Improving soil physical and chemical properties for better tree performance

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Canada

Orchard floor management

- Mulches and Amendments
- Organic Additions (C & other nutrients)
- Soil Quality (Physical & Chemical)
- Plant performance (Case studies)

Paper mulch

Straw Mulch

Wood waste

Spray-on-Mulch

Biosolids

Agassiz compost

- vegetation/poultry manure/straw
- aerated, turned
- 65°C (weed, disease control)

Applying soil amendment in the planting row

Liquid organics

- peat/soft coal
- compost tea

Nutrient content

	N	P	K	Zn	Cu
	% dw			mg/kg dw	
Agassiz compost	2.27	1.56	1.16	nm	nm
GVRD biosolids	3.30	1.10	0.50	758	977*
Wood waste	0.80	0.12	0.30	62	8

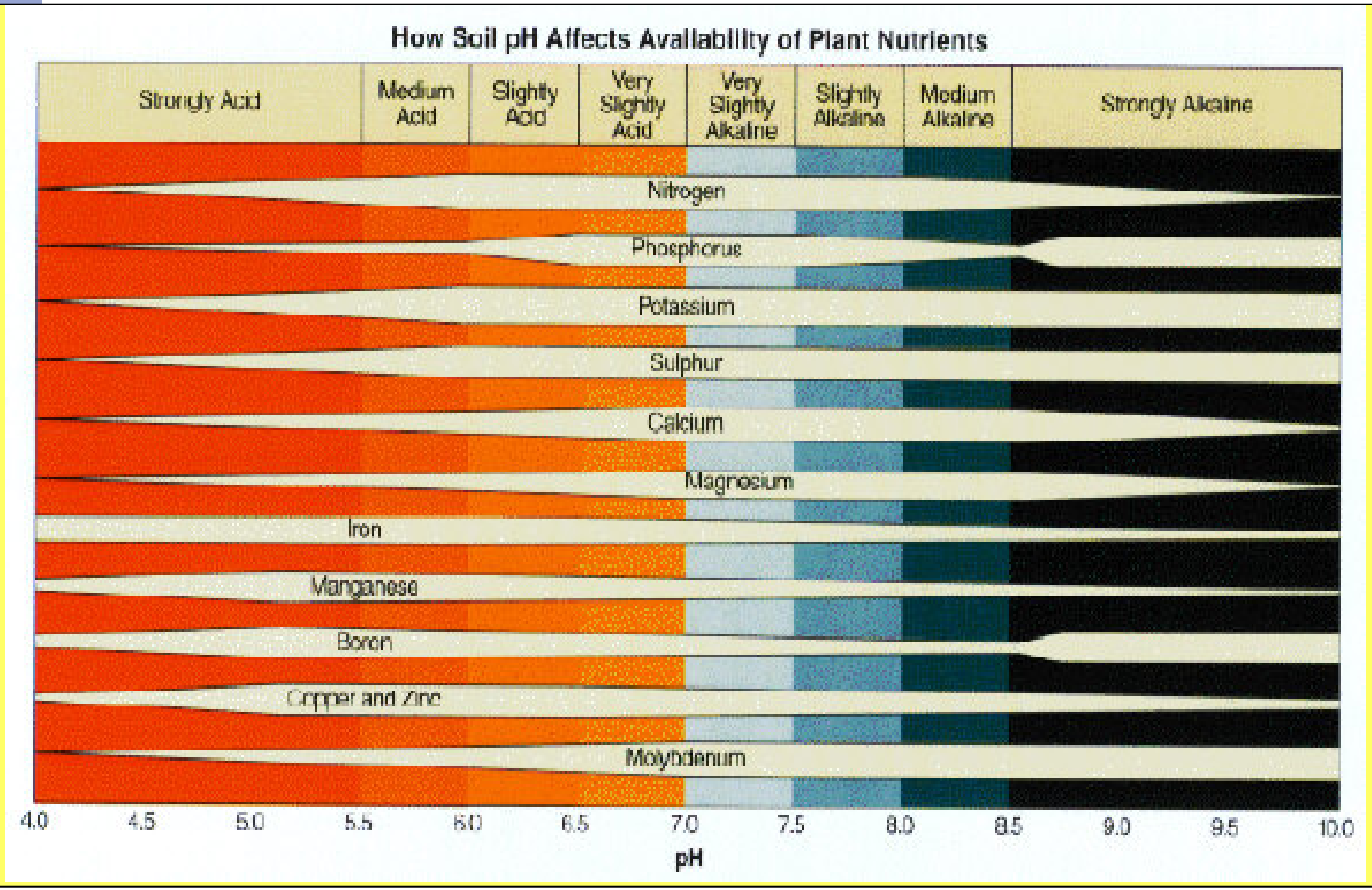
dw=dry weight

Compost N availability

	N (%)	C/N	Available Yr 1 (%)
Broiler litter	3.84	9.5	42 (27-54)
Dairy solids	1.99	19.8	6 (-2-16)
Pelleted fish	9.40	4.5	77

Gale et al. (2006) JEQ 35:2321-2332

Soil pH and nutrient availability



Compost pH varies

- Riverside bark mulch 5.3
- PARC compost 6.8
- Riverside burner ash 12.5

Site History

- Soil chemical changes in five orchards (12 – 40 years old) sprinkler irrigation and ammonium based fertilizer

	Row	Alley
pH_w	4.2	6.7
Ca (ppm)	736	2592
Al (ppm)	621	27
Bases (%)	56	99

Why identify soil pH?

Low pH toxicities

- aluminum
- manganese

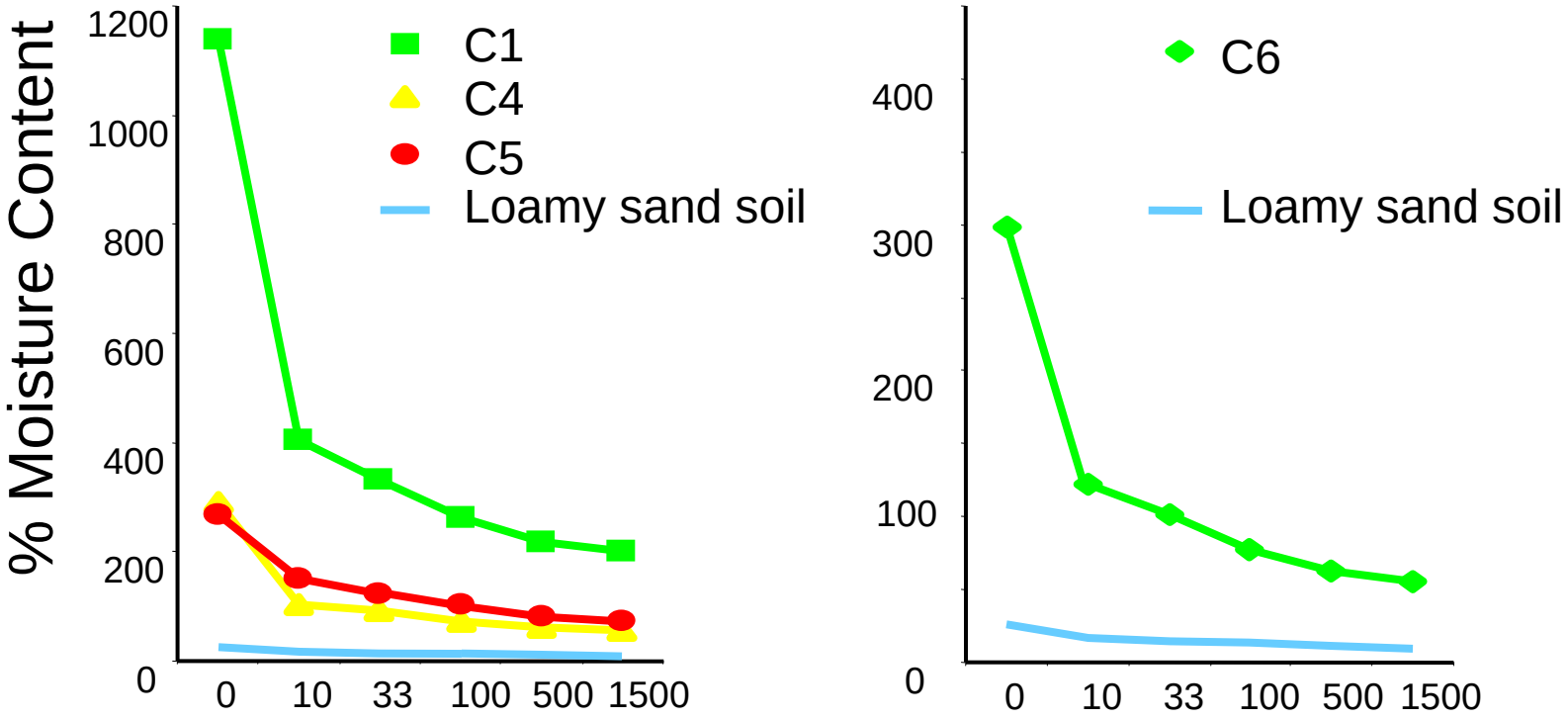
Mn toxicity causing bark measles in Red Delicious apple tree

Salinity

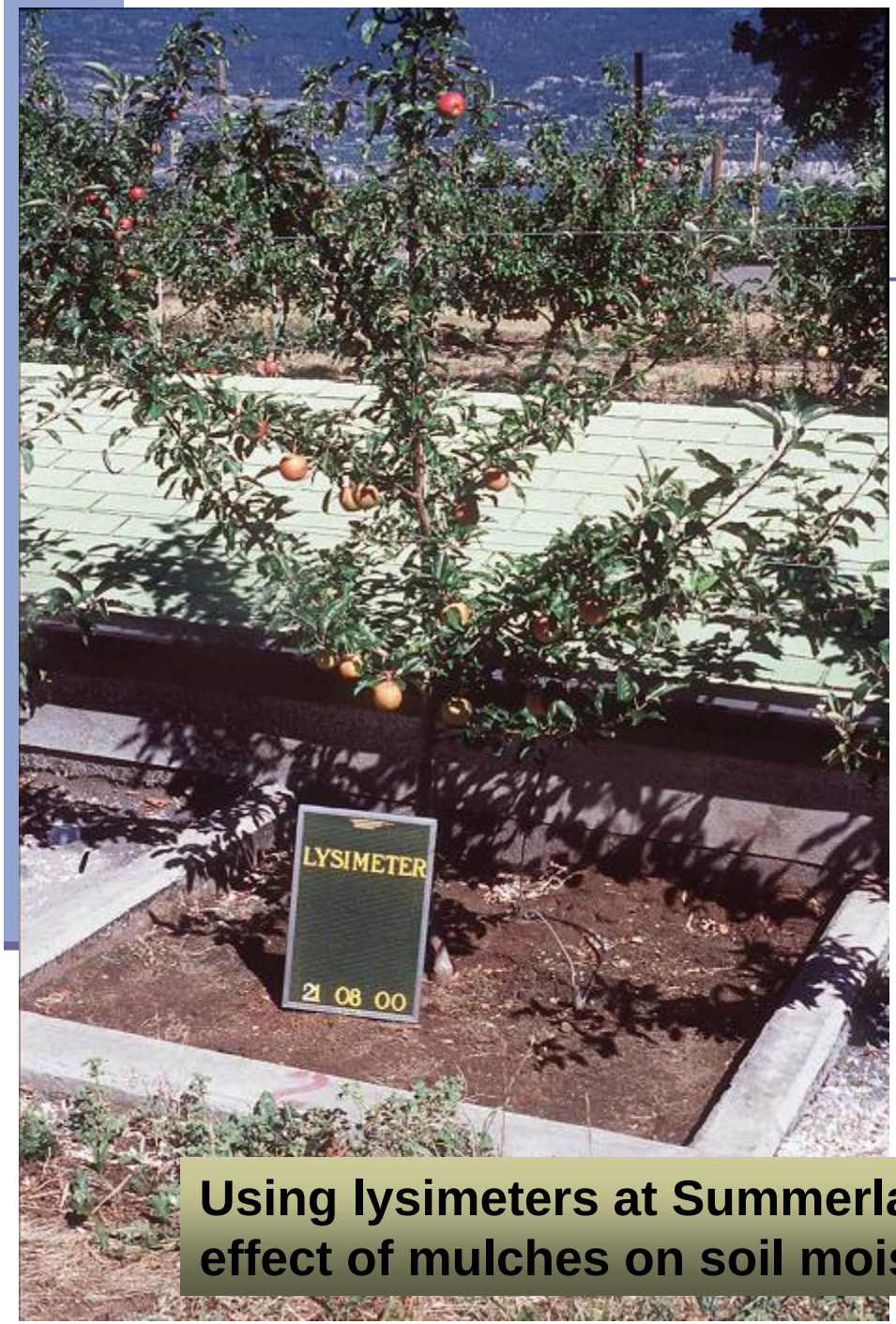
- Electroconductivity 1-2 mS/cm (tree fruits)
- Pelletized peat 1.4
- Poultry compost
  - Similkameen 6.7
  - 80% poultry 48.2

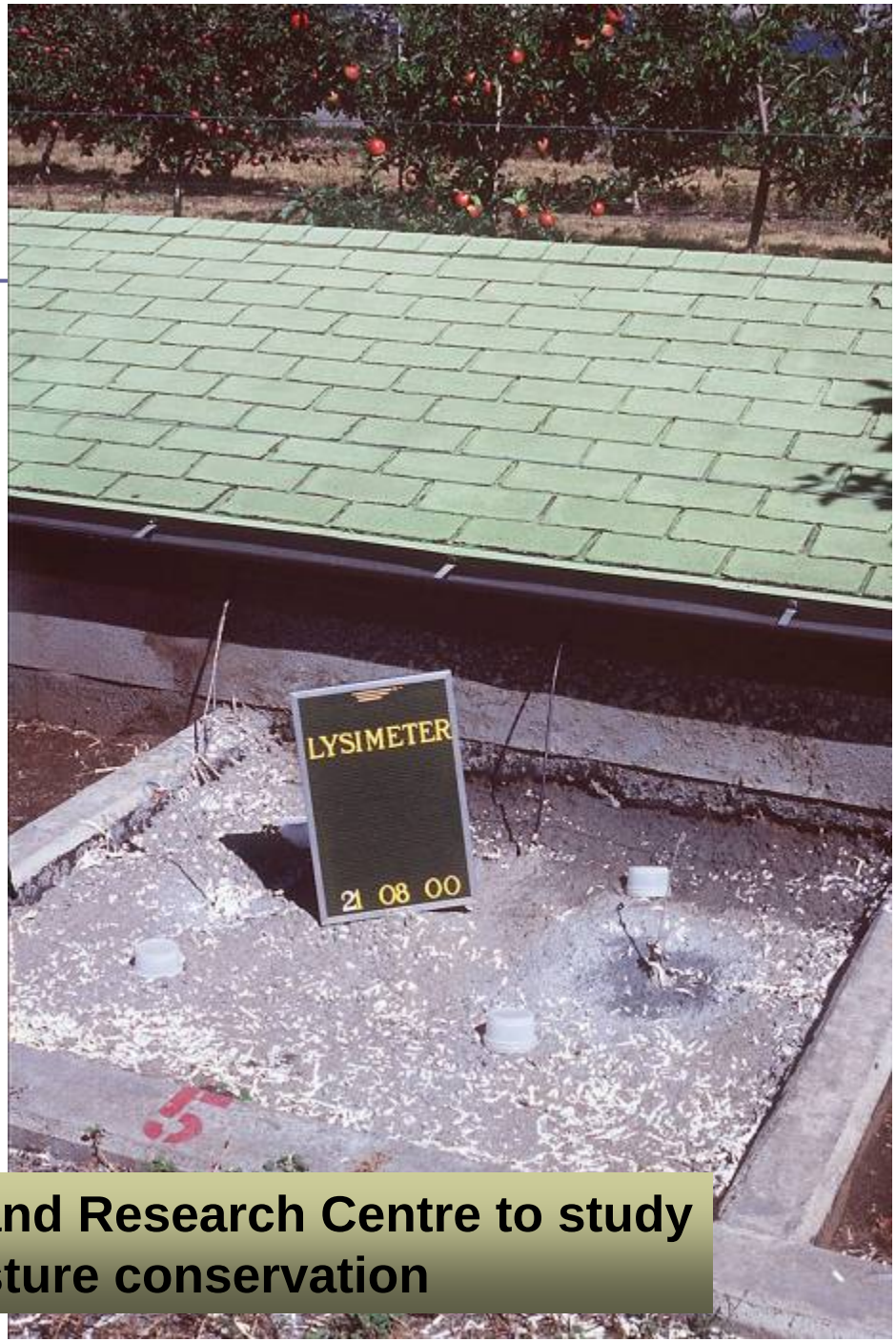
Can damage or kill fruit trees with high EC soil amendments in proximity to roots

Water holding capacity



Comparison between moisture content of several different composts (C1, C4, C5, C6) relative to a loamy sand orchard soil over a range o f pressure contents.





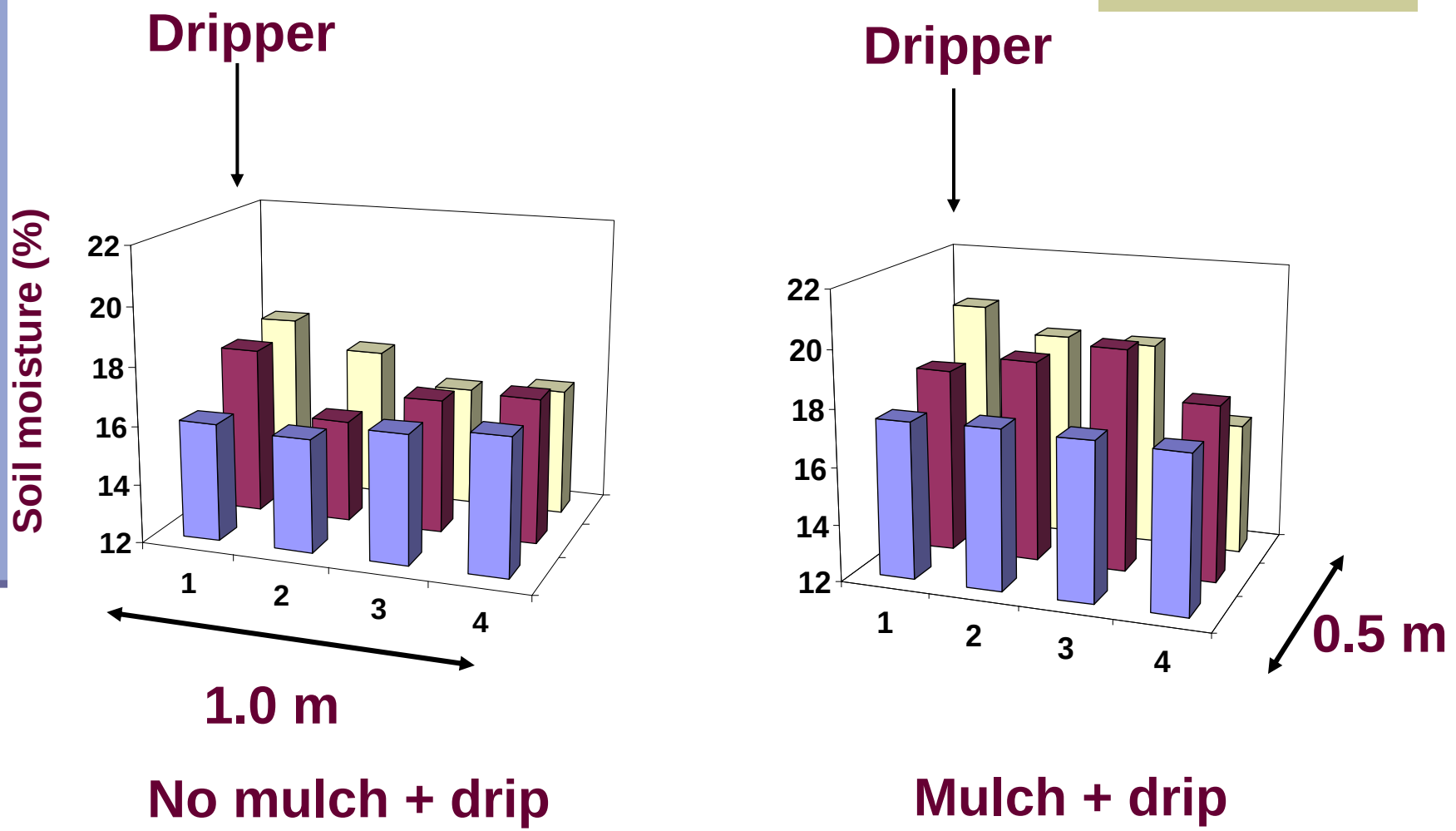
Using lysimeters at Summerland Research Centre to study effect of mulches on soil moisture conservation

EFFECT OF MULCHING ON WATER USE BY APPLE TREES IN LYSIMETER PLOTS, 2001

Trunk diam. (mm)	H_2O used/tree (L)		Irr. H_2O saved by mulching (%)
	Non-mulched	Mulched	
25	1009	466	54
50	2427	2072	15

The water-saving benefit of mulch decreases as trees grow larger and provide more canopy shade on the soil.

Soil moisture distribution under mulched and un-mulched soils



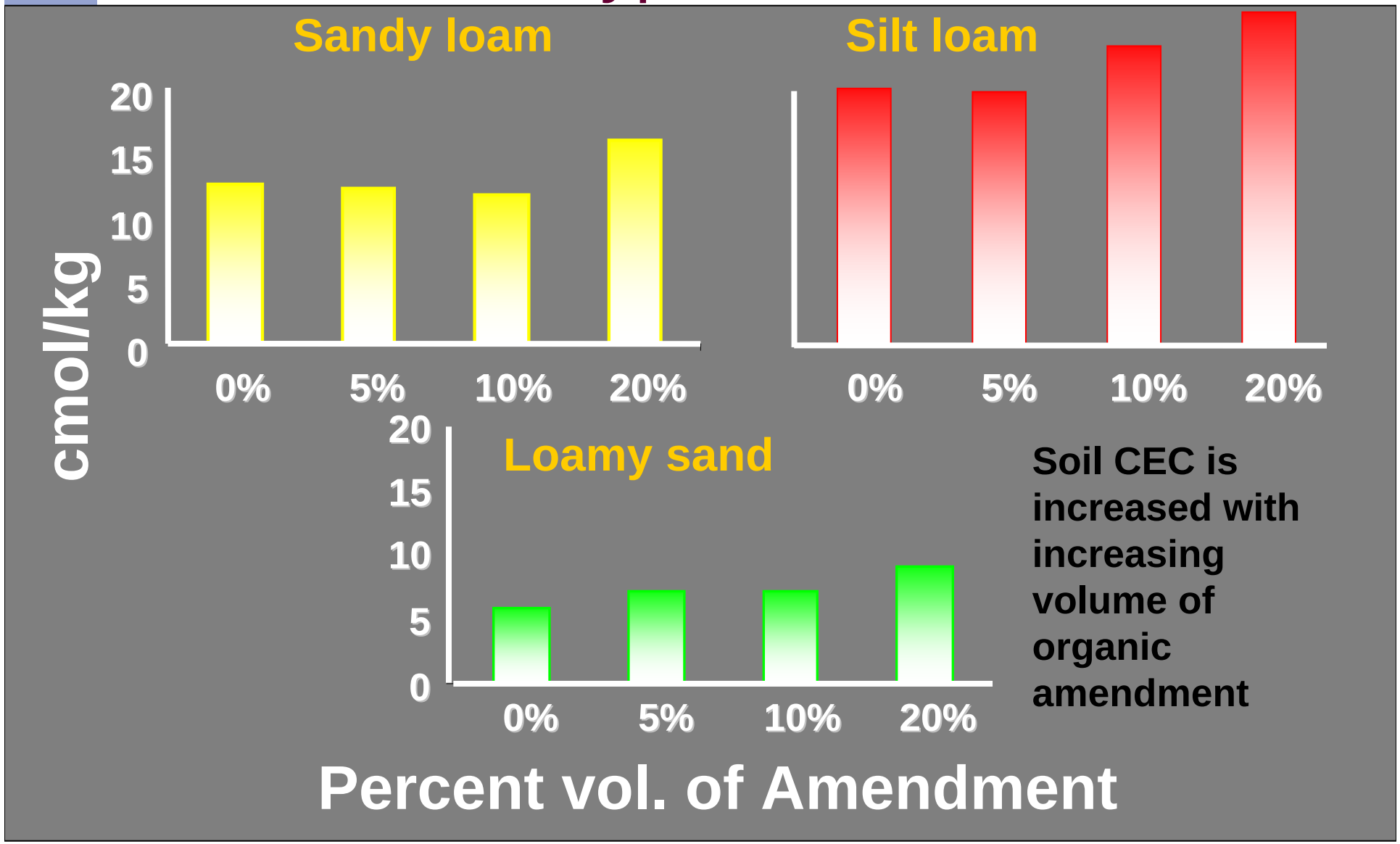
Cation exchange capacity me $100g^{-1}$ ($cmol(+)kg^{-1}$)

Sandy Loam (Osoyoos)	4.8
Sandy Loam (Skaha)	12.5
Silt Loam (Penticton)	18.0
Ogogrow compost	89.7
Dairy solids (vermicompost)	175.3

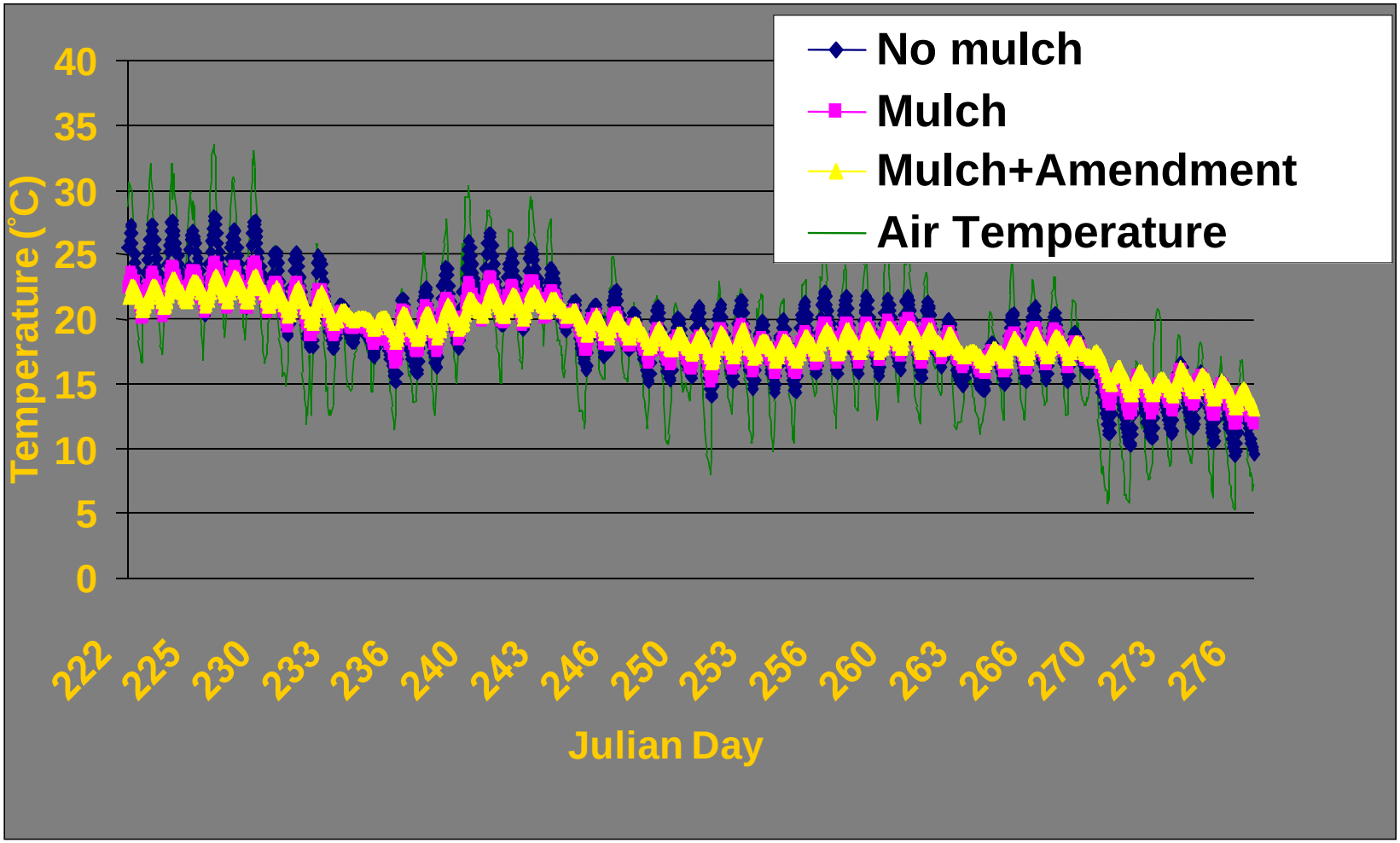
Organic amendments can have very high cation exchange capacity (CEC) and make measurable changes to a soil.

Cation Exchange Capacity

Soil Type/Amendment



Soil temperature, 2001



Heat Accumulation 2002-2003

	Jan-Mar	Apr-June	Jul-Sep	Oct-Dec
	GDD5			
No mulch	18	1049	1470	161
Mulch	52	819	1291	179
Significance	***	**	**	*

Long Term Mulching and Amendment Trial, PARC-Summerland, 1994-2003

Experimental design

‘Spartan’ * M.9 (1994)

1.25m x 3.5m spacing
7 treatments, RCB, 5 replicates
4 tree plots

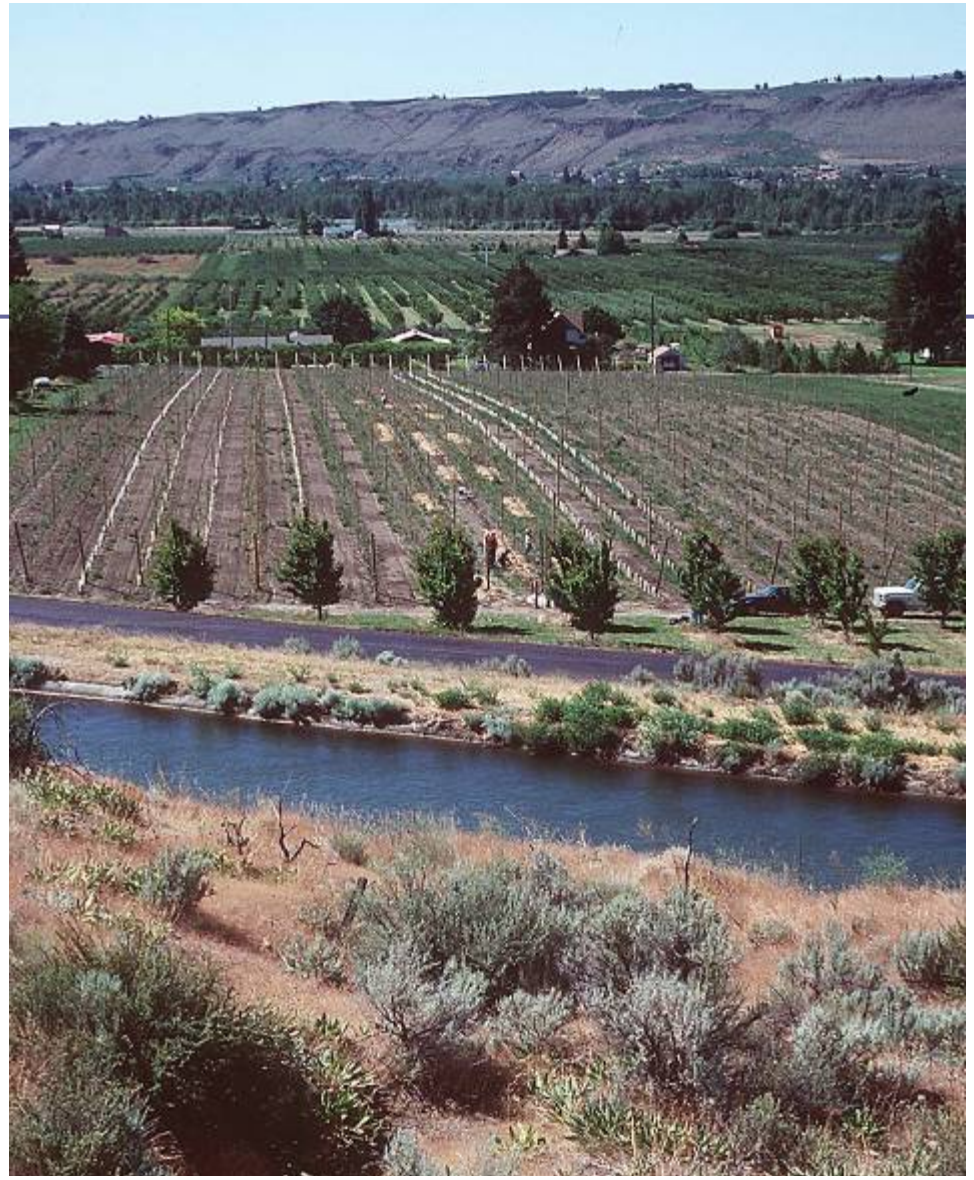
Daily drip irrigation
N fertigation (70 – 100 kg N/ha/yr)

Plant and Soil Response to Mulches

Treatment	TCSA (cm^2)		Yield (kg/tree)		Soil properties			
					Total C (%)	Total N (%)	Extract. P (ppm)	Infiltr'n (L/hr)
	1997	2001	1997	2001	2001			
Check	4.6c[z]	11.5d	3.2c	14.7b	1.0c	0.10bc	40b	5.50b
GVRD	4.5c	11.6d	4.5bc	14.7b	1.9a	0.18a	205a	14.6ab
Paper mulch (PM)	7.4a	17.4a	6.5a	20.4a	1.3bc	0.12b	26b	10.0b
Geotextile	5.8bc	12.4d	5.2ab	16.0b	0.9c	0.09c	29b	3.40c

[z]Means with a column followed by the same letter are not significantly different at the 5% level according to Duncan's multiple range test.

Neilsen et al. 2003. HortSci.
Neilsen et al. 2003. Can.J.SoilSci.



Mulch trial in Naches, WA. 2 levels of N, 2 levels of drip irrigation, organic soil amendment, mulch. Braeburn/M.9


Only alfalfa hay mulch increased growth both years. No treatment affected 1st year fruit yield.

Water saved with drip + mulch compared with sprinkler

	Drip Mulch	Sprinkler
Water use (acre-feet)	2.4	3.6
Change in TCSA (%) since 2000	120*a*	119*a*
Yield (lb/tree)	9.9*a*	7.3*b*
Fruit size (lb)	0.42	0.46
Starch (1-6)	3.44*a*	2.39*b*
Firmness (lb)	19.6	20.4

Means with same letters are not significantly different

[1]estimated from previous year


Spray-on Mulch
Summerland, BC
Made from recycled paper fibers that were normally land-filled.

Spray on mulch trial

Treatment	Weed cover[z] (%)		Tree growth	
	June 7	Oct 25	TCSA (mm^2)	Shoot gr. (cm)
Check	38	12.0	194a	156a
Spray on mulch (SOM)	8	4.4	222b	216b
Compost + SOM	3	1.6	245b	259b
Comp/zeolite + SOM	3	1.0	232b	245b

Experimental organic block

Compost

Tillage

Straw over bark mulch

Alfalfa mulch

Nutrient Additions
Alfalfa (3 cuts/yr; 6reps)

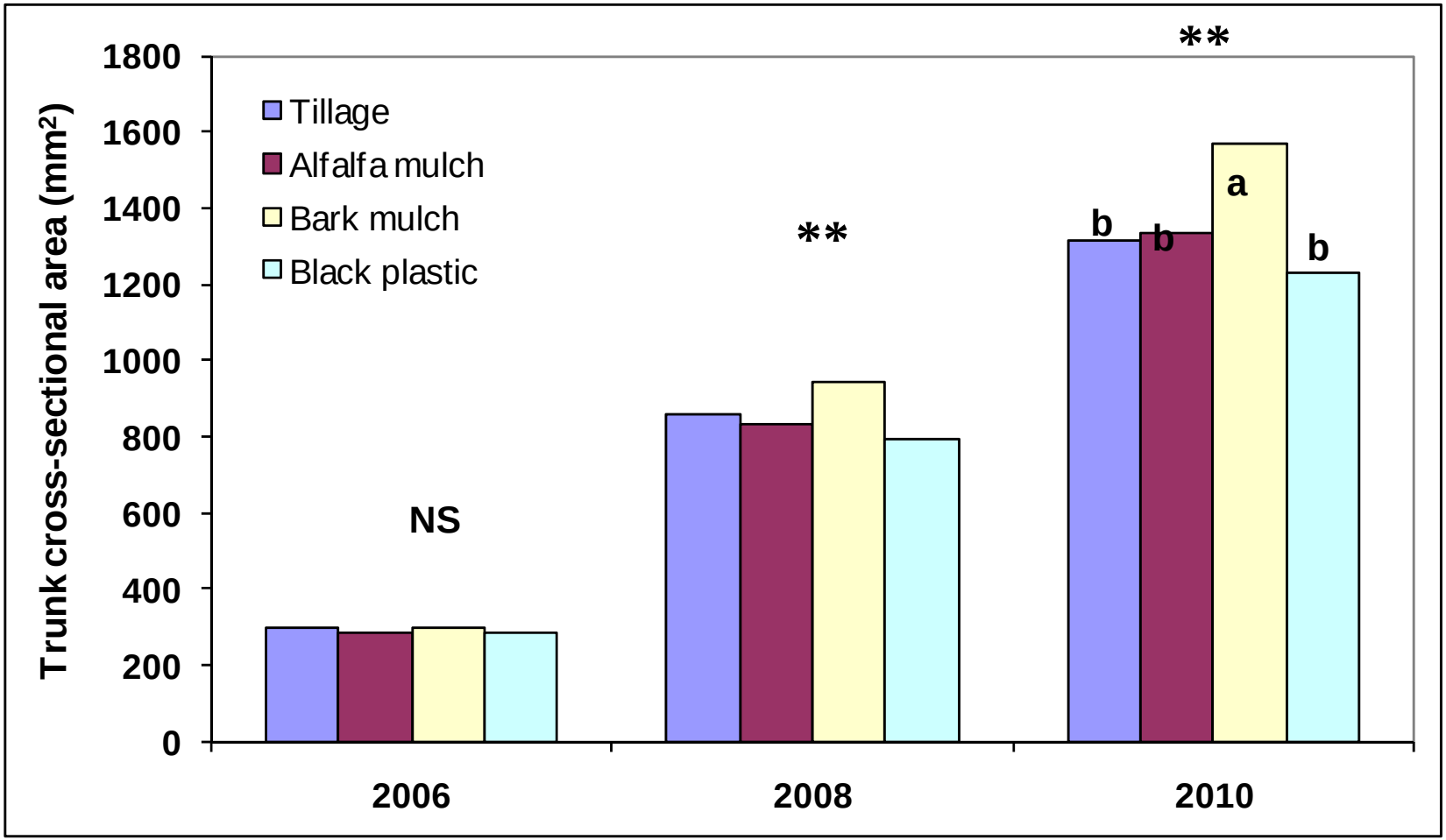
	OM	N	P	K	Zn
	Kg /ha in row				
2007	17,692	584	55	509	0.53
2008	5,964	190	18	176	1.38
2009	4,982	129	14	150	nm

Plastic landscape fabric

Nutrition

	Leaf N (% dw)		Leaf K(% dw)	
	2008	2009	2008	2009
Tillage/comp.	2.69 *a*	2.45	1.82 *b*	1.65 *b*
Alfalfa	2.68 *a*	2.46	1.84 *b*	1.70 *b*
Bark mulch	2.54 *b*	2.42	2.04 *a*	1.86 *a*
Black plastic	2.67 *a*	2.38	1.76 *b*	1.60 *b*
	**	NS	**	***

Trunk cross-sectional area and treatments



First crop (2010)

	Yield (kg/tree)
Tillage/compost	6.9 a
Alfalfa	5.9 ab
Bark mulch	5.3 b
Black plastic	7.4 a
	*

Soil nutrients (2009)

	P	K
	Mehlich-extractable (mg/kg soil)	
Tillage/compost	378 *b*	330 *b*
Alfalfa	323 *b*	489 *a*
Bark mulch	299 *b*	481 *a*
Black plastic	494 *a*	273 *b*
	****	****
Conventional	168 *c*	335 *b*
Unirrigated	149 *c*	255 *6*

Soil biology (2007)

	Microbial biomass (mg/kg soil)
Tillage/compost	326 *bc*
Alfalfa	374 *ab*
Bark mulch	281 *cd*
Black plastic	237 *d*
Conventional	199 *d*
Unirrigated	466 *a*

Thank you