COURSE SYLLABUS – FALL 2009

SOIL FERTILITY AND PLANT NUTRITION

COURSE TITLE AND ID: Soil Fertility and Plant Nutrition, CRSS (HORT) (ECOL) 4590/6590

The course syllabus is a general plan for the course; deviations announced to the class by the instructor may be necessary.

COURSE DESCRIPTION: Soil conditions affecting availability of plant nutrients; function and movement of nutrients in plants; methods of determining nutrient levels in plants, soils, and other growing media.

PREREQUISITES: CHEM 1211-1211L and CRSS 3050-3050L or CRSS(FORS) 3060-3060L or permission of major.

REQUIRED COURSE MATERIAL: Soil Fertility and Fertilizers by John L. Havlin et al. 7th edition.

COURSE OBJECTIVES: The objective of this course is to provide students with a comprehensive understanding of soil fertility, plant nutrition, and nutrient management so that they can:

1) Describe the influence of chemical, biological, and physical properties of soil and other growing media on nutrient availability to plants;
2) Identify soil (or growing media) fertility and plant nutrition problems and recommend proper corrective action;
3) Identify soil (or growing media) and nutrient management practices that maximize plant productivity and profitability
while maintaining or enhancing environmental quality.

TOPICAL OUTLINE (tentative):

1. Soil Fertility and Plant Nutrition (Chapter 1)
2. Basic Soil-Plant Relationships (Chapter 2)
3. Nutrient Transport in Plants (Chapter 2)
4. Soil Acidity and Alkalinity (Chapter 3)
5. Nitrogen (Chapter 4)
6. Phosphorus and Potassium in Soil (Chapters 5 and 6)
7. Phosphorus and Potassium in Plants (Chapters 5 and 6)
8. Sulfur, Calcium, and Magnesium in Soil (Chapter 7)
9. Sulfur, Calcium, and Magnesium in Plants (Chapter 7)
10. Micronutrients in Soil (Chapter 8)
11. Micronutrients in Plants (Chapter 8)
12. Evaluation of Soil Fertility and Plant Nutrition (Chapter 9)

13. Nutrient Management (Chapters 10, 11, 12)
14. Nutrients and Environmental Quality (Chapter 13)

ACADEMIC HONESTY POLICY

All academic work must meet the standards contained in "A Culture of Honesty." Students are responsible for informing themselves about those standards before performing any academic work.
See: http://www.uga.edu/honesty/

INSTRUCTORS:
Dr. Miguel L. Cabrera - Room 4119 Miller Plant Sciences Bldg. -- 542-1242, mcabrera@uga.edu
Dr. Anish Malladi – Room 1121, Miller Plant Sciences Bldg. – 542-0783, malladi@uga.edu

OFFICE HOURS:
Miguel L. Cabrera – Tuesday and Thursday 11 am – 1 pm
Anish Malladi – Wednesday and Friday: 10 am - noon

INSTRUCTION: There will be 2 lectures per week (75 minutes each). The lecture material will come from the class textbook and from references such as the ones listed below. Class participation is encouraged.

Each week, the students will be given a problem set which will emphasize the application of concepts covered in class. The problem set will be due a week later. ***Problems sets turned in late will be docked 25% of the total points for each day late.***

There will be three 75-minute exams in addition to the final exam. The exam material will include topics from the textbook, lectures, and problem sets. All exams will be comprehensive and will include material covered through the lecture previous to the one in which the exam is held.

From time to time there will be an unannounced short quiz during the class period. This quiz will consist of a few questions on the material covered in the previous class or in the assigned reading material (the lowest quiz grade will not count towards the quiz average).

Graduate students will be required to write a term paper on a topic agreed in consultation with the course instructors. The term paper will count for 20% of the final course grade. ***The paper is due on December 3***. Exams for graduate students may differ from those given to undergraduate students.

GRADING POLICY

Lect. Quizzes	10%
Problem Sets	20%
First Exam	10%
Second Exam	15%
Third Exam	20%
Final Exam	25%
TOTAL	100% (80% for graduate students (paper 20%))

USEFUL REFERENCES

Russell's Soil Conditions and Plant Growth by A. Wild (Ed.). 1988.
Soil Science Principles & Practices by R.L. Hausenbuiller. 1985.
Mineral Nutrition of Higher Plants by H. Marschner. 1995.
Principles of Plant Nutrition by K. Mengel and E.A. Kirkby. 2001.
Plant Analysis Handbook II: A Practical Sampling, Preparation, Analysis, and Interpretation Guide by H.A. Mills and J.B. Jones Jr.
Mineral Nutrition of Plants by Epstein and Bloom, 2004.

EXAM DATES

Exam 1 - September 22, 2009 (3:30-4:45 pm)

Exam 2 - October 22, 2009 (3:30-4:45 pm)

Exam 3 - November 19, 2009 (3:30-4:45 pm)

Final Exam – December 15, 2009 (3:30-6:30 pm)

POLICY FOR MAKE-UP OF EXAMINATIONS

Exams may be made up with proper justification of the reasons why the student could not take them at the specified dates and times. Make-up exams may be administered as oral exams.

CRSS (HORT) (ECOL) 4590/6590 - Outline of Lecture Topics

0. Review of chemical concepts
   a. Terminology
   b. Units and conversion
   c. pH calculations

1. Soil Fertility and Plant Nutrition (Chapter 1) - 1 lecture
   a. Soil Productivity

b. Soil Fertility
c. World Fertilizer Consumption
d. World Population and Food Production
e. Yield Limiting Factors
f. Law of the Minimum
g. Essential Elements

2. Basic Soil-Plant Relationships (Chapter 2) - 1 lecture
a. Soil Solution
b. Ion Exchange
- Clay Minerals
- Organic Matter
c. Cation Exchange Capacity
- Common cations
- Units
- CEC determination
- Base saturation
d. Anion Exchange Capacity
e. Movement of Ions from Soil to Root
- Root Interception
- Mass Flow
- Diffusion

3. Nutrient Transport in Plants (Chapter 2) - 1 lecture
a. Ion Uptake by Plants
- Passive
- Active
b. Long Distance Transport of Nutrients
-Movement in Roots
-Phloem
-Xylem
c. Membrane Transport
-Ion Pumps and Electrochemical Gradients
-Cation/Anion Balance
-Nutrient Compartmentation

4. Soil Acidity and Alkalinity (Chapter 3) - 2 lectures
a. Acid and Base concepts
b. Soil acidity
- Sources
- Factors
c. Active Acidity
d. Potential Acidity
e. Determination of Lime Requirements
f. Soil pH for Crop Production
g. Liming Materials

h. Benefits of Lime
i. Liming Program
j. Soil Acidification
k. Saline and Sodic Soils

5. Nitrogen (Chapter 4) - 3 lectures on soil, one lecture on plants
a. The N Cycle
b. Nitrogen Additions from the Atmosphere
c. Biological N fixation
d. Forms of Soil N
e. Nitrogen Transformations in Soil
1. N mineralization
2. N immobilization
3. Nitrification
4. Ammonium Fixation
f. Nitrogen Losses from Soil
1. Nitrate Leaching
2. Gaseous Losses
g. Nitrogen Sources for Crop Production
1. Organic forms
2. Inorganic forms

h. Forms of N in Plants
i. Nitrogen transport in plants
j. Nitrogen metabolism
1. Nitrate versus ammonium
2. Nitrate reduction
3. Incorporation into organic compounds
k. Functions of N in the plant
l. Deficiency and toxicity symptoms

6. Phosphorus and Potassium in Soil (Chapters 5 and 6) - 3 lectures
a. The P cycle
b. Forms of P in Soil
- Soil Solution P
- Organic Soil P
- P mineralization
- phosphatase
- Inorganic Soil P
c. Factors affecting P fixation
d. P Sources for Crop Production
1. Organic Forms
2. Inorganic Forms

e. The K cycle in soil
f. Forms of K in Soil

- Soil Solution K
- Exchangeable K
- Mineral K
- Nonexchangeable K

g. Leaching of K
h. Factors affecting K availability
I. Sources of K for Crop Production
1. Organic K
2. Synthetic Inorganic K forms

7. Phosphorus and Potassium in Plants (Chapters 5 and 6) - 1 lecture
a. Forms of P in Plants
b. P transport in Plants
c. Functions of P in plants
d. Deficiency and Toxicity Symptoms
e. K transport in Plants
f. Functions of K in plants
1. Stomates and K
2. Cell elongation and meristematic growth
3. Translocation of photosynthates
4. Enzyme activation
g. Deficiency and Toxicity Symptoms

8. Sulfur, Calcium, and Magnesium in Soil (Chapter 7) - 1 lecture
a. The S cycle in soil
b. Forms of S in Soil
- Soil Solution S
- Adsorbed S
- SO42- Co-precipitated with CaCO3
- Reduced Inorganic S
- Organic S
- Residual S

c. Sulfur Mineralization/Immobilization
d. Sulfur Volatilization
e. Sources of S for Crop Production
1. Organic S
2. Synthetic Inorganic S forms
f. The Ca cycle
g. Forms of Ca in Soil
- Soil Solution S
- Exchangeable Ca
- Ca minerals

h. Sources of Ca for Crop Production

i. The Mg cycle
j. Forms of Mg in Soil

- Soil Solution Mg
- Exchangeable Mg
- Mg minerals

k. Sources of Mg for Crop Production

9. Sulfur, Calcium, and Magnesium in Plants (Chapter 7) - 1 lecture

a. Forms of S in Plants
- Sulfate reduction

b. S Transport in Plants
c. Functions of S in plants
d. Sulfur Deficiency and Toxicity Symptoms

d. Forms of Ca in Plants
f. Ca Transport in Plants
g. Functions of Ca in Plants
h. Calcium Deficiency and Toxicity Symptoms

i. Forms of Mg in Plants
j. Mg Transport in Plants
k. Functions of Mg in Plants
- Mg and chlorophyll

l. Magnesium Deficiency and Toxicity Symptoms

10. Micronutrients in Soil (Chapter 8) - 1 lecture

Iron (Fe)

a. The Fe cycle
b. Forms of Fe in Soil
- Mineral Fe
- Soil Solution Fe

c. Sources of Fe for Crop Production
1. Organic Sources
2. Inorganic Sources

Zinc (Zn)

a. The Zn cycle
b. Forms of Zn in Soil
- Mineral Zn
- Adsorbed Zn
- Soil Solution Zn

c. Sources of Zn for Crop Production
1. Organic Sources
2. Inorganic Sources

Copper (Cu)

a. The Cu cycle
b. Forms of Cu in Plants

c. Forms of Cu in Soil
    - Mineral Cu
    - Adsorbed Cu
    - Soil Solution Cu
d. Sources of Cu for Crop Production
    1. Organic Sources
    2. Inorganic Sources

Manganese (Mn)
a. The Mn cycle
b. Forms of Mn in Soil
    - Mineral Mn
    - Adsorbed Mn
    - Soil Solution Mn
c. Sources of Mn for Crop Production
    1. Organic Sources
    2. Inorganic Sources

Boron (B)
a. The B cycle
b. Forms of B in Soil
    - Mineral B
    - Adsorbed B
    - Soil Solution B
    - Organic Matter B
c. Sources of B for Crop Production
    1. Organic Sources
    2. Inorganic Sources

Molybdenum
a. The Mo cycle
b. Forms of Mo in Soil
    - Mineral Mo
    - Adsorbed Mo
    - Soil Solution Mo
    - Organic Matter Mo
c. Sources of B for Crop Production
    1. Organic Sources
    2. Inorganic Sources

Chlorine
a. The Cl cycle
b. Forms of Cl in Soil
c. Sources of Cl for Crop Production
    1. Organic Sources
    2. Inorganic Sources

Nickel
a. The Ni cycle
b. Forms of Ni in Soil
c. Sources of Ni for Crop Production
    1. Organic Sources
    2. Inorganic Sources

11. Micronutrients in Plants (Chapter 8) - 1 lecture
Iron (Fe)
a. Forms of Fe in Plants
    - Fe reduction
b. Fe Transport in Plants
c. Functions of Fe in Plants
    - Fe and chlorophyll
d. Iron Deficiency and Toxicity Symptoms

Zinc (Zn)
a. Forms of Zn in Plants
b. Zn Transport in Plants
c. Functions of Zn in Plants
    - Enzyme activation
    - Zn and chlorophyll
d. Zinc Deficiency and Toxicity Symptoms

Copper (Cu)
a. Forms of Cu in Plants
b. Cu Transport in Plants
c. Functions of Cu in Plants
    - Cu reduction
    - Cu and photosynthesis
d. Copper Deficiency and Toxicity Symptoms

Manganese (Mn)
a. Forms of Mn in Plants
b. Mn Transport in Plants
c. Functions of Mn in Plants
    - Cu and photosynthesis
d. Manganese Deficiency and Toxicity Symptoms

Boron (B)
a. Forms of B in Plants
b. B Transport in Plants
c. Functions of B in Plants
    - Cell Walls
    - Membranes

d. Boron Deficiency and Toxicity Symptoms

Molybdenum (Mo)
a. Forms of Mo in Plants
- Mo and nitrate reduction
b. Mo Transport in Plants
c. Functions of Mo in Plants
- Cell Walls
- Membranes
d. Mo Deficiency and Toxicity Symptoms

Chlorine (Cl)
a. Forms of Cl in Plants
b. Cl Transport in Plants
c. Functions of Cl in Plants
- Photosynthesis
d. Chlorine Deficiency and Toxicity Symptoms

Nickel (Ni)
a. Forms of Ni in Plants
b. Ni Transport in Plants
c. Functions of Ni in Plants
- Ni and Urea
d. Nickel Deficiency and Toxicity Symptoms

Other beneficial elements
-Sodium
- Silicon
- Cobalt
- Selenium
- Aluminum

12. Evaluation of Soil Fertility and Plant Nutrition (Chapter 9) - 4 lectures (2 on plant analysis, 2 on soil analysis)
1. Nutrient Deficiency Symptoms of Plants
2. Plant Analysis
   a. Field Tests
   b. Lab Analysis
3. Biological Tests
4. Soil Analysis
   a. Sample collection
   b. Soil extraction
   c. Soil test interpretation
   d. Estimation of amount of nutrient required

13. Nutrient Management (Chapters 10, 11. 12) - 2 lectures

a. Crop Characteristics
b. Soil Characteristics
c. Nutrient Placement
    - Preplant
    - At Planting
    - Postplant
d. Specific Recommendations
    - Nitrogen
    - Phosphorus
    - Potassium
e. Fertilization with Manure
    - Benefits
    - Problems
f. Fertilization with Sludge
g. Nutrient management in ornamental horticulture - 2 lectures
    - soil amendments
    - Incorporation into the growing medium
    - Slow release fertilizers
    - Water soluble fertilizers
    - Application methods

14. Agricultural Productivity and Environmental Quality (Chapter 13) - 1 lecture
    a. Sustainable Agriculture
    b. Soil and Crop Productivity
    c. Environmental Quality
        - Soil erosion (silt)
        - Leaching (nitrate, P)
        - Runoff (N, P)