Soil Fertility / Soil-Plant Relations  
Stephen F. Austin State University  
Department of Agriculture  
**Semester:** Spring 2018

### Courses:
- Soil Fertility (AGN 434) 2 credits
- Soil Fertility Lab (AGN 434L) 1 credit
- Soil-Plant Relations (AGN 508) 3 credits

### Location and time:
- **Lecture:** R 3 PM – 6 PM, Agriculture 108
- **Laboratory:** W 3 PM – 4:50 PM, Agriculture 109

### Information:
- https://d2l.sfasu.edu (D2L)
- All course information, supporting documents and scores for this course will be maintained on this website so check the site regularly for updates. All course related communication will be conducted via your SFA email (@jacks.sfasu.edu), not the d2l email. Lecture and lab fees are $3 and $10, respectively.

### Instructor:
- Dr. Franta Majs
- majsf@sfasu.edu (preferred contact)
- 936-468-4390 office phone

### Office hours:
- @ Agriculture 122A by appointment, or
- MWF 10:00 AM – 11:30 AM, TR 09:00 AM – 10:00 AM

### Instructional Methods:
- The classroom component of the course will consist of lectures augmented with visuals aids. Lecture is a time when I can explain important concepts in the study of soil fertility and plant nutrition. Some concepts learned in lecture will be further illustrated in laboratory. Attending lecture is thus very important.

### Required Materials:
- non-programmable, non-graphing scientific calculator, cell phone app cannot be used

#### Textbook:
- **Soil Fertility and Fertilizers – 8th edition**
  - Authors: Havlin, Tisdale, Nelson, and Beaton
  - Publisher: Pearson Education

### Useful references (i.e. not required):
Course Description: This course builds upon foundation of knowledge learned in Soil Science (AGN 331) or similar courses, and prerequisites therein, and provides students with a comprehensive understanding of soil plant relationship, soil fertility, plant nutrition, and nutrient management. Emphasis will be given to 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, and environmental quality associated with application of fertilizers.

Course will follow this tentative Topical Outline:

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 in Soil and Plants (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 and 11)
14. Nutrients and Environmental Quality (Chapter 12)

Learning Outcomes: Upon completing this course students will:

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.

University Policies:

Academic Integrity is a responsibility of all university faculty and students. Faculty members promote academic integrity in multiple ways including instruction on the components of academic honesty, as well as abiding by university policy on penalties for cheating and plagiarism. Academic Dishonesty includes both cheating and plagiarism. Cheating includes but is not limited to (1) using or attempting to use unauthorized materials to aid in achieving a better grade on a component of a class; (2) the falsification or invention of any information, including citations, on an assigned exercise; and/or (3) helping or attempting to help another in an act of cheating or plagiarism. Plagiarism is presenting the words or ideas of another person as if they were your own. Examples of plagiarism are (1) submitting an assignment as if it were one’s own work when, in fact, it is at least partly the work of another; (2) submitting a work that has been purchased or otherwise obtained from an Internet source or another source; and (3) incorporating the words or ideas of an author into one’s paper without giving the author due credit. Please read the complete policy at www.sfasu.edu/policies/academic_integrity.asp. Academic Dishonesty could result in a letter grade of F.
Disability Accommodations: To obtain disability related accommodations, alternate formats and/or auxiliary aids, students with disabilities must contact the Disability Services (DS), Human Services Building, Room 325, 936-468-3004 as early as possible in the semester. Once verified, the DS will notify the course instructor and outline the accommodation and/or auxiliary aids to be provided. Failure to request services in a timely manner may delay your accommodations. For additional information, go to www.sfasu.edu/disabilityservices/. Accommodations cannot be provided retroactively.

Student Code of Conduct: Classroom behavior should not interfere with the instructor’s ability to conduct the class or the ability of other students to learn from the instructional program. Unacceptable or disruptive behavior will not be tolerated. Students who disrupt the learning environment may be asked to leave class and may be subject to judicial, academic or other penalties. This policy applies to all instructional forums, including electronic, classroom, labs, discussion groups, field trips, etc. The instructor shall have full discretion over what behavior is appropriate/inappropriate in the classroom. Students who perform poorly on class projects/exams and do not attend class regularly may be referred to the iCare: Early Alert Program at SFA. Information regarding the iCare program is found at www.sfasu.edu/judicial/earlyalert.asp or call the office at 936-468-2703.

University Closings / Cancelled Classes: When SFA State University campus is closed, students, faculty and staff will be notified via emergency notification system; update your contact information! If classes are meeting, but you feel that you cannot find a safe way to get to class, you should notify the Instructor as soon as possible.

Course Policies:

Electronic Devices: The use of any electronic devices, including cell phones, during class is not permitted. Especially during examination there will be no electronic devices within reach or in sight. During lectures, electronic devices may be used only if required for compliance with a directive by The Office of Disability Services or for note taking.

Food and Drink: There should be no food in the classroom. Beverages are permitted only in spill-proof containers. No beverages are permitted in the classroom or laboratory when any chemicals are used.

Attendance, Unforeseen Emergency, and Preparation: Students are expected to read the assigned sections of the textbook or other material prior to class, and attend class and actively participate*. You are responsible to inform your instructor concerning any expected absences ahead of time. In the event of an unforeseen emergency on an exam day, contact me as soon as possible. You may be asked to document your excuse. Acceptable unforeseen emergencies include severe illness, family emergencies, or other unavoidable events including dangerous weather conditions and serious car accidents. Proper communication MAY create a possibility to make up missed exams.

*Participation = engage in discussion and in class assignments, being on time, paying attention during class, keeping good lecture notes, and keeping laboratory notebook.

Laboratory: There will be thirteen laboratory periods during the semester. Some laboratory exercises or assignments may take more than one lab period. Your overall lab/assignment score will be calculated on highest eleven scores (two lowest scores will be dropped); however, know that you must complete at least ten assigned periods to pass the course. The laboratory is designed to help you learn about concepts presented in lecture and in the readings. Because I want you to be able to use these terms and concepts
in real world situations, description of demonstrations and your laboratory experiments will require use of these terms and concepts. Every student is expected to keep laboratory notebook and may be asked to present their notes to the instructor for evaluation. Laboratory reports are to be prepared in Microsoft Word. All laboratory reports, including tables and figures, are to be prepared with great care, and attention to accuracy and aesthetic values. Please submit your work via D2L before the deadline. Late assignments are subject to a 10% score reduction per day with a 50% maximum (i.e. five days’ worth). No work will be accepted after the day five and student will receive zero points.

Testing: You will learn many new terms and concepts in this class. Because I want your learning to be incremental, you will be tested frequently, at the end of each lecture block, on your understanding of these terms and concepts. In addition, three lecture exams will be given and a final. All exams will be comprehensive. Lecture exams will take 50 minutes and final exam 120 minutes. The exams are closed book. Makeup lecture exams will be allowed only with preapproval of the instructor and for acceptable reason, though the format may be different, i.e. oral exam. Final exam has been scheduled for Wednesday, 10 May 2018, 1 PM – 3 PM; www.sfasu.edu/registrar/.

Grading: Laboratory, Assignments/Problem sets 15% Completion 10/13
Quizzes 15%
Exams: 10% + 15% + 20% 45%
Final exam 25%
Total score 100%

Letter grade: A > 90.0% B > 80.0% C > 70.0% D > 60.0% F < 60.0%
Incomplete – Ordinarily, at the discretion of the instructor of record and with the approval of the academic chair/director, a grade of WH will be assigned only if the student cannot complete the course work because of unavoidable circumstances. Students must complete the work within one calendar year from the end of the semester in which they receive a WH, or the grade automatically becomes an F. If students register for the same course in future terms the WH will automatically become an F and will be counted as a repeated course for the purpose of computing the grade point average.

Amending this Syllabus: The instructor may initiate changes to this syllabus. Any changes will be clearly communicated via email and posted on D2L. The instructor reserves the right to make minor changes to the course schedule (attached) and to make changes to the grading policy that are of benefit to ALL students enrolled in the course. Neither of these two types of changes is subject to student vote/approval.

Tentative Course Schedule:

<table>
<thead>
<tr>
<th>Week</th>
<th>Date</th>
<th>Activity</th>
<th>Week</th>
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<th>Activity</th>
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<tbody>
<tr>
<td>1</td>
<td>18 Jan</td>
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<td>9</td>
<td>15 Mar</td>
<td>Spring break – No classes</td>
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<td>2</td>
<td>25 Jan</td>
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<td>10</td>
<td>22 Mar</td>
<td>Last day to withdraw w/out “W”</td>
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<td>3</td>
<td>1 Feb</td>
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<td>11</td>
<td>29 Mar</td>
<td>No class – Easter Holiday</td>
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<td>4</td>
<td>8 Feb</td>
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<td>12</td>
<td>5 Apr</td>
<td>2nd lecture exam</td>
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<td>5</td>
<td>15 Feb</td>
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<td>13</td>
<td>12 Apr</td>
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<td>6</td>
<td>22 Feb</td>
<td>1st lecture exam</td>
<td>14</td>
<td>19 Apr</td>
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<td>7</td>
<td>1 Mar</td>
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<td>15</td>
<td>26 Apr</td>
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<td>3 May</td>
<td>3rd lecture exam</td>
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<td>17</td>
<td>10 May</td>
<td>Final exam, 1 PM – 3 PM</td>
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Tentative Lecture Schedule:

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
      i. Clay Minerals
      ii. Organic Matter
   c. Cation Exchange Capacity
      i. Common cations
      ii. Units
      iii. CEC determination
      iv. Base saturation
   d. Anion Exchange Capacity
   e. Movement of Ions from Soil to Root
      i. Root Interception
      ii. Mass Flow
      iii. Diffusion

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

4. Soil Acidity and Alkalinity (Chapter 3): 2 lectures
   a. Acid and Base concepts
   b. Soil acidity

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
      i. N mineralization
      ii. N immobilization
      iii. Nitrification
      iv. Ammonium Fixation
   f. Nitrogen Losses from Soil
      i. Nitrate Leaching
      ii. Gaseous Losses
   g. Nitrogen Sources for Crop Production
      i. Organic forms
      ii. Inorganic forms
   h. Forms of N in Plants
   i. Nitrogen transport in plants
   j. Nitrogen metabolism
      i. Nitrate versus ammonium
      ii. Nitrate reduction
      iii. 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
      i. Soil Solution P
      ii. Organic Soil P
      iii. P mineralization
iv. Phosphatase
v. Inorganic Soil P
c. Factors affecting P fixation
d. P Sources for Crop Production
   i. Organic Forms
   ii. Inorganic Forms
e. The K cycle in soil
f. Forms of K in Soil
   i. Soil Solution K
   ii. Exchangeable K
   iii. Mineral K
   iv. Nonexchangeable K
g. Leaching of K
h. Factors affecting K availability
   i. Sources of K for Crop Production
      i. Organic K
      ii. 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
      i. Stomates and K
      ii. Cell elongation and meristematic growth
      iii. Translocation of photosynthates
      iv. 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
      i. Soil Solution S
      ii. Adsorbed S
      iii. $\text{SO}_4^{2-}$ Co-precipitated with $\text{CaCO}_3$
      iv. Reduced Inorganic S
      v. Organic S
      vi. Residual S
c. Sulfur Mineralization/Immobilization
d. Sulfur Volatilization
e. Sources of S for Crop Production
      i. Organic S
      ii. Synthetic Inorganic S forms
f. The Ca cycle
g. Forms of Ca in Soil
   i. Soil Solution S
   ii. Exchangeable Ca
   iii. Ca minerals
h. Sources of Ca for Crop Production
   i. The Mg cycle
j. Forms of Mg in Soil
   i. Soil Solution Mg
   ii. Exchangeable Mg
   iii. 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
      i. Sulfate reduction
   b. S Transport in Plants
c. Functions of S in plants
d. Sulfur Deficiency and Toxicity Symptoms
e. 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
      i. 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
      i. Mineral Fe
      ii. Soil Solution Fe
c. Sources of Fe for Crop Production
      i. Organic Sources
      ii. Inorganic Sources
   Zinc (Zn)
   a. The Zn cycle
   b. Forms of Zn in Soil
      i. Mineral Zn
      ii. Adsorbed Zn
      iii. Soil Solution Zn
c. Sources of Zn for Crop Production
      i. Organic Sources
ii. Inorganic Sources

Copper (Cu)
   a. The Cu cycle
   b. Forms of Cu in Plants
      i. Mineral Cu
      ii. Adsorbed Cu
      iii. Soil Solution Cu
   c. Forms of Cu in Soil
      i. Mineral Cu
      ii. Adsorbed Cu
      iii. Soil Solution Cu
   d. Sources of Cu for Crop Production
      i. Organic Sources
      ii. Inorganic Sources

Manganese (Mn)
   a. The Mn cycle
   b. Forms of Mn in Soil
      i. Mineral Mn
      ii. Adsorbed Mn
      iii. Soil Solution Mn
   c. Sources of Mn for Crop Production
      i. Organic Sources
      ii. Inorganic Sources

Boron (B)
   a. The B cycle
   b. Forms of B in Soil
      i. Mineral B
      ii. Adsorbed B
      iii. Soil Solution B
      iv. Organic Matter B
   c. Sources of B for Crop Production
      i. Organic Sources
      ii. Inorganic Sources

Molybdenum (Mo)
   a. The Mo cycle
   b. Forms of Mo in Soil
      i. Mineral Mo
      ii. Adsorbed Mo
      iii. Soil Solution Mo
      iv. Organic Matter Mo
   c. Sources of Mo for Crop Production
      i. Organic Sources
      ii. Inorganic Sources

Nickel (Ni)
   a. The Ni cycle
   b. Forms of Ni in Soil
   c. Sources of Ni for Crop Production
      i. Organic Sources
      ii. Inorganic Sources

11. Micronutrients in Plants (Chapter 8): 1 lecture

Iron (Fe)
   a. Forms of Fe in Plants
      i. Fe reduction
   b. Fe Transport in Plants
   c. Functions of Fe in Plants
      i. 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
      i. Enzyme activation
      ii. 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
      i. Cu reduction
      ii. 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
      i. 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
      i. Cell Walls
      ii. Membranes
   d. Boron Deficiency and Toxicity Symptoms

Molybdenum (Mo)
   a. Forms of Mo in Plants
      i. Mo and nitrate reduction
   b. Mo Transport in Plants
c. Functions of Mo in Plants  
   i. Cell Walls  
   ii. 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  
   i. 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  
   i. Ni and Urea  
d. Nickel Deficiency and Toxicity Symptoms  

Other 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)  
a. Nutrient Deficiency Symptoms of Plants  
b. Plant Analysis  
   i. Field Tests  
   ii. Lab Analysis  
c. Biological Tests  
d. Soil Analysis  
   i. Sample collection  
   ii. Soil extraction  
   iii. Soil test interpretation  
   iv. Estimation of amount of nutrient required  

13. Nutrient Management (Chapters 10, 11): 2 lectures  
a. Crop Characteristics  
b. Soil Characteristics  
c. Nutrient Placement  
   i. Pre-planting  
   ii. At Planting  
   iii. Post-planting  
d. Specific Recommendations  
   i. Nitrogen  

ii. Phosphorus  
iii. Potassium  
e. Fertilization with Manure  
   i. Benefits  
   ii. Problems  
f. Fertilization with Sludge  
g. Nutrient management in ornamental horticulture (2 lectures)  
   i. Soil amendments  
   ii. Incorporation into the growing medium  
   iii. Slow release fertilizers  
   iv. Water soluble fertilizers  
   v. Application methods  

14. Agricultural Productivity and Environmental Quality  
   (Chapter 12): 1 lecture  
a. Sustainable Agriculture  
b. Soil and Crop Productivity  
c. Environmental Quality  
   i. Soil erosion (silt)  
   ii. Leaching (nitrate, P)  
   iii. Runoff (N, P)