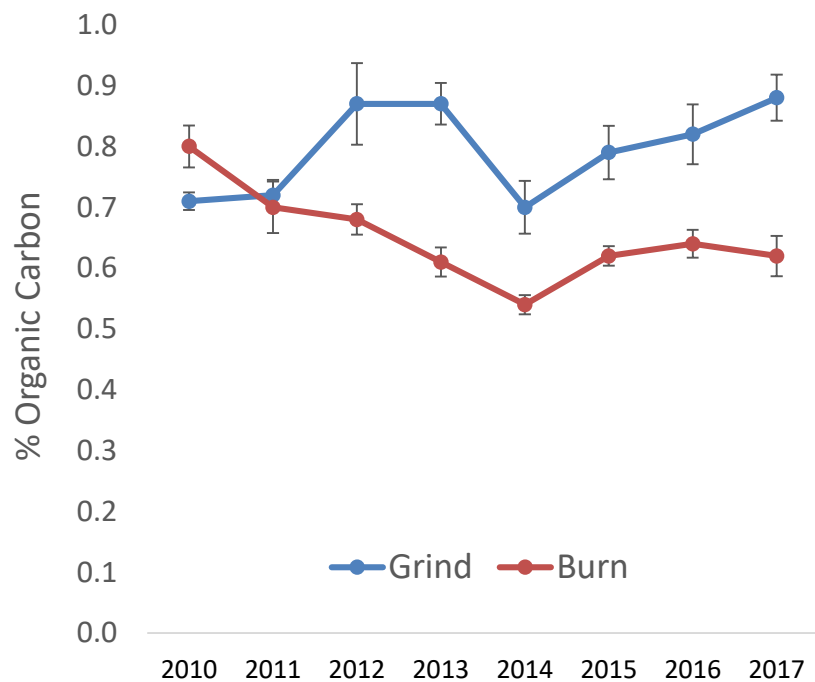




Carmel trees were rated for bud failure symptoms

Trees growing in the grind plots had less bud failure





Whole Orchard Recycling has:

- Increased soil organic matter
- Increased soil organic carbon
- Increased soil nutrients
- Increase soil microbial diversity
- Increased orchard productivity

Closure of more biomass plants reduces options

By Christine Souza

The closure or threatened closure of more California biomass power plants leaves farmers with fewer options for disposing of tree prunings or of trees uprooted during planned orchard removals.

"The last few projects that we've done,



A few growers have used manure spreaders to spread wood chips back on the soil surface





G & F Ag
Services
orchard
removal
typically involves 5
machines
and costs
~\$600 acre





G & F Ag Services in Ripon has purchased two Kuhn & Knight Spreaders and modified them for spreading wood chips.

Keeping the chips and having them spread back onto your orchard floor will cost an additional \$400 acre.

Wood chips are spread uniformly over entire field surface





After spreading the woodchips growers can proceed with typical land preparation practices for the next orchard: ripping, disking, fumigation....







When 64 tons of wood chips are returned to the soil per acre:

N= 0.31 %, 396 lbs/ac

K= 0.20 %, 256 lbs/ac

Ca= 0.60 %, 768 lbs/ac

C= 50 %, 64,000 lbs/ac

The nutrients will be released gradually and naturally



Tallerico Orchard in Manteca

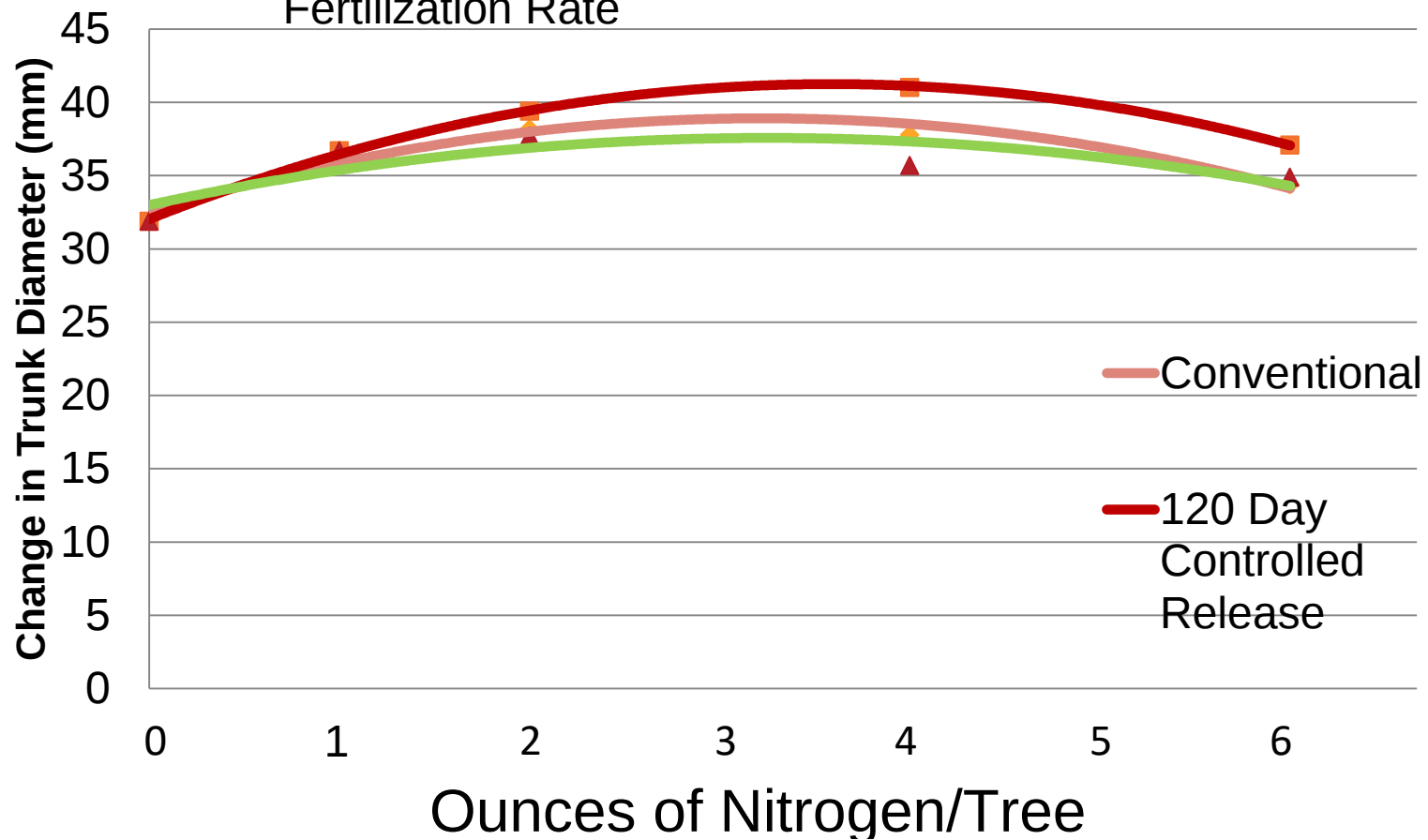
In the portion of the orchard where the wood chip piles were—there was total weed control.

We doubled our nitrogen applications through fertigation in order to keep the tree growth up.

Water and Nitrogen efficiency?

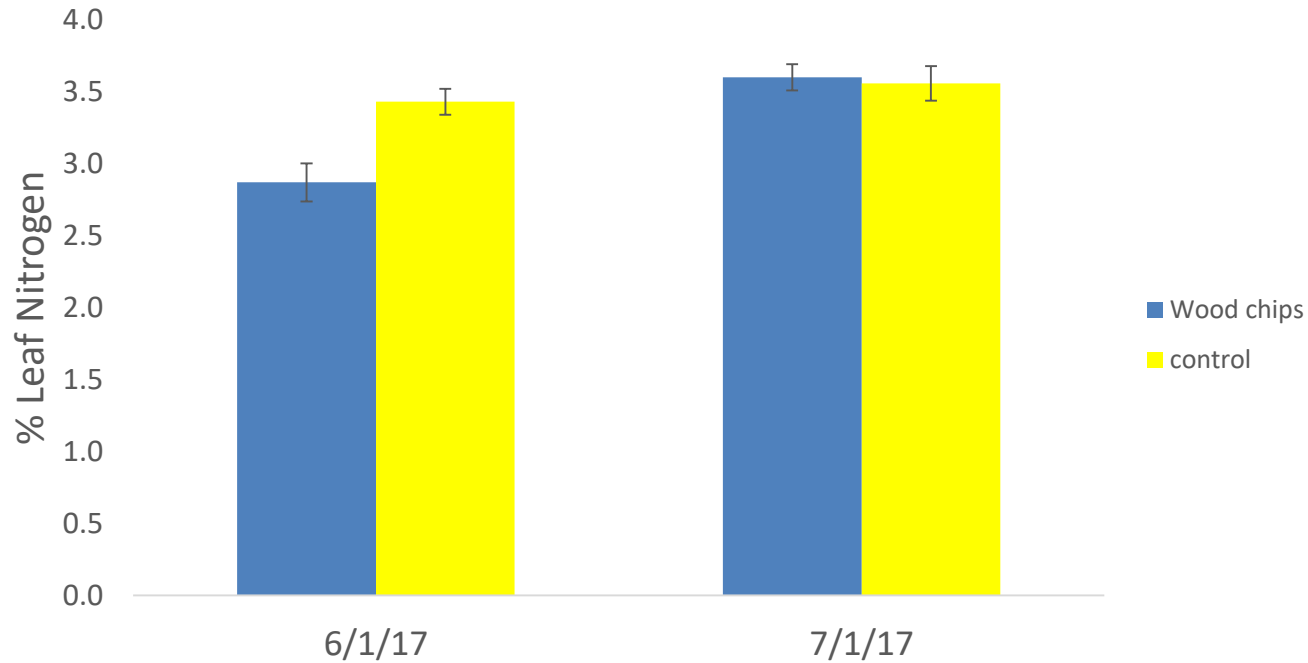


David Doll Trial – First Year Almond Fertilization Rate





Leaf Analysis Manteca



Farm ID: Almond

Field id: Airport

Sample Id : Fld 1-G

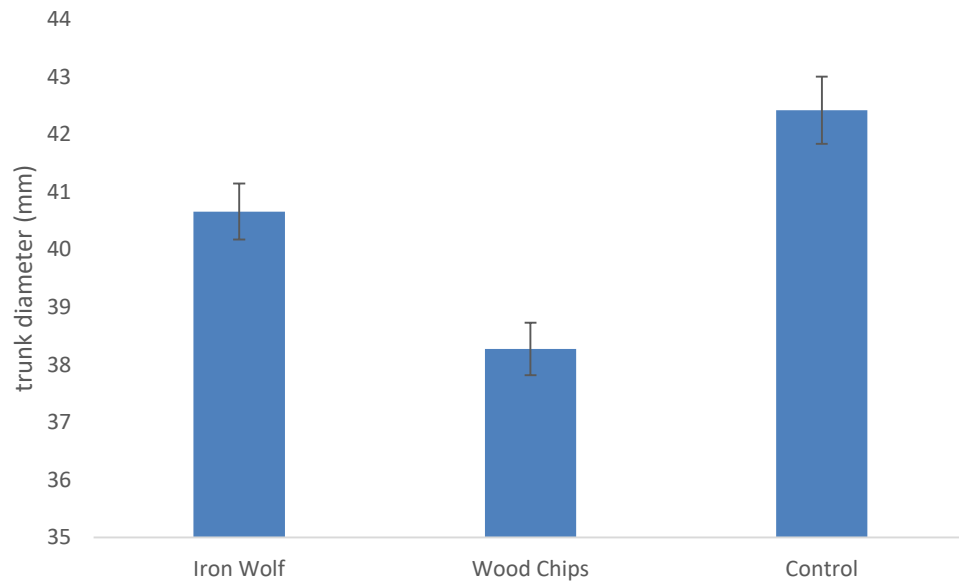
Growth Stage : June

Crop : ALMOND (Helena Chem)

Plant Part: YML

	Nitrogen %	Sulfur %	Phosphorus %	Potassium %	Magnesium %	Calcium %	Sodium %	Boron ppm	Zinc ppm	Manganese ppm	Iron ppm	Copper ppm	Aluminum ppm	
Analysis	4.38	0.21	0.45	1.35	0.38	1.21	0.04	68	31	40	100	15	39	
Normal Range	2.50	0.20	0.16	1.90	0.75	3.00	0.09	30	30	40	80	5	0	
	3.09	0.24	0.20	2.99	0.84	3.39	0.35	70	80	200	200	20	300	
	N/S	N/K	P/S	P/Zn	K/Mg	K/Mn	Ca/B	Fe/Mn	Ca/K	Ca/Mg				
Actual Ratio	20.9	3.2	2.1	145.2	3.6	337.5	177.9	2.5	0.9	3.2				
Expected Ratio	12.7	1.1	0.8	32.7	3.1	203.8	639.1	1.2	1.3	4.0				
Very High														
High														
Sufficient														
Low														
Deficient														
	N	S	P	K	Mg	Ca	Na	B	Zn	Mn	Fe	Cu	Al	

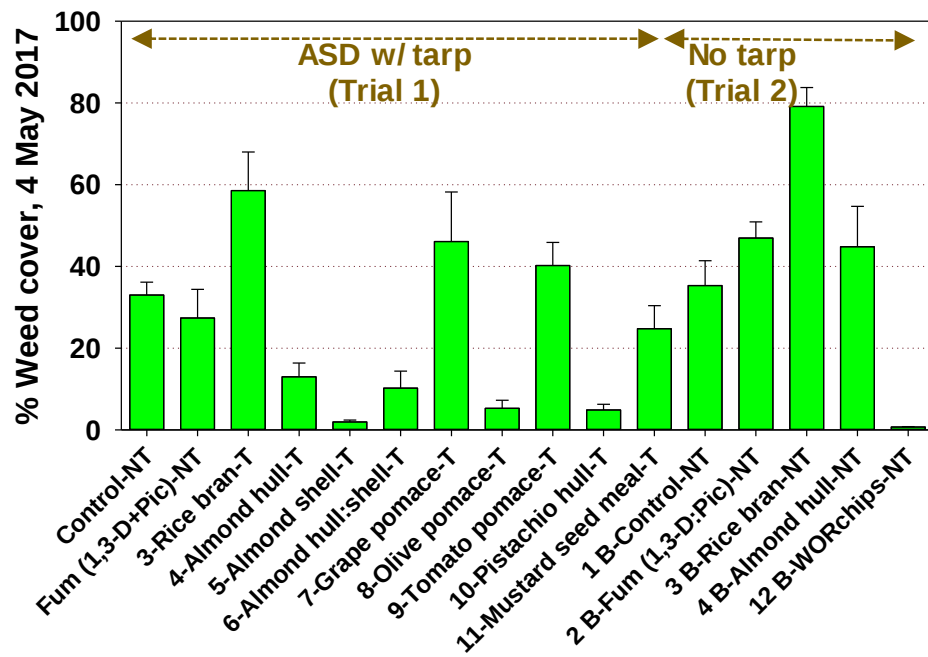
Comments :



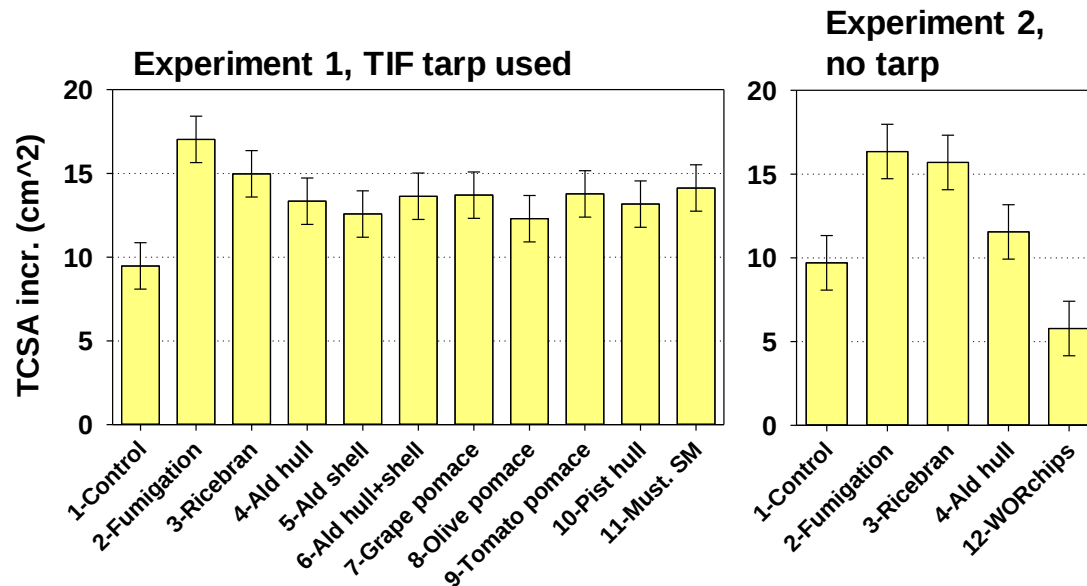
85 tons per acre rate—Kearney REC



Parlier (KARE) trials, 2016-17

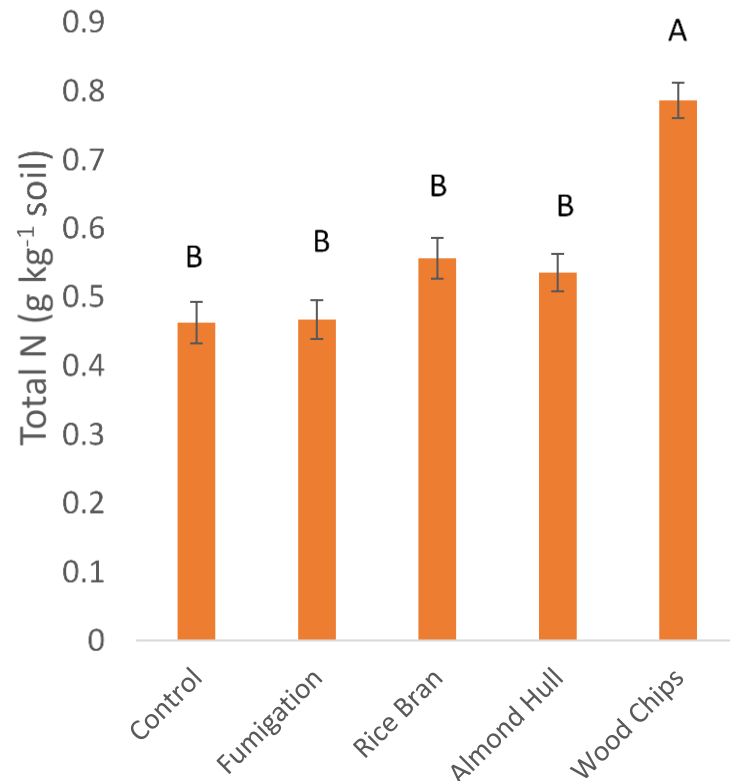
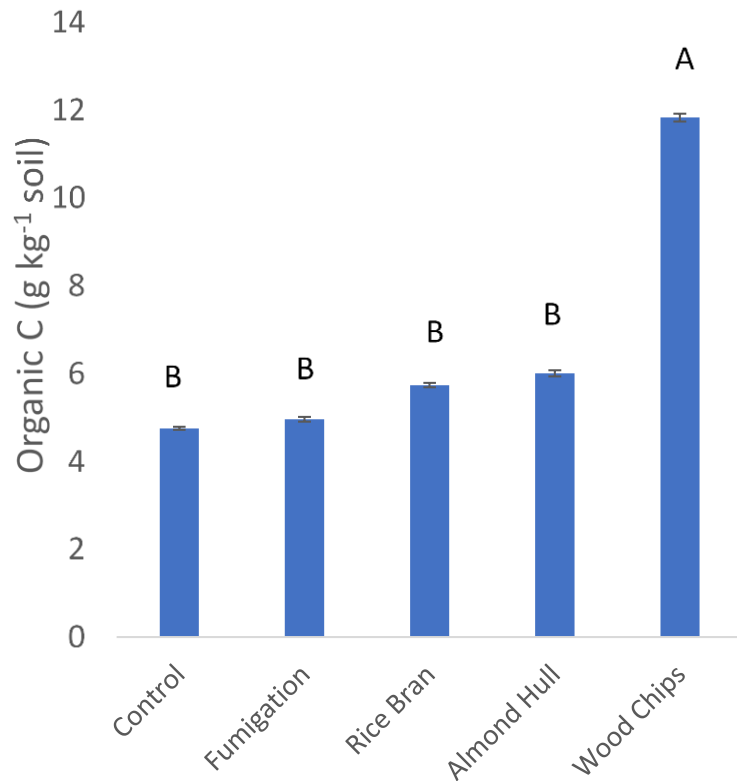


Parlier (KARE) trials, 2016-17



Stunted tree growth in foreground vs. improved growth in background.





	100% efficiency	22% efficiency of UAN 32
	<u>total N oz/tree/year</u>	<u>total N oz/tree/year</u>
White	8.65	1.91
Blue	12.78	4.31
Yellow	13.98	5.51
Orange	15.18	6.71
Red	16.38	7.91

	100% efficiency	22% efficiency
	<u>total lbs N /acre</u>	<u>total lbs N /acre</u>
White	62.70	13.84
Blue	92.60	31.24
Yellow	101.35	39.94
Orange	110.05	48.64
Red	118.75	57.34





Control



0.8 oz of N applied in March



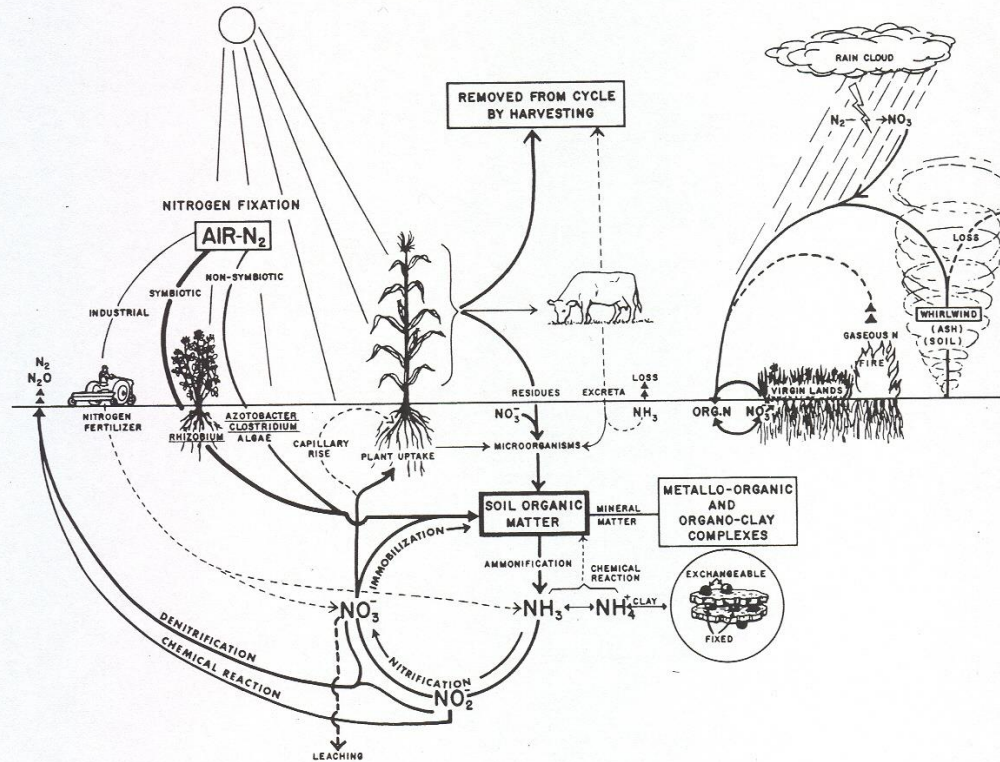


Figure 8.1. Nitrogen cycle in soil. (From Stevenson, 1982.)

Will Whole Orchard Recycling:

- Increase water holding capacity?
- Bind pesticides and fertilizers?
- Increase Nitrogen efficiency?
- Increase/decrease Green House Gas production?
- Provide carbon credits to farmers?



This Duratech grinder is mobile and spreads the wood chips evenly as it grinds.

Efficiencies are improved every year that whole orchard recycling is performed.



Thank You!