

**SOIL 364/564 - Soil and Plant Analysis (3.0 credits)  
SPRING 2024**

Lecture (2h): Monday/Wednesday 10:00-10:50  
Laboratory (3h): (1) F 8:00-10:50 (2) Th 11:00-1:50 (3) Th 2:00-4:50 (4) F 11:00-1:50 in TNR 260  
Final Exam: TBD

Instructor: Dr. R. Michitsch  
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Office Hours: drop by office or by appointment

**Course Description:**

Sample, prepare, and analyze soil and plant samples. Interpret chemical results for environmental quality and soil fertility management. Understand soil chemical processes of each plant nutrient. Choose analytical methods and maintain laboratory quality control.

**Expectations:**

- students will distinguish the main characteristics for describing soils and plants, and conduct basic soil and plant analyses
- students will apply their knowledge to interpret measurements in terms of agricultural applications
- students will appreciate the diversity and interdependence of soils and plants
- students will understand that soil and plant characteristics are dynamic and unique to a particular sample at a given time

**Objectives and essential questions:**

- what are the basic soil/plant characteristics to interpret quality?
- why are these characteristics important?
- how do these characteristics interact?
- how do these measurements apply to agricultural decision making?
- why do we care?

**Texts:**

1. Laboratory Guide for Soil Testing and Plant Analysis. J. Benton Jones, Jr. CRC Press. (text rental)
2. Plant Nutrition and Soil Fertility Manual. J. Benton Jones. CRC Press (text rental)
3. UW-Extension articles A2100, A2809, A3030, A3588 and others (D2L)
4. The Bedford Handbook: 6<sup>th</sup> Ed. Hacker. Bedford/ St. Martin's. (suggested/text rental)
5. Methods of Soil Analysis. Part III. Chemical Methods. ASA Publication (library reserve)
6. Other materials as provided

**Course Layout:**

- get a 2-inch binder or something else suitable to contain your notes/materials
- use a binder divider if possible (half for lecture notes, half for laboratory procedures and data)
- if you use a coiled binder, tape or staple extra materials onto associated pages

**Evaluation:**

- 3 exams:     - 2 midterms (20%, 20%)  
                  - final exam (25%)
- professionalism and laboratory notebook (5%, 5%)
- 1 final laboratory report (1 × 25%)
- extra proposal (graduate credit only - see instructor for grade breakdown)
- late assignments may be docked 5% of possible score per day

Cheating and/or plagiarism will not be tolerated. You may work together in laboratory and class discussions, but you will do all assignments and exams independently. You must present your own interpretations of analyses and reflect your understanding of the problem or assignment. Your instructor may allow you to submit joint assignments on a case-by-case basis.

**Tentative Schedule**

| <b>Week</b> | <b>Topic</b>                                        | <b>Laboratory</b>                      | <b>Reading (in order)</b>                               |
|-------------|-----------------------------------------------------|----------------------------------------|---------------------------------------------------------|
| 1           | Syllabus introduction<br>Principles of soil testing | Lab set-up and safety                  | LGSTPA Ch 2.A-H<br>A2100, A3588 (Ch 12), A2809 (Ch 1-4) |
| 2           | Quality Control<br>Interpretation for policy        | No lab                                 | LGSTPA Ch 6                                             |
| 3           | pH and lime recommendations                         | Soil pH                                | LGSTPA Ch 2.I-J, A2809                                  |
| 4           | Soil organic matter                                 | SOM                                    | LGSTPA Ch 2.R, A3588 Ch 7                               |
| 5           | Phosphorus                                          | Soil P                                 | LGSTPA Ch 2.K, SFF Ch 5                                 |
| 6           | Potassium/Soluble Salts                             | <i>Midterm 1</i>                       | LGSTPA Ch 2.L, SFF Ch 6                                 |
| 7           | Potassium/Soluble Salts                             | Soil K, EC<br>Lab book check           | LGSTPA Ch 2.S, SFF Ch 3 (p81-96)                        |
| 8           | CEC                                                 | No lab                                 | LGSTPA Ch 2.L.7                                         |
| 9           | No Class – Spring Break                             | No lab - Spring Break                  |                                                         |
| 10          | CEC/Other soil cations                              | CEC                                    | LGSTPA Ch 3.A-C                                         |
| 11          | Principles of plant analysis                        | Plant Harvest                          |                                                         |
| 12          | Plant nutrient deficiencies                         | Plant Na & K                           |                                                         |
| 13          | Nitrogen                                            | <i>Midterm 2</i>                       | LGSTPA Ch 3.E, SFF Ch 4<br>MSA Ch 37-39                 |
| 14          | Nitrogen/Anionic nutrients                          | Plant P, Ca, Mg, Zn                    | LGSTPA Ch 2.P, Ch 2.M.2.a                               |
| 15          | Anionic nutrients/Wrap-up                           | Soil and plant N/S/B                   |                                                         |
| 16          | Flexibility                                         | Soil and plant N/S/B<br>Lab book check |                                                         |

**Final Laboratory Report**

15% Final report covers final unknown amendment report and all data collected

**Laboratory Safety**

Safety procedures must be followed at all times to avoid danger to yourself and those you share laboratory with. If you ever have a safety question, **ASK!!!**

General – Basic safety equipment in the laboratory includes: eye wash station, safety showers, gloves, aprons, fire extinguishers, chemical absorbents, etc. You should be aware of the location of all these items.

Chemical Spills – In the event of a spill:

1. Alert others in area.
2. Determine chemical type.
3. Put on necessary protective equipment.
4. Contain spill with absorbent.
5. Call **x3456** or **9-911** or **911** if necessary.

Chemical absorbent is located by the door in rm. 260.

Note: not all chemicals can be contained with paper towels, in fact some chemicals are flammable in contact with organic materials such as paper.

Fire – In the event of a fire:

1. Turn off gas, remove flammables.
2. Alert others in area.
3. Determine chemical type.
4. Contain with appropriate material.

Attire – Chemical spills do happen. To avoid damage to your clothes or person we recommend: laboratory coats, old clothes, closed toe shoes, and (when necessary) use of PPE

Sharps – Needles, etc. are to be disposed of in “Sharps” containers, not the trash.

**Laboratory Notebook**

You are required to maintain organized laboratory notes, which will be checked periodically and will be a part of your laboratory grade. More information will follow. Notebooks will be (tentatively) checked during weeks 7 and 15.

The notebook should have:

**Overall:**

- A List of Tables/Figures/Appendices
- No non-laboratory materials, though reference materials will be allowed

**Each Laboratory:**

- A brief introductory paragraph describing the purpose of the experiment.
- Procedures - If the procedure is identical with that given in the laboratory manual, a reference to the source is sufficient. However, if the procedure differs in any manner, the changes must be clearly stated. Examples of variation are weight of sample used, strength of chemical used, etc.
- Raw data - The units of each quantity should always be included.
- Calculations - If repetitive, sample calculations may be used. These sample calculations may be placed in an appendix if desired.
- Final Data – Make sure final data is clearly marked and properly labeled (with units).
- A brief results paragraph summarizing findings of the study, if values appear normal, if there seems to be a treatment effect, etc. Pictures, tables, graphs, etc. may be helpful. Are the results/conclusions logical?

Your submitted reports are more important than non-submitted notes on a per-laboratory basis. Keep your notebook organized, logical and neat. Apply the above points to the logic you use towards your submitted laboratory reports.

The laboratory notebook will be spot checked during your laboratory sections (weeks 6 and 12), suggestions will be made, and errors will be corrected at that time. If you have any questions at any time on the proper keeping of your notebook, be sure to ask your instructor.

**Final Report: Amendment Determination (more instruction will follow)****Directions:**

Use the data from our laboratory experiments to determine which amendment was added to your soil.

Possible amendments:

Ammonium Nitrate ( $\text{NH}_4\text{NO}_3$ ), Boric Acid ( $\text{H}_3\text{BO}_3$ ), Calcium Carbonate ( $\text{CaCO}_3$ ), Calcium Chloride ( $\text{CaCl}_2$ ), Calcium Phosphate ( $\text{Ca}(\text{H}_2\text{PO}_4)_2$ ), Calcium Sulfate ( $\text{CaSO}_4$ ), Potassium Carbonate ( $\text{K}_2\text{CO}_3$ ), Potassium Chloride ( $\text{KCl}$ ), Magnesium Carbonate ( $\text{MgCO}_3$ ), Magnesium Chloride ( $\text{MgCl}_2$ ), Sodium Carbonate ( $\text{Na}_2\text{CO}_3$ ), Sodium Chloride ( $\text{NaCl}$ ), Sodium Phosphate ( $\text{Na}_2\text{HPO}_4$ ), Starch ( $\text{CHO}$ ), Zinc Chloride ( $\text{ZnCl}_2$ )

Summarize the results for both control and amended samples in the following format.

**Introduction**Soil Information

Soil series and horizon

Amendment rate (lbs/ac)

Plant Information

Crop type and stage

Dry weight and percent dry matter

Any visual defects

**Results**Soil Analysis

pH (water)

% SOM (Walkley-Black)

dS/M Electrical Conductivity (Saturated Paste)

ppm P (Wisconsin Method)

ppm K (ICP – Ammonium Acetate)

ppm Ca (ICP – Ammonium Acetate)

ppm Mg (ICP – Ammonium Acetate)

ppm Na (ICP – Ammonium Acetate)

ppm Zn (ICP – HCl)

ppm  $\text{NH}_4^+$  (KCl and Distillation)

ppm  $\text{NO}_3^-$  (Distillation)

ppm S (Calcium phosphates and acetic acid)

ppm B (Hot Water)

Plant Analysis

g/kg K

g/kg Na

g/kg Ca

g/kg Mg

g/kg P

g/kg Zn

g/kg N

**Discussion**

The discussion should provide a multifaceted support of your conclusion using not only evidence of higher levels of some elements but lower levels as well. For example the amendment may increase the availability of some elements while precipitating or reducing the plant uptake of other elements. The discussion will cover pertinent soil reactions of your amendment and its role in plants.