NORTH CAROLINA STATE UNIVERSITY
GRADUATE COURSE ACTION FORM

NOTE: Click once on shaded fields to type data. To check boxes, right click at box, click “Properties”, and click “Checked” under Default Values.

DEPARTMENT/PROGRAM: Crop Science
COURSE PREFIX/NUMBER: CS 714
PREVIOUS PREFIX/NUMBER: CS 590C
DATE OF LAST ACTION:
COURSE TITLE: Crop Physiology: Plant Response to Environment
ABBREVIATED TITLE: CROP PHYSIOLOGY
SCHEDULING: Fall ☑ Spring ☐ Summer ☐ Every Year ☑ Alt. Year Odd ☐ Alt. Year Even ☐ Other ☐
COURSE OFFERED: BY DISTANCE EDUCATION ONLY ☐ ON CAMPUS ONLY ☒ BOTH ON CAMPUS AND BY DISTANCE EDUCATION ☐
CREDIT HOURS: 3.0
CONTACT HOURS: Lecture/Recitation 3.0 Seminar ☐ Laboratory ☐ Problem ☐
Studio ☐ Independent Study/Research ☐ Internship/Practicum/Field Work ☐
GRADING: ABCDF ☑ S/U ☐
INSTRUCTOR (NAME/RANK): Randy Wells/Professor
Graduate Faculty Status: Associate ☐ Full ☑
ANTICIPATED ENROLLMENT: Per semester 12 Max. Section 20 Multiple sections Yes ☐ No ☐
PREREQUISITE(S): BO 321 or BO 421, CH 223
COREQUISITE(S):
PRE/Corequisite For:
RESTRICTIVE STATEMENT:
CURRICULA/MINORS:
Required ☐
Qualified Elective ☐
PROPOSED EFFECTIVE DATE: Fall 2005

CATALOG DESCRIPTION (limit to 80 words): Examines interactions between plants and the environment. Light environment, plant canopy development, photosynthesis, source-sink relations, growth analysis, growth regulation, water relations, and environmental stresses are addressed.

RECOMMENDED BY:

Department Head/Director of Graduate Programs ☐
Chair, College Graduate Studies Committee ☐
College Dean(s) ☐
Dean of the Graduate School ☐

DOCUMENTATION AS REQUIRED
Please number all document pages

Course Justification ☑
Proposed Revision(s) with Justification ☐
Student Learning Objectives ☑
Enrollment for Last 5 Years ☑
New Resources Statement ☑
Consultation with other Departments ☑
Syllabus (Old and New) ☑
Explanation of differences in requirements of dual-level courses ☐

APPROVED EFFECTIVE DATE:

Date

Type of Proposal:
New Course ☑
Drop Course ☐
Course Revision ☐
Dual-Level Course ☐

Revision:
Content ☐
Prefix/Number ☐
Title ☐
Abbreviated Title ☐
Credit Hours ☐
Contact Hours ☐
Grading Method ☐
Pre-Corequisites ☐
Restrictive Statement ☐
Description ☐
Scheduling ☐
I. Course Justification:

This course is intended for Ph.D. and M.S. students in the plant sciences. It will address environmental aspects of plant physiology and the effect of environment on crop plants in the varied growth environments. In addition, research methods for field-oriented physiology will be covered. No other course offered at this institution addresses these aspects of whole plant physiology. The course is a useful addition to the course of work for students in crop science, soil science, horticulture, botany, entomology, plant pathology, forestry and all other sciences.

II. Student Learning Outcomes:

Upon completion of this course students will be able to:

1. Develop a theoretical framework and vocabulary for understanding environmental factors that impact plants in field situations.

2. Comprehend the impacts of environmental stresses on plant growth and yield.

3. Understand factors that determine plant productivity and how environment affects them.

4. Design research experiments that utilize measurements to examine plant response to environmental factors.

III. Enrollment History as a Special Problem Course

<table>
<thead>
<tr>
<th>YEAR</th>
<th>Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000-2001</td>
<td>11</td>
</tr>
<tr>
<td>2001-2002</td>
<td>9</td>
</tr>
<tr>
<td>2002-2003</td>
<td>4</td>
</tr>
<tr>
<td>2003-2004</td>
<td>15</td>
</tr>
<tr>
<td>2004-2005</td>
<td>13</td>
</tr>
<tr>
<td>mean</td>
<td>10.4</td>
</tr>
</tbody>
</table>

IV. Resources:

Dr. Wells has a 26 % academic appointment. He has taught the course as a special problem course over the last eight years. Dr. Fiscus is a USDA-ARS employee and has permission to teach the nine lectures that are indicated. No other lecturers are lecturing on more than three dates. No other resources are required.
V. Consultation with Outside Departments:

The course is truly unique both within the college and the university. Presently, there are no graduate level plant physiology courses offered in the College of Agriculture and Life Sciences or the University.

The Directors of Graduate Programs for graduate programs in Biological and Agricultural Engineering, Botany, Genetics, Horticultural Science, Plant Pathology, Entomology, Soil Science, and Forestry were provided a list of topics and other supporting information. Comments and concerns were requested. A number of comments were returned and they are attached.

VI. Syllabus:

Instructor: Randy Wells

Office: 2210 Williams Hall
Telephone: 515-4062
Email: randy_wells@ncsu.edu
Class Time: M,W,F; 9:10-10:00 AM
Office Hours: 10:00-Noon; M,W,F

Prerequisites: BO 321 or BO 421, CH 223 or equivalent

Student Learning Outcomes:
Upon completion of this course students will be able to:

1. Develop a theoretical framework and vocabulary for understanding environmental factors that impact plants in field situations.

2. Comprehend the impacts of environmental stresses on plant growth and yield.

3. Interpret factors that determine plant productivity and how environment affects them.

4. Design research experiments that utilize measurements to examine plant response to environmental factors.

Textbook(s): None

Subjects Covered:

I. Physical Environment
   A. Radiation
B. Temperature
C. Atmospheric Components

II. Growth & Development of Crop Plants
A. Photosynthesis
   1. Overview: Photosynthesis
   2. Field Processes: Single leaf vs. Canopy rates
   3. Environmental Influences
   4. Photorespiration and Photoinhibition

B. Vegetative Development
   1. Development of the leaf canopy
      a. Importance of early leaf area
      b. Leaf area index
      c. Light interception
      d. Canopy extinction coefficients
      e. Growth analysis

C. Compound Interest Law and Plant Growth
D. Plant-to-plant interactions
   1. Light spectral balance and plant morphological changes
   2. Phytochrome, nature’s light switch
   3. Mutual shading of leaves and its effect on leaf function

E. Plant population effects on plant growth
   1. Individual plant vs. Community responses

F. Plant Growth Regulators
   1. Auxin
   2. Gibberelins
   3. Cytokinins
   4. Abscisic Acid
   5. Ethylene
   6. Brassinosteroids
   7. Salicylates
   8. Jasmonates

III. Reproductive Development & Determination of Yield
A. Source-sink relationships
   1. Mass flow
   2. Sucrose gradients
   3. Source-sink experiments

B. Biological versus fruit yield
C. Harvest index and dry matter allocation
D. Photosynthesis and yield

IV. Plant senescence: Late Season Implications
A. What is senescence?
B. Monocarpic vs. progressive Senescence
C. Leaf area duration and late-season photosynthesis

V. Biological Nitrogen Fixation
A. Nitrogen cycle
B. Symbiotic nitrogen fixation
C. Nitrogenase
D. Leghemoglobin
E. Measurement

VI. Secondary Products
A. Alkaloids
B. Glycosides
C. Isoprenoids and terpenes
D. Plant amines
E. Phenolics
F. Lignin
G. Polyisoprenes

VII. Limitations to Growth and Yield: Plant - Water Relations
A. Fundamental questions
B. Soil-Plant atmosphere continuum
   1. The pathway
   2. Anatomy
C. General Transport Laws
   1. Newton's first law and friction
   2. Empirical transport laws
   3. Driving forces, fluxes, conductances and resistances
D. The potential concept
   1. Free energy
   2. The chemical potential
   3. Partial molar quantities
   4. The water potential
   5. Implications
E. Xylem Pressure potential
   1. Surface tension and capillarity
   2. Generation of pressure potential
   3. Measurement of xylem pressure potential
F. Measuring water potential
   1. The thermocouple psychrometer
   2. The pressure chamber
   3. Equilibrium techniques
G. Simple Cell Water Relations
   1. Tissue osmotic and turgor potentials
   2. The Hvler diagram
   3. Potential volume analysis with the pressure chamber
H. Total flux of the water component
   1. Diffusion and convection
   2. Use and misuse of the potential concept
   3. Which way will water go and how fast?
I. Transpiration
   1. The driving forces
   2. Stomatal control
VIII. Field Effects of Water Limitation

A. Whole plant response to water deficits
   1. Dry matter production
   2. Stand establishment
   3. Carbon and nitrogen assimilation and utilization
   4. Modulation of leaf area development by plant water deficit
   5. Regulation of reproductive capacity
   6. Crop improvement for drought resistance - traditional and biotech approaches

B. Crop management and environmental manipulations for efficient water use
   1. Relation between production (seed and biomass) and water use
   2. Crop characteristics related to water use
   3. Crop manipulation
      a. Intended
      b. Inadvertent (including elevated CO₂)

C. Yield, quality, and water-use relationships
   1. Predicting yield from water use
   2. Problems of relating grain yield to transpiration (or evaportranspiration)
   3. Irrigation options to avoid critical stress
   4. Water resource management in a diverse society
<table>
<thead>
<tr>
<th>LECTURE</th>
<th>TOPIC</th>
<th>INSTRUCTOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Overview, review course requirements</td>
<td>Wells</td>
</tr>
<tr>
<td>2</td>
<td>Physical environment: radiation</td>
<td>Wells</td>
</tr>
<tr>
<td>3</td>
<td>Physical environment: radiation, temperature, humidity</td>
<td>Wells</td>
</tr>
<tr>
<td>4</td>
<td>Physical environment: temperature, humidity (cont)</td>
<td>Wells</td>
</tr>
<tr>
<td>5</td>
<td>Canopy development and light interception</td>
<td>Wells</td>
</tr>
<tr>
<td>6</td>
<td>Plant spatial relationships and growth</td>
<td>Wells</td>
</tr>
<tr>
<td>7</td>
<td>No Class - Labor Day Holiday</td>
<td>Wells</td>
</tr>
<tr>
<td>8</td>
<td>Photosynthesis &amp; Photorespiration</td>
<td>Wells</td>
</tr>
<tr>
<td>9</td>
<td>Photosynthesis: Measurement with IRGA</td>
<td>Wells</td>
</tr>
<tr>
<td>10</td>
<td>Growth analysis: Crop growth rate, Relative growth rate</td>
<td>Wells</td>
</tr>
<tr>
<td>11</td>
<td>Growth analysis Net assim. rate; LA expansion rate</td>
<td>Wells</td>
</tr>
<tr>
<td>12</td>
<td>Source-sink relationships &amp; methods of study</td>
<td>Wells</td>
</tr>
<tr>
<td>13</td>
<td>Source-sink (cont)</td>
<td>Wells</td>
</tr>
<tr>
<td>14</td>
<td>Harvest Index, Yield and components of yield</td>
<td>Wells</td>
</tr>
<tr>
<td>15</td>
<td>Phytochrome and photomorphogenesis</td>
<td>Wells</td>
</tr>
<tr>
<td>16</td>
<td>Phytochrome (cont)</td>
<td>Wells</td>
</tr>
<tr>
<td>17</td>
<td>Phytochrome (cont) Photoperiodism</td>
<td>Wells</td>
</tr>
<tr>
<td>18</td>
<td>Plant growth regulation: GA, Auxin</td>
<td>Wells</td>
</tr>
<tr>
<td>19</td>
<td>Plant growth regulation: ABA, Cytokinin</td>
<td>Wells</td>
</tr>
<tr>
<td>20</td>
<td><strong>TEST I</strong> (all material to date)</td>
<td>Wells</td>
</tr>
<tr>
<td>21</td>
<td>Plant growth regulation: Brassinosteroids, JA</td>
<td>Wells</td>
</tr>
<tr>
<td>22</td>
<td>Biological nitrogen fixation</td>
<td>Wells</td>
</tr>
<tr>
<td>23</td>
<td>Plant senescence: Symptoms</td>
<td>Wells</td>
</tr>
<tr>
<td>24</td>
<td>Plant senescence: monocarpic vs. progressive</td>
<td>Wells</td>
</tr>
<tr>
<td></td>
<td>Topic</td>
<td>Author</td>
</tr>
<tr>
<td>---</td>
<td>----------------------------------------------------------------------</td>
<td>----------</td>
</tr>
<tr>
<td>25</td>
<td>Soil-Plant-Atmosphere I. Analytical Overview</td>
<td>Fiscus</td>
</tr>
<tr>
<td>26</td>
<td>Forces and fluxes</td>
<td>Fiscus</td>
</tr>
<tr>
<td>27</td>
<td>The water potential (osmotic and pressure components)</td>
<td>Fiscus</td>
</tr>
<tr>
<td>28</td>
<td>Cell wall matrix and capillary forces</td>
<td>Fiscus</td>
</tr>
<tr>
<td>29</td>
<td>Transpiration and vapor pressure gradients</td>
<td>Fiscus</td>
</tr>
<tr>
<td>30</td>
<td>Laminar flow and the xylem system</td>
<td>Fiscus</td>
</tr>
<tr>
<td>31</td>
<td>Cell and tissue equilibria</td>
<td>Fiscus</td>
</tr>
<tr>
<td>32</td>
<td>Flow through membranes</td>
<td>Fiscus</td>
</tr>
<tr>
<td>33</td>
<td>Soil-Plant-Atmosphere II: Synthetic overview</td>
<td>Fiscus</td>
</tr>
<tr>
<td>34</td>
<td>Plant response to drought</td>
<td>Patterson</td>
</tr>
<tr>
<td>35</td>
<td>Plant response to drought (cont)</td>
<td>Patterson</td>
</tr>
<tr>
<td>36</td>
<td>Plant response to drought (cont)</td>
<td>Patterson</td>
</tr>
<tr>
<td>37</td>
<td>TEST II (all materials since last test)</td>
<td>Patterson</td>
</tr>
<tr>
<td>38</td>
<td>Other plant stresses - high temperature</td>
<td>Wells</td>
</tr>
<tr>
<td>39</td>
<td>Other plant stresses - low temperature</td>
<td>Wells</td>
</tr>
<tr>
<td>40</td>
<td>Other plant stresses - atmospheric pollutants</td>
<td>Wells</td>
</tr>
<tr>
<td>41</td>
<td>Secondary products: Flavinoids, phenolics, terpenes, etc.</td>
<td>Wells</td>
</tr>
<tr>
<td>42</td>
<td><strong>Crop Physiology Jeopardy</strong></td>
<td>Wells</td>
</tr>
<tr>
<td>43</td>
<td><strong>Crop Physiology Double Jeopardy</strong></td>
<td>Wells</td>
</tr>
</tbody>
</table>
# Projected Schedule of Reading Assignments

**Journal Articles and Book Chapters:**
(Articles and book chapters can be found on E-reserve at the library web site)

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reference</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------------------------------------------------</td>
</tr>
<tr>
<td>14</td>
<td>Chory, Chatterjee, Cook, Elich, Fankhause, Nagpal, Neff, Pepper, Poole, Reed, and Vitart. 1996. From seed germination to flowering, light controls plant development via the pigment Phytochrome. Proceedings of National Academy of Science 93: 12066-12071</td>
</tr>
<tr>
<td>16</td>
<td>Wells and Meredith. 1984. Comparative growth of obsolete and modern cotton cultivars. III. Relationship of yield to observed growth characteristics. Crop Science 24:868-872</td>
</tr>
<tr>
<td>40</td>
<td>Krupa et al. 2001. Ambient ozone and plant health. Plant Disease 85: 4-12</td>
</tr>
<tr>
<td>BOOK CHAPTERS</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WEB SITES</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
</tr>
</tbody>
</table>
Projected Schedule of Tests and Research Proposal

Tests 1 and 2 will be during the approximate lecture number 20 and 37. The final examination will be held during the time specified by the University final examination schedule. The research proposal will be due on a lecture date late in October.

Grading:

All tests (including the final examination) and the research proposal will each be 25% of the total grade.

Incomplete Grades and Late Assignments:

An incomplete or IN grade may be given to students for work not completed because of a serious interruption in their work not caused by their own negligence. An IN is only appropriate if a documented serious event would result in the student failing the course due to missed assignments or tests. Late assignments without prior approval will be assessed a letter grade reduction per lecture period of tardiness.

http://www.ncsu.edu/grad/handbook[section3_18.php#incompletes

Attendance Policy:

While attendance will not be taken, all students will be considered professionals and will be expected to attend. The instructor will appreciate notice of an impending absence, if known, in advance.

http://www.ncsu.edu/policies/academic_affairs/courses_undergrad/REG02.20.3.php

Academic Integrity:

The highest standards of academic integrity will be expected and upheld in the course. Students should read the Student Code of Conduct found at:

http://www.ncsu.edu/policies/student_services/student_discipline/POL11.35.1.php

The honor pledge will be expected to be upheld on all tests and assignments unless otherwise indicated by the instructors. The honor pledge states:

"I have neither given nor received unauthorized aid on this test or assignment."

Complete honesty is expected during all tests and assignments.

Students with Disabilities:

Reasonable accommodations will be made for students with verifiable disabilities. In order to take advantage of available accommodations, students must register with Disability Services for Students at 1900 Student Health Center, Campus Box 7509, 515-7653.

http://www.ncsu.edu/provost/offices/affirm_action/dss/ For more information on NC State's policy on working with students with disabilities, please see the Academic Accommodations for Students with Disabilities Regulation (http://www.ncsu.edu/policies/academic_affairs/courses_undergrad/REG02.20.1.php).

Laboratory Safety or Risk Assumption:

None expected since laboratory and field trips are not planned.

Extra Expenses:
No extra expenses are expected.

**Transportation:**
No travel from campus is expected, therefore transportation is not an issue.
Responses from Consultation with Other Departments

Dear Randy,

We have reviewed the proposed course CS 714 and the Department of Genetics does not have any concerns. It should be a good addition to the campus curriculum.

Sincerely,
Stephanie

Stephanie E. Curtis, Ph.D.
Professor and Department Head
Department of Genetics
Box 7614
North Carolina State University
Raleigh, NC 27695-7614
Phone: 919-515-5747
Fax: 919-515-3355
Email: securtis@ncsu.edu
Randy- In the overall, the course offering looks fine. My only comment pertains to the learning outcomes. Namely, being able to "list" and "describe" in outcomes 2 and 3 seems somewhat less than what we'd expect from graduate student comprehension.

Michael

Randy Wells wrote:

Dear Fellow DGP's:

I am in the process of submitting the course action form for a new course that I will coordinate. The proposed course is CS 714, Crop Physiology: Plant Response to Environment. Please view the attached materials and return to me any comments or concerns you may have about the proposed course. As you know, consultation with other departments is encouraged prior to form submission. The course has been taught as a special problems course for a number of years.

If you desire more information, please contact me.

Thank you,

Randy Wells
Director of Graduate Programs
Dep. of Crop Science
NC State Univ.
(919)515-4062

<<DepartConsult.doc>>
Randy, as the DGP for Plant Pathology, I see no conflicts with any of our PP courses and the proposed course may be of value to our grad students who have field and/or commodity focused dissertation research.

Dave Ritchie

Randy Wells wrote:

Dear Fellow DGP’s:

I am in the process of submitting the course action form for a new course that I will coordinate. The proposed course is CS 714, Crop Physiology: Plant Response to Environment. Please view the attached materials and return to me any comments or concerns you may have about the proposed course. As you know, consultation with other departments is encouraged prior to form submission. The course has been taught as a special problems course for a number of years.

If you desire more information, please contact me.

Thank you,

Randy Wells
Director of Graduate Programs
Dep. of Crop Science
NC State Univ.
(919)515-4062

<<DepartConsult.doc>>

--
David (Dave) F. Ritchie
Professor and Director of Graduate Programs
Department of Plant Pathology
North Carolina State University
Raleigh, NC 27695-7616 USA

Tel: 919.515.6809
FAX: 919.515.7716
Randy,

I circulated your course description to the faculty and it has the full support of our department. Let me know if you want any more formal input.

Bob Abt
DGP Forestry

At 04:15 PM 1/24/2005, you wrote:

Dear Fellow DGP's:

I am in the process of submitting the course action form for a new course that I will coordinate. The proposed course is CS 714, Crop Physiology: Plant Response to Environment. Please view the attached materials and return to me any comments or concerns you may have about the proposed course. As you know, consultation with other departments is encouraged prior to form submission. The course has been taught as a special problems course for a number of years.

If you desire more information, please contact me.

Thank you,

Randy Wells
Director of Graduate Programs
Dep. of Crop Science
NC State Univ.
(919)515-4062

<<DepartConsult.doc>>
Randy,

The course outline looks excellent. Our students have been asking for more plant physiology and this will fit the bill.

When will it be taught next and how frequently will it be taught? Can you send a final version of the syllabus when you are done? We will promote it within the department.

Also, noticed a typo in section III. C. 3. "resistances" is misspelled in the original.

John Dole

At 04:15 PM 1/24/2005 -0500, you wrote:

Dear Fellow DGP's:

I am in the process of submitting the course action form for a new course that I will coordinate. The proposed course is CS 714, Crop Physiology: Plant Response to Environment. Please view the attached materials and return to me any comments or concerns you may have about the proposed course. As you know, consultation with other departments is encouraged prior to form submission. The course has been taught as a special problems course for a number of years.

If you desire more information, please contact me.

Thank you,

Randy Wells
Director of Graduate Programs
Dep. of Crop Science
NC State Univ.
(919)515-4062

<<DepartConsult.doc>>

John Dole
158 Kilgore Hall, Campus Box 7609
Dept. of Horticultural Science
North Carolina State University
Raleigh, NC 27695-7609
919-515-3537
Randy,
This course has some topical overlap with offerings in our department but it is minimal and I suspect that we cover similar topics from very different perspectives and levels of detail (whole plant vs. molecular). Topical overlap with our undergrad BO421 is not relevant because that is a prerequisite for your course. There should be no problems with Botany.
Becky

At 04:15 PM 1/24/2005, you wrote:

Dear Fellow DGP's:

I am in the process of submitting the course action form for a new course that I will coordinate. The proposed course is CS 714, Crop Physiology: Plant Response to Environment. Please view the attached materials and return to me any comments or concerns you may have about the proposed course. As you know, consultation with other departments is encouraged prior to form submission. The course has been taught as a special problems course for a number of years.

If you desire more information, please contact me.

Thank you,

Randy Wells
Director of Graduate Programs
Dep. of Crop Science
NC State Univ.
(919)515-4062

<<DepartConsult.doc>>