Building Soil Quality With Organic Amendments

Leslie Cooperband
Department of Soil Science
University of Wisconsin

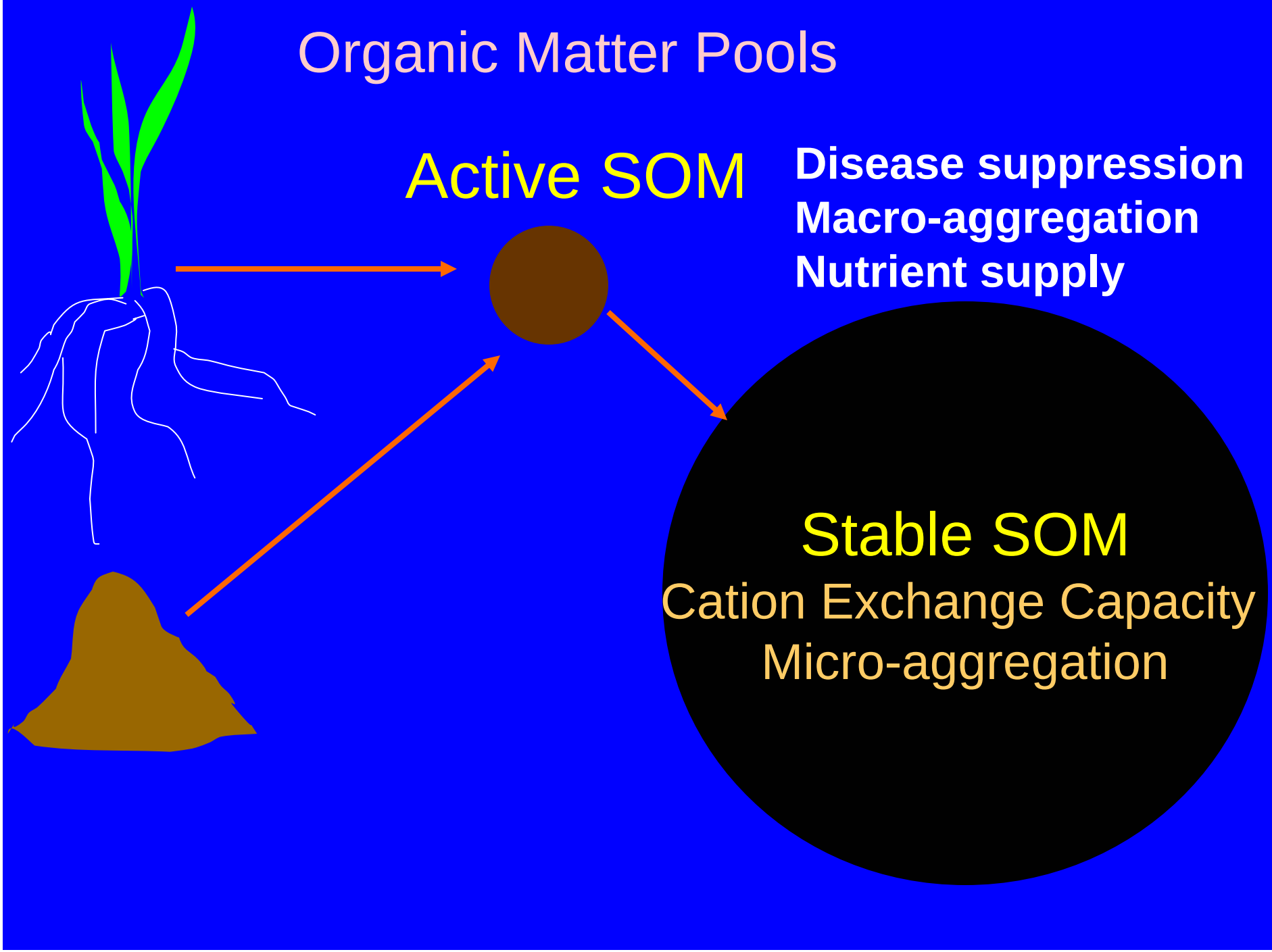
What is “Soil Quality”

Ability of soil to perform certain functions critical for crop and ecosystem production and critical for environmental integrity

- Supply nutrients
- Supply water
- Provide effective rooting environment
- Reduce plant diseases
- Minimize runoff and leaching of nutrients and pesticides
- Minimize soil erosion
- Sequester carbon (reduce greenhouse gas emissions)

You can change soil functions by building soil organic matter.

Organic Matter Pools



How do we build active and stable soil organic matter pools?

- Cover crops
- Raw organic amendments
  - Animal manures
  - Food processing wastes
  - Leaves
  - Industrial wastes (paper mill residuals)
- Composts

Fresh Vs. Composted Organic Matter

Fresh residues & raw waste

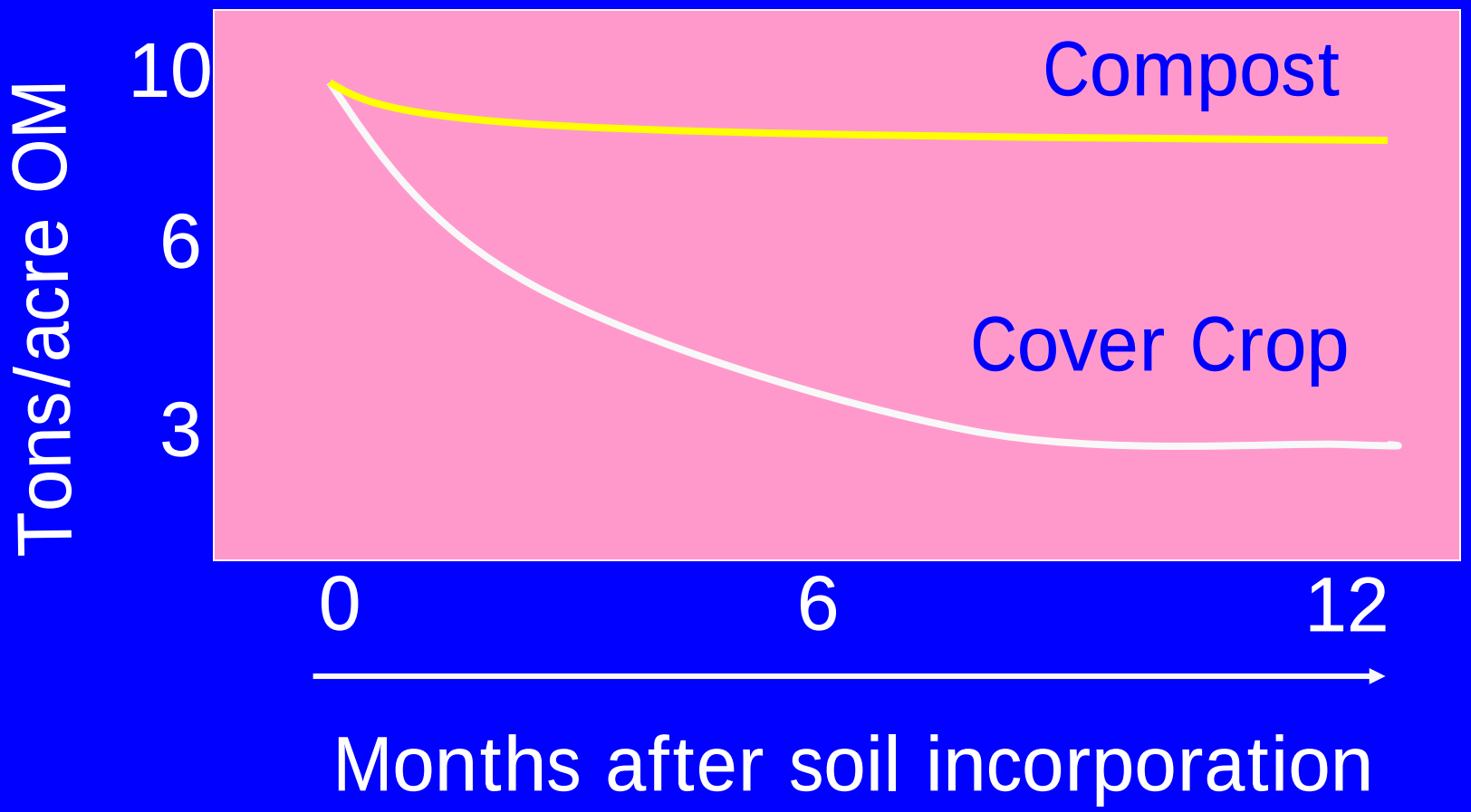
- Immobilize nutrients during early stages of decomposition
- Increases water retention in soils
- Cover crop plowed into soil can increase Pythium damping off within 1st week

Compost

- Already gone through decomposition
- Mature compost should provide some nutrients
- Improves drainage
- Provides for biological control of Phytophthora root rot

Cover Crops

Compost vs. Cover Crop Effects on Soil Organic Matter



Cover Crop Effects on Soils and Crops

- Legumes supply mineral N
- Fall cover crops scavenge excess nitrate N to reduce nitrate leaching
- Provide cover for wind and water erosion control
- Cover crops add active SOM
- Some control plant diseases

Effect of Cover Crops on Vegetable Production

Mwaja et al., 1996

- Fall seeded rye and hairy vetch in cabbage, tomato and snap bean.
- Killed covers in spring and either applied as mulch or disked into soil.
- Control plot (CT) produced greater yields in 1st year.
- In 2nd and 3rd years, mulched treatments produced similar yields to CT.
- Mulched plots had 0.5% ↑ OM, lower incidence of diamond back moth, cabbage worm and cabbage looper.

Manure, Composts or Other Organic Wastes

Chemical characteristics of organic amendments

	Cow manure	Poultry manure	Peat	Yard debris compost	Biosolids/ bark compost	MSW compost
Moisture (%)	74	25	61	49	45	30
pH	8.4	8.5	4.4	7.6	7.4	7.9
EC	2.5	6.8	0.24	1.0	1.3	3.8
Ash (%)	27	34	2.9	55	36	50
OM (%)	66	57	88	44	55	40
C:N	19	12	55	15	18	19
N	2.01	3.13	0.93	1.01	1.76	1.27
P	0.87	1.98	0.06	0.25	0.74	0.31
K	1.48	2.59	0.08	0.37	0.52	0.54

Source: Pinamonti & Sicher, 2001

Raw Manure

- High available nutrients: N forms, P, K, etc.
- Heterogeneous, high volume
- Very biologically active
- Strong odor
- Wet
- Contains weed seeds, pathogens

Composted Manure

- Low available nutrients, esp. N
- Relatively Homogeneous, reduced volume
- Biologically stable
- Non-offensive odor
- Moist-dry
- Weed seeds, pathogens killed

Changes in Soil Properties after Organic Amendment of an Irrigated Loam

Martens and Frankenburger, 1992

- Chicken manure, sewage sludge, barley straw, and alfalfa
- Amended 3X in 2 years (with 11 dry T/A) to irrigated loam in southern CA
- Infiltration increased 18-25%
- Infiltration highly related to increased aggregation and lower bulk density

Organic Amendments in Tomato Production

Steffen et al, 1995 ; Penn State Univ.

- Silt loam soil
- 29 dry tons mushroom compost and
  25 dry tons aged cattle manure per acre
- 35% increase in soil available water
- Trickle irrigation requirements cut in half
- Reduced blossom end rot by 63% and cracking by 85%

Use of paper mill residuals in vegetable production

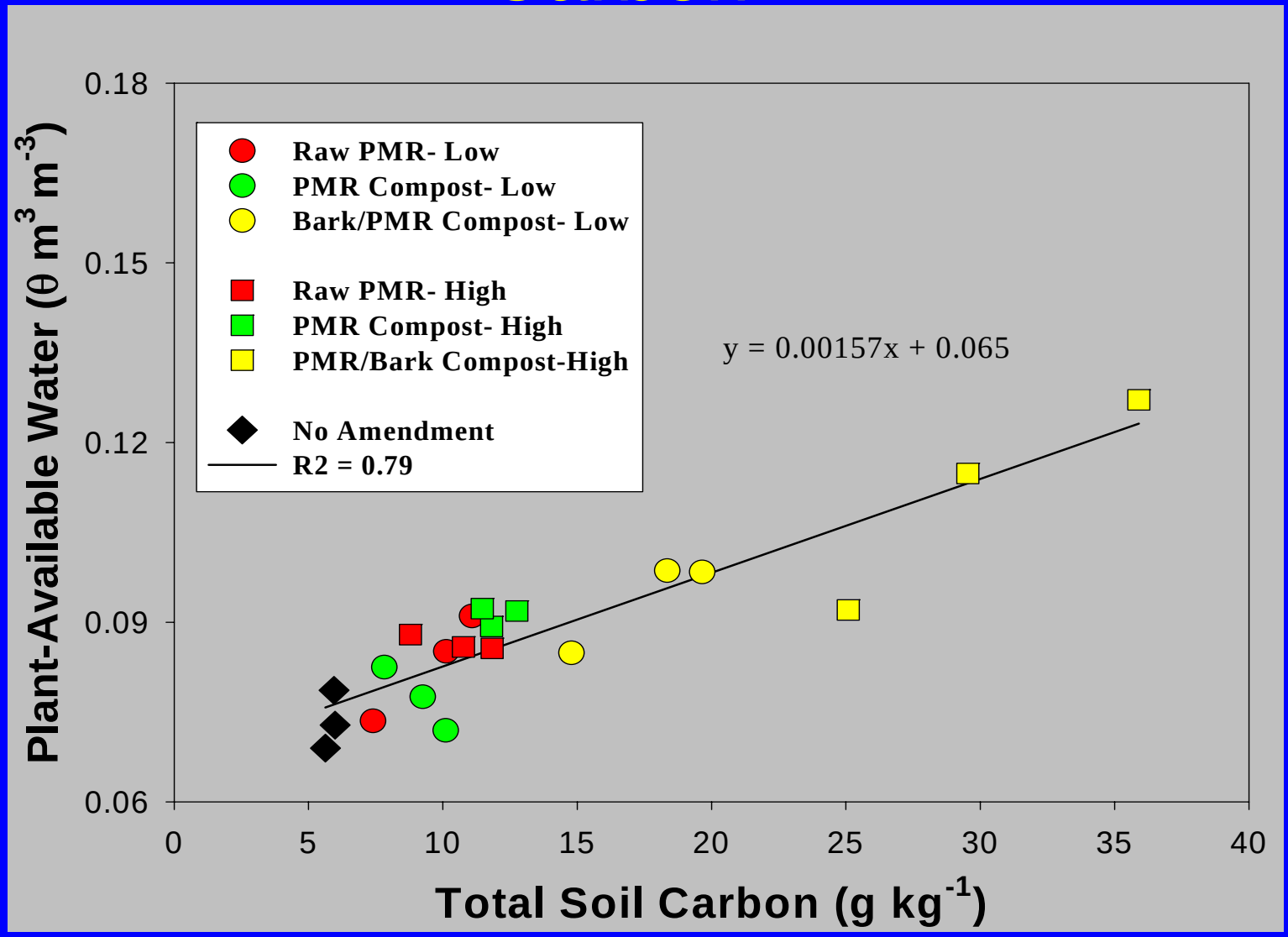
Cooperband et al. 2002

- Long term research project in WI Central Sands
- 3-yr. vegetable rotation
- Raw paper mill residuals (PMR), PMR composted without bulking agent, PMR composted with bark
- Annual additions to sandy soils

  at 2 rates: 10-35 d tons/acre

Plant-available Water vs. Total Soil Carbon

Foley and Cooperband



Field Production of Ornamental Shrubs with Compost

- Three composts
- 1” incorporated
- 1” inc. + 1” mulch
- Silt loam soil

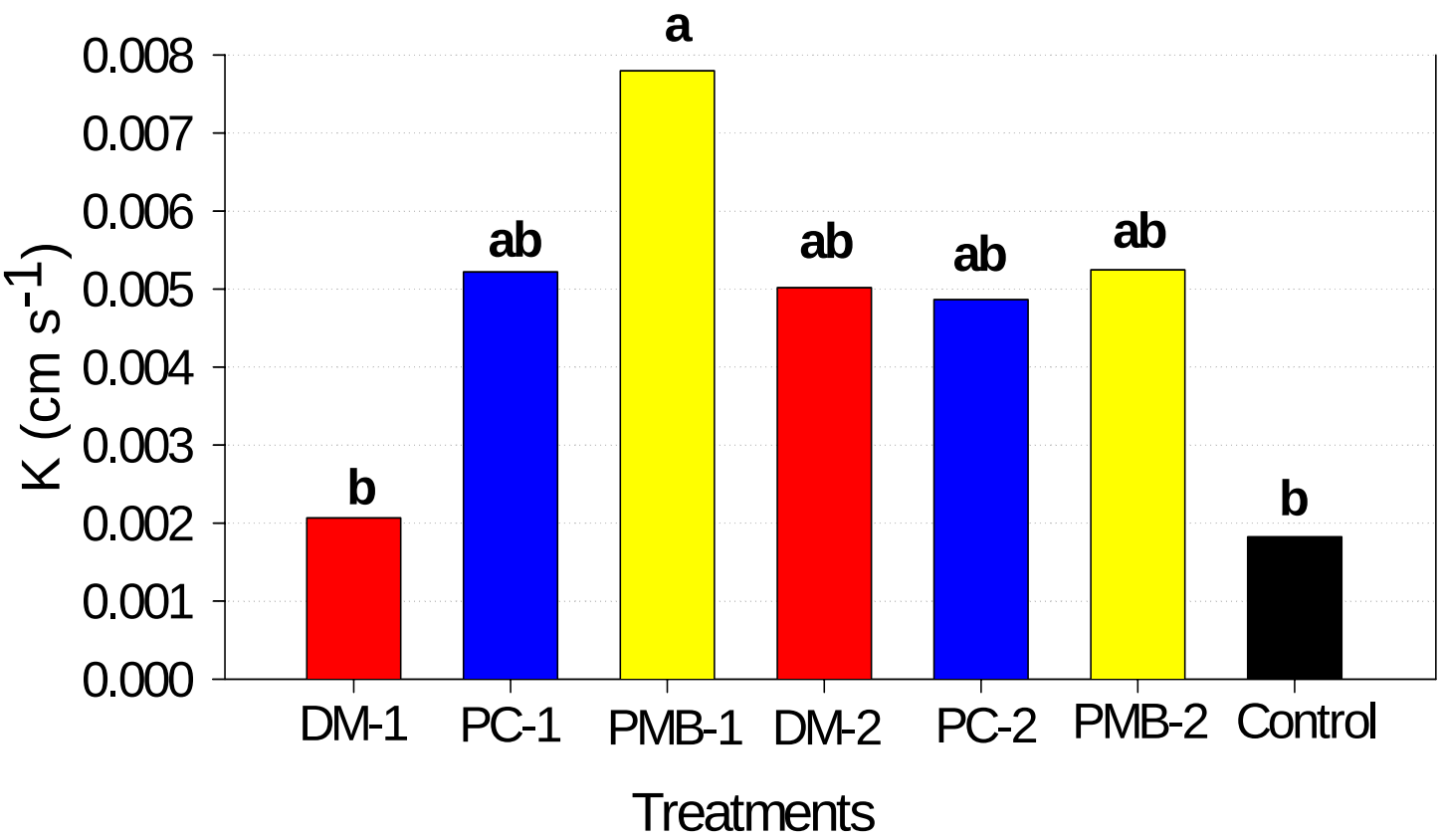
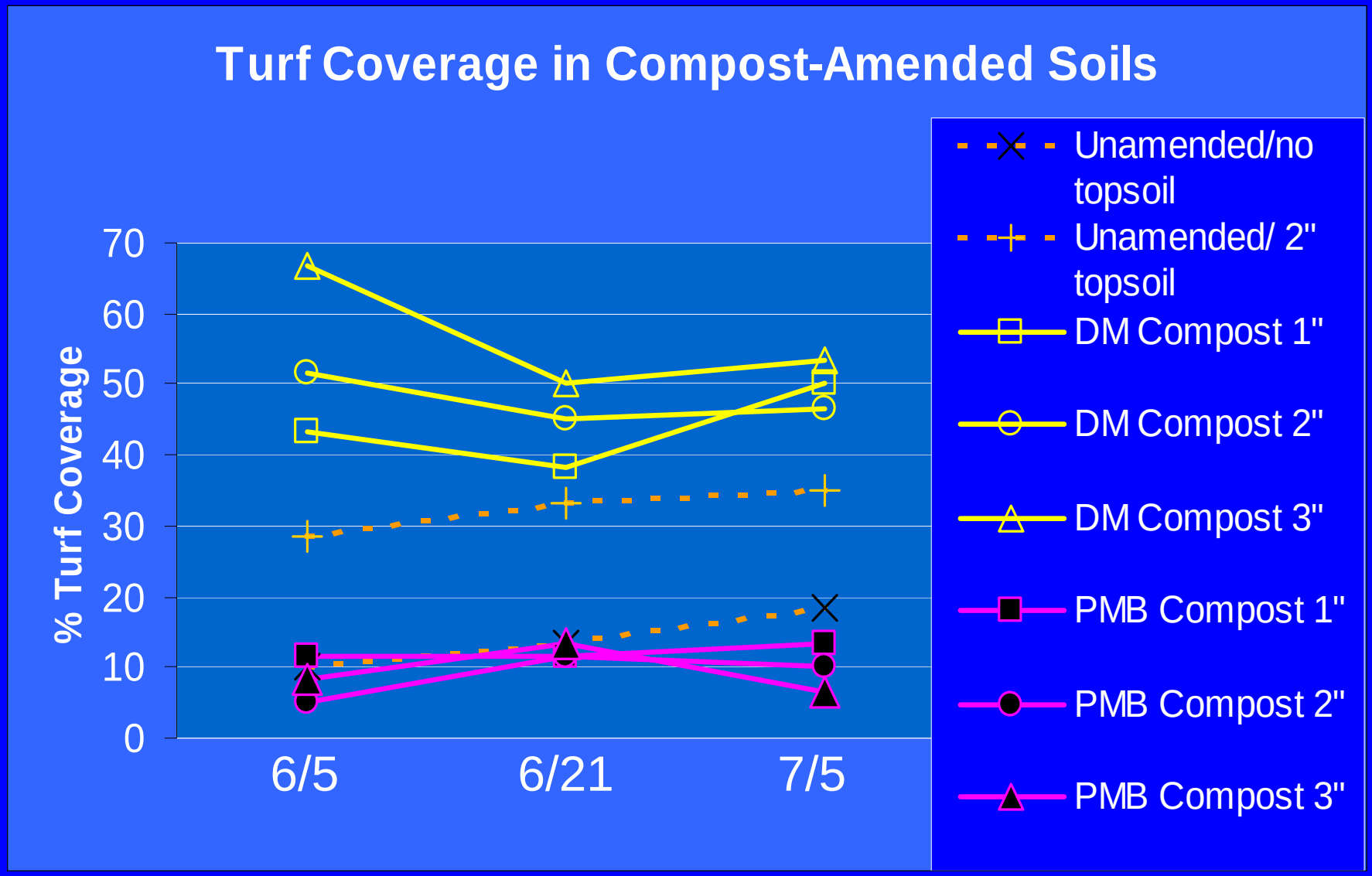


Figure 5. Mean soil hydraulic conductivity by treatment, 2000

Significant effect at $\alpha = 0.05$. Columns with the same letter are not significantly different.

Effect of compost type and rate on turf establishment



Soil Quality and Plant Disease Suppression

Summary of Literature on Plant Disease Suppression

Amendment	Pithium + Phytophthora root rots	Rhizoctonia Diseases	Fusarium wilts
Sphagnum peat (H_4)	-	-	-
Sphagnum (H_2, H_3)	+	-	-
Pine bark	+	+	+
Hardwood bark	+	+	+
Yard wastes	+	+	
Grape pomace	+	+	
Cow manure	+	+	
biosolids	+	+	

Source: Hoitink et al., 2001)

WI-Central Sands PMR Research: Soil-borne Diseases

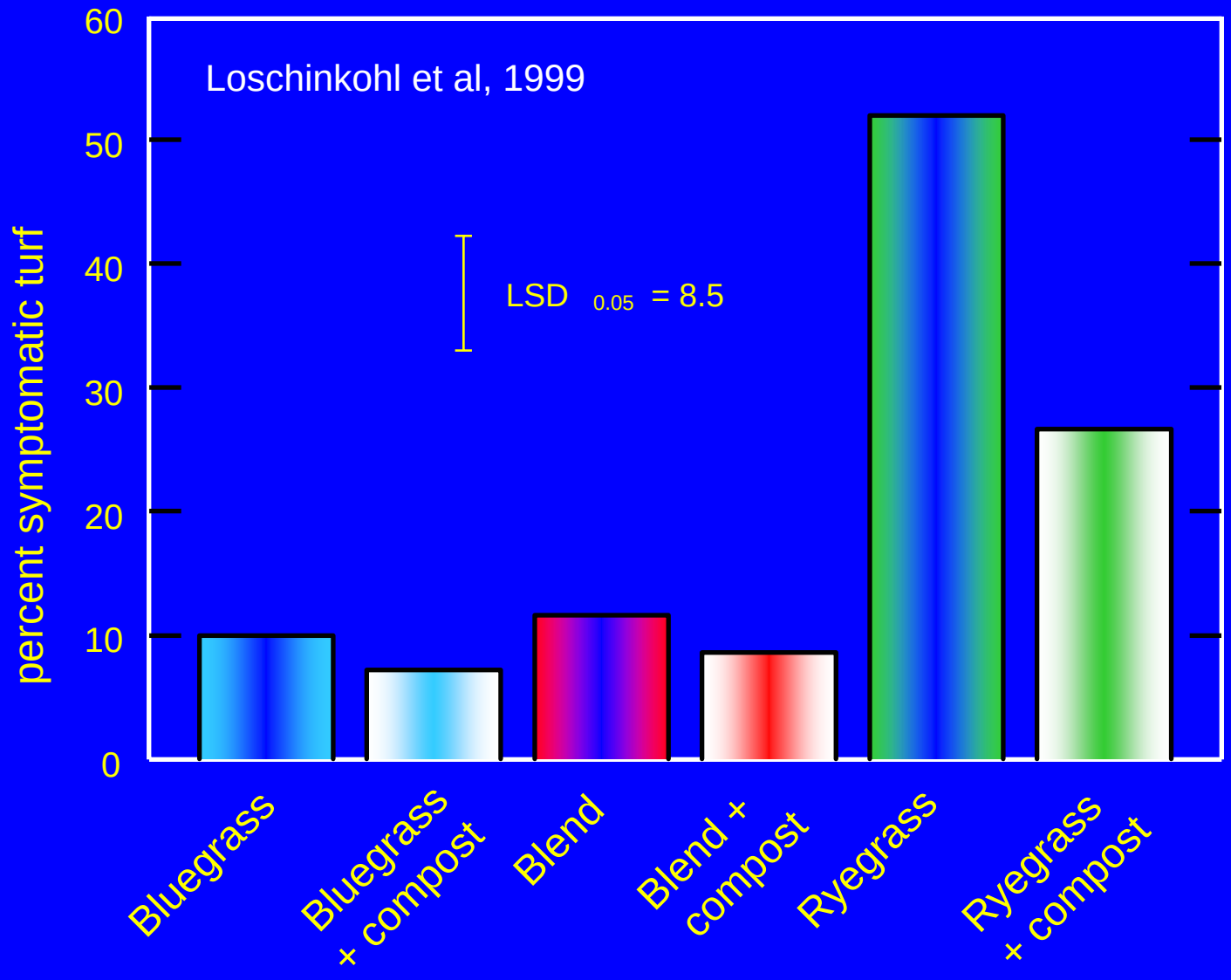
Pythium leak

Common root rot

Potato early dying

Soil-borne Diseases

		1998	1999	2001	2002
Treatment	Rate	Pythium leak	Aerial Pythium	Potato Early Dying	Common Root Rot
Raw PMR	L	7 b	3 a	27 a	1.05 b
	H	5 a	2 a	41 bc	0.49 c
PMR Compost	L	10 b	2 a	44 bc	0.59 c
	H	5 a	2 a	50 c	0.54 c
Bark/PMR Compost	L	4 a	2 a	39 b	0.40 c
	H	9 b	2 a	41 bc	0.69 c
No Amendment		13 b	15 b	26 a	1.75 a



Rust Incidence in Compost-Amended Turfgrass

Suppression of Tomato Bacterial Spot in Soils Amended with Composted Yard Waste

Abbasi et al, 1997

Compost T/A	% Bacterial Spot	% Anthracnose
0	17.6	9.5
20	12.6	8.3
40	11.7	8.7
LSD P=0.05	3.6	NS

Relationship Between Organic Amendment Age and Soil Function