


**Soil Physics**

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Phil Busey Agronomy Consulting Inc. [www.philbusey.com](http://www.philbusey.com)

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by Philip Busey 




**FACTORS RELATED TO SOIL PHYSICS**

**Irrigation** Because soil physics is very closely related to soil water relationships, need to be thinking about irrigation uniformity

**Traffic** Because of the interrelated roles of soil physics, water, and wear and compaction, need to be thinking about managing traffic

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**ATHLETIC FIELD USE CAPACITY**

Field Condition	Hours per year
Sustain good field conditions	200 hours or less
Fair to good field conditions, some thinning turf and localized wear areas	400 to 600 hours
Significant turf loss, field surface damage, increased potential for athlete injury	Over 800 hours

From: Miller, Grady L. 2004. Athletic field use capacity. ENH991 (EP246). Univ. Florida.

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**REMEMBER**

- A healthy soil allows roots to breath
- Fines dominate (and amending with sand to improve drainage is almost futile)
- Geotechnical engineering (“soil mechanics”) very different from agronomics
- Don’t be confused by terms infiltration, percolation, leaching, drainage
- Soil is very, very complicated and there are major myths and major mistakes

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**SOIL PHYSICAL FACTORS – 2 BIGGIES**

**Soil particle size** Fractions of sand, silt, clay, and sand sieve classes; coarse + medium + fine sand should be > 70%; sand sieve size very important

**Organic matter** Can lead to improved soil structure (flocules), stability for athletes; more often, impedes drainage, should be below about 3% by weight; for quality peat with bulk density less than 0.15, about 1.5% by weight or 10% by volume may be suitable

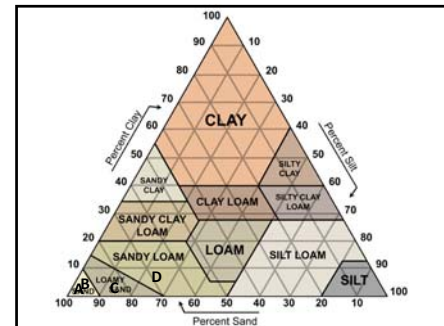
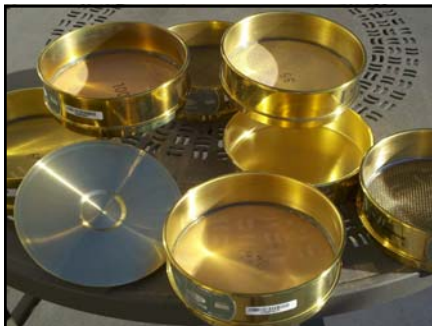
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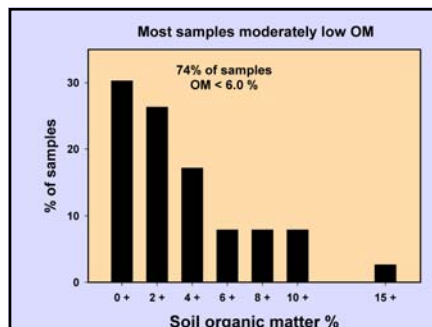
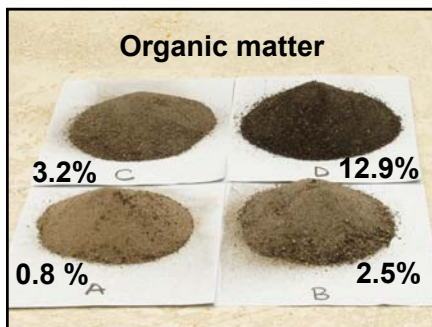
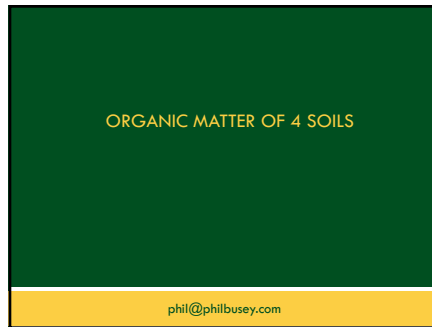
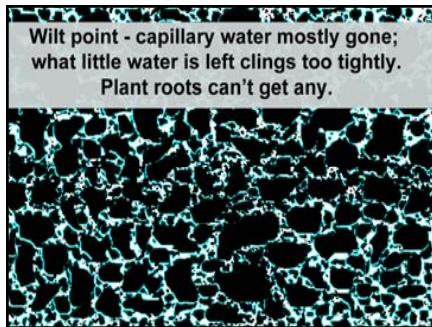
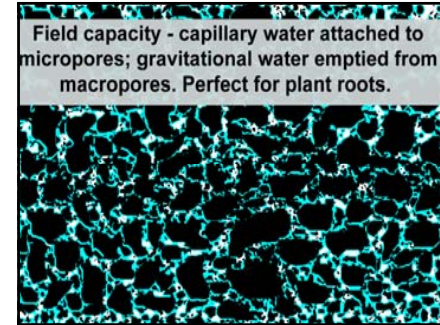
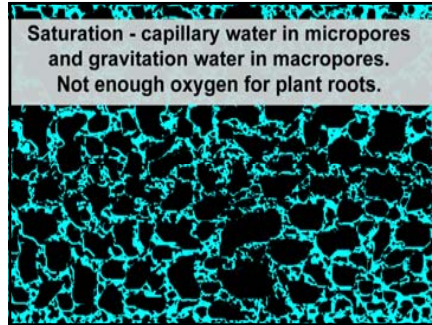
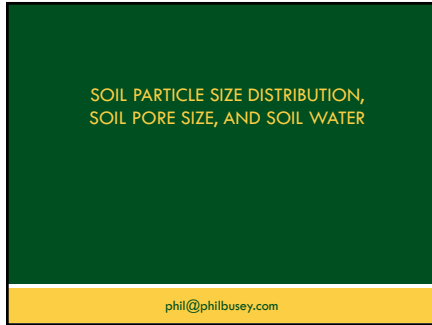
**SOIL TEXTURE (SIZE DISTRIBUTION OF PARTICLES)**

Separates	Particles larger than:
Gravel	2 mm
Very coarse sand	1 mm
Coarse sand	0.5 mm
Medium sand	0.25 mm
Fine sand	0.10 mm
Very fine sand	0.05 mm
Silt	0.002 mm
Clay	

USDA system from: Brady and Weil, 2008. The nature and properties of soil, 14th edition.

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**Measuring organic matter: Weight or volume?**

Try the organic matter - organic source converter by Philip Busey

Organic matter is the most valuable part, by weight, of soil. But organic sources in soil mixes are specified by volume which is mostly air. What is the price of the air part?

What made me wonder was an 80:20 sand:peat mix that a friend bought, which tested at only 0.66% organic matter. Soil is blended by volume, so my friend's mix was supposed to be 20% peat by volume. But soil scientists analyze organic matter by weight. How can a buyer figure out if 20% peat by volume is only 0.66% organic matter by weight? Or if the buyer is paying mostly for air?

Bags of soil mixes being prepared to incorporate in golf greens, Sequesta Country Club, Bill Wagner, Superintendent

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**Measuring organic matter: Weight and volume converter**

Return to Organic Matter

**The Problem:** The first converter below calculates organic matter content by weight % of a mix that will result based on physical characteristics of the organic and sand sources and the volume mixing ratio. The second converter goes backwards to verify, based on soil test organic matter by weight %, and the alleged volume mixing ratio and typical organic matter contents of organic sources, if there resulted in a plausible value for organic source bulk density.

The equations of these calculators are at the bottom of the page.

Whenever tests of root-zone mixes have less than 1.0% organic matter by weight it is likely the enough organic source was used, or a poor quality source was used. Ideally organic matter should be derived from fibrous peat such as sphagnum and the resulting organic matter content for sand:root zone mixes should be between 1% and 5%, with values near 1.5% to achieve adequate exchange capacity, available water capacity, and moderate stability. Higher organic matter can be achieved with lower quality sources, so acceptable organic matter content cannot be evaluated quality alone without knowing the source. However, very low organic matter content is a clear indication of potential problems.

**Question:** What will be the estimated organic matter content (% weight) of a soil mix?

Initial numbers in the blanks are provided as examples. Replace with values you measure.

**MORE SOIL PHYSICAL ANALYSIS**

- Texture (sand, silt, clay particle sizes, including sand sieve sizes)
- Porosity (macro or air-filled vs. micropores)
- Organic matter (very complex)
- Bulk density
- Hydraulic conductivity - how easily water flows through soil pores (if saturated,  $K_{sat}$ )

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**\*\* PHYSICAL ANALYSIS REPORT \*\***

Submitted by: Philip Busey      Received by: *Justin Pancher*

Lab Number: 1000 0305

**Particle Size Analysis**

Clay < 0.002mm	Silt 0.002 - 0.075mm	Sand 0.075 - 2.0mm	Total fines
1.1%	37.2%	61.7%	38.3%

7.3% (circled)

**Sand Fractions**

Clay < 0.002mm	Silt 0.002 - 0.075mm	Very Fine Sand 0.075 - 0.25mm	Medium Sand 0.25 - 0.5mm	Coarse Sand 0.5 - 0.85mm	Very Coarse Sand 0.85 - 2.0mm
1.1%	37.2%	12.5%	12.5%	12.5%	25.2%

**Soil Moisture Measurement**

Moisture content by weight: 1.1% (circled)

**Soil Pore Space**

Air Filled Pore Space: 11.1% (circled)

**Soil Density**

Bulk Density: 1.59 g/cc

Particle Density: 2.65 g/cc

PH: 5.3

PHYSICAL CLASSIFICATION: Medium silt/clay/sand/peat to sand/clay



**SOIL PHYSICS AND HEALTHY SPORTS TURF**

**Sports Turf Soil**

Particle size	A	B	C	D
Sand (%)	96.9	92.1	81.4	69.4
Silt (%)	2.6	6.2	15.2	22.8
Clay (%)	0.5	1.1	2.7	6.6

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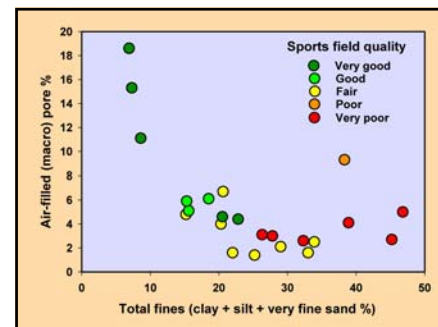
**Saturated hydraulic conductivity (inches/hour)**

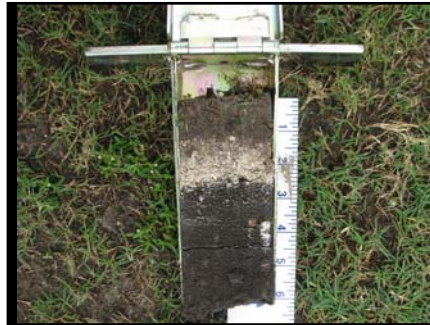
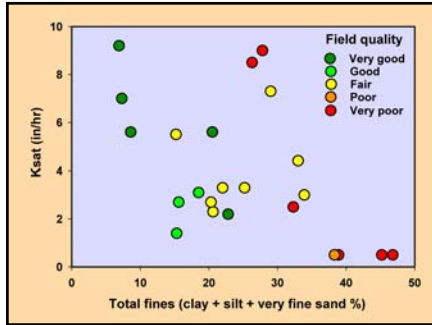
5.6      3.0      < 1      < 1

**SOIL PHYSICS AND HEALTHY SPORTS TURF**

Sample Location	A	B	C	D	Goal
Saturated conductivity (in/hr)	5.6	3	< 1.0	< 1.0	> 3
Moisture retention (%)	22	30.4	29.8	57.6	14 to 20
Air filled pore space (%)	4.6	2.5	9.3	2.7	18 to 25
Bulk density (g/cc)	1.59	1.43	1.33	0.95	1.2 to 1.6
Organic matter (%)	0.8	2.5	3.2	12.9	< 3
Very fine sand + Silt + Clay	20.5	33.9	38.3	45.2	< 25

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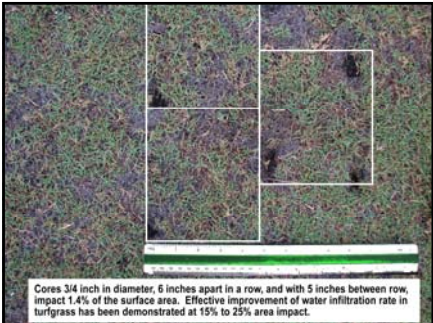


**EFFECTIVE CORE CULTIVATION**

- 2 to 6 times per year
- Soil exposed should be 3.5 to 10% of area
- Prefer 2.5 to 4 inches penetration
- Area and depth determine enhancement of diffusion
- During times of peak shoot and root growth
- Be careful at times of peak goosegrass germination
- Prefer cam (vertical tines) over drum
- Prefer closed hollow tines over open spoon tines
- Not a panacea if soil is not right

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Cores 3/4 inch in diameter, 6 inches apart in a row, and with 5 inches between row, impact 1.4% of the surface area. Effective improvement of water infiltration rate in turfgrass has been demonstrated at 15% to 25% area impact.

