Soil Particle Characterization Techniques and Their Influence on Bulk Density

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ABSTRACT

Soil texture is a physical property that determines water retention, nutrient availability, and agricultural productivity. Making accurate characterization is essential for effective farm management in the Rio Grande Valley, a critical region for Texas agriculture. This study compared hydrometer and laser diffraction methods for particle size analysis using twenty-four samples from four local farms. Laser diffraction provided faster, more consistent results than the hydrometer method, making it ideal for routine agricultural soil assessment. Results revealed two distinct soil types: silt loam soils (CD&J and Dos Rios Winery) with excellent water retention capabilities, and sandy loam soils (Teplicek and The Hour Farm) with well drainage. Bulk density measurements confirmed these texture classifications and their agricultural implications. Accurate soil texture determination is essential for optimizing irrigation, crop selection, and land management in the Rio Grande Valley's agricultural systems.

INTRODUCTION

Soil Texture Fundamentals:

- Soil Texture is determined by the relative proportions of sand, silt, and clay particles.
- Texture directly influences water retention, nutrient availability, bulk density, and agricultural productivity.

Particle Size Analysis Methods:

- Hydrometer Method: Traditional sedimentation technique using Stokes' Law principles
- Laser Diffraction: Modern optical method measuring particle light scattering patterns

METHODS

Step One: Prepare Soil Samples

Figure 1: Soil sieving procedure (DAHAN, 2025)

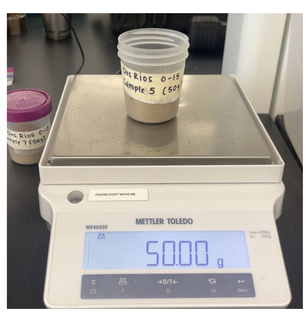
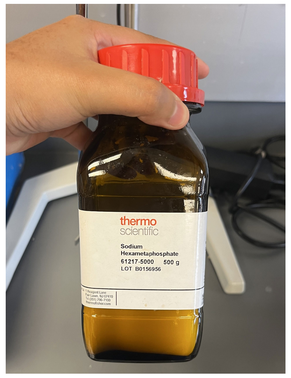


Figure 2: Weigh soil sample

METHODS

Step Two: Add Sodium Hexametaphosphate $(NaPO_3)_6$

Sodium hexametaphosphate is a dispersing agent that breaks down clumps of clay and other fine particles.



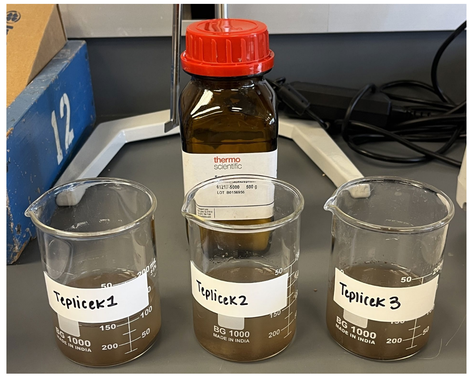


Figure 3 & 4: Sodium hexametaphosphate added to soil solution

Step Three: Perform Soil Particle Characterization

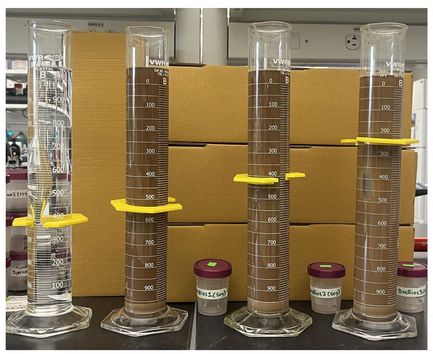


Figure 5: Hydrometer Analysis

Hydrometer Method

- 50 (g) of soil per sample
- Add 400mL of water
- Add 100mL of sodium hexametaphosphate
- Mix for 1 minute
- Fill cylinder to 1000mL
- Take readings at: 40 sec., 4 min., 37 min., 2 hrs.
- Calculate & Plot

Laser Diffraction Method

- 1 tbsp. of soil per sample
- Add 1 tsp. of sodium hexataphosphate
- Mix immediately
- Allow to sit for 24 hrs.
- Place solution on magnetic stirrer after 24 hrs.
- Pipette 4 mL of solution
- Transfer to Microtrac
- Run Test

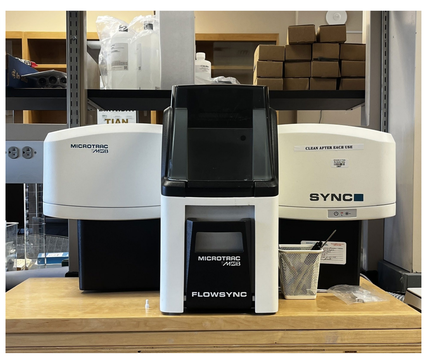


Figure 6: MicroTrac Laser Diffractor

RESULTS

Table 1: Soil Texture and Bulk Density Summary by Farm

Farm	Clay %	Silt %	Sand %	Texture Class	Bulk Density (g/cm^3)
CD&J	9.08	56.91	34.01	Silt Loam	1.400
Dos Rios Winery	8.44	55.47	36.09	Silt Loam	1.380
Teplicek	8.04	30.89	61.07	Sandy Loam	1.550
The Hour Farm	11.03	45.01	43.96	Sandy Loam	1.401

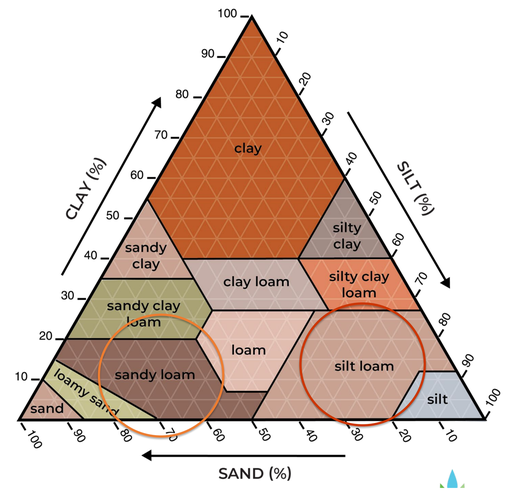


Figure 7: Soil Textural Triangle (USDA, 2023)

CONCLUSIONS

- Both methods determined soil texture across RGV
- Laser diffraction was faster and more consistent, while hydrometer required more time and manual steps
- CD&J and Dos Rios Winery were silt loam
- Teplicek and The Hour Farm were sandy loam
- Bulk density closely aligned with texture

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