

H475 (3cr) - Environmental Requirements of Horticultural Plants - Spring - 2005

Instructor: Dr. Cecil Stushnoff, Shepardson 113b, 491-7110

Assistant: Emma Locke

Classroom: Shepardson 118, Lectures 11:00-12:15 AM

Office hours: T, TR, 9:15 -10:00

Text: None required.

Recommended reading references

Taiz and Zeiger, Plant Physiology, 1st, 2nd or 3rd edition

All journal article papers assigned in class

Course Objectives:

1. To facilitate integration of concepts pertaining to the impact of environmental factors on the growth and development of horticultural crops and other plants. To encourage in-depth study and application of special environmental conditions to achieve maximum growth and development of horticultural crops for commercial and/or avocational purposes.
2. To become familiar with terminology, definitions, and concepts connected with research on environmental physiology.
3. To encourage students to think about innovative applications of micro-environmental manipulations in the production of horticultural crops.
4. To create an awareness and to encourage discussion about the impact of global climatic change on the outdoor environment and on implications to agricultural productivity.
5. To promote an understanding of how research publications can further our appreciation of environmental physiology.
6. To conduct an experiment that examines the impact of an environmental stress on nutritional quality of a horticultural food crop; to collect, graph, and analyze data, and communicate the results verbally and in the form of a poster or power point presentation. Individual projects will be compiled as a class CD.

OR alternatively

7. To prepare an extension report with sufficient detail to enable the reader to optimize field production of a horticultural crop. The document must cover environmental management requirements that determine successful production. It should be based upon and should cite at least five published journal research papers and must extract graphic and /or tabular data based on water, temperature and light requirements. The final product should be in electronic format that can be compiled as a class CD.

Grades :

- (1) **Three quizzes** Feb. 10 on water and salinity; March 11 on temperature; April 20 on light, UV-B, pollutants, free radical and antioxidants (100 points each) = 300
- (2) **Responses** to literature reading assignment questions (100 points, 10 points each)
- (3) **Research project or extension report** with a 10 minute oral presentation to the class. = 200 points. Students are encouraged to enter their posters in the University -wide undergraduate research poster competition. (50 point bonus)

The research project topic can be chosen from the project plan provided. These projects are short-term in nature and generally anticipated to provide results, but students are expected to be creative in adding or modifying the projects to explore special interests and add depth. Students are expected to prepare a written report that will include: (A) a brief literature review (3-5 references) with a hypothesis statement and objectives of the research, (B) materials and methods including an outline the experimental details, (C) results in graphs and tables, (D) discussion and conclusions, (E) literature cited.

The project consists of red and green cultivars of four leafy vegetables: lettuce, basil, kale and chard. Plants will be grown in the Plant Science greenhouse until Feb.23, when treatments will be started. Regimes that impose drought stress (dry-down), salinity stress, cold-stress, heat stress and low light intensity will be completed by spring break, March 15-19. Teams will harvest and weigh plants. Samples will be freeze dried during spring break. Total phenolics analyses will be conducted (two to three days for each team) after spring break.

Data collected must be analyzed and prepared in the form of a power point class presentation April 29, May 4, May 6. Guidance, facilities and equipment required can be coordinated through Todd Einhorn and Ann McSay. Brief reports on progress can be made to the class at regular intervals to keep all informed and to seek suggestions with problems.

The poster should contain:

- (1) a title, investigators name and affiliation, a one paragraph abstract;
- (2) a one or two paragraph literature review based on cited research journal papers, that introduce the reader to the importance of the problem and justifies why the work was done, and what approach was used to do the work;
- (3) a materials and methods section that briefly, but concisely states how the work could be repeated by someone else;
- (4) a presentation of results in the form of graphs, and/or tables, and photos;
- (5) a discussion and conclusion of the significance of the results relative to previous knowledge and their potential practical or scientific impact.

(6) a few (2-3) references

Other requirements: Size: 4'x4'; easy to read from 4' away; title, text and visuals mounted on poster board or some other stiff background in an attractive display; printed in an easy to read font such as arial or CG Times using bold for headings, etc. For additional help and tips on designing posters visit the CTSS plotting services webpage: http://www.ctss.colostate.edu/plotting_services.asp 224 Weber bldg.

General Topic Outline

Introduction: research impact; communicating research;
Discussion of potential research projects
Concepts used in creative problem solving
Communication of research results

A. Water

Physical and biochemical properties
Water relations in plants and soils
Control of key growth processes
Water logging
Drought
Salinity

B. Temperature

Plants and the thermal environment
Temperature and plant adaptation
Control of growth and biochemical reactions
Dormancy
Low temperature stresses
High temperature stresses
Managing the environment for horticultural production
Protected environment production
Frost and freeze protection

C. Light

Energy and carbon
Radiation and irradiance
Leaf canopies
Spectral distribution
Intensity, duration, quality

D. UV-B and air pollutants

Free radicals and antioxidants in plants and food

E. Applications

Antioxidants and health attributes of fruits and vegetables
Opportunities and limitations of organic fruit and vegetable production

Proposed Schedule of Topics (subject to change as speakers are inserted into the schedule)		
Jan.	20 22	Introduction to course structure, creative problem solving, Water relations, soil/plant/atmosphere continuum
	27 29	Water stress, osmotic potential, measurement Drought stress
		Problem set #1
Feb.	3 5	Salinity and ion toxicity Water logging, anoxia, hypoxia
		Problem set# 2
Feb.	10 12	Quiz #1 on water, drought, salinity Temperature regulation of growth, development, and survival, measurement
	17 19	Chilling injury Ice nucleation
		Problem set #3
	24 26	Avoidance (supercooling) and tolerance mechanisms Cryopreservation of plant germplasm
		Problem set # 4
Mar.	2 4	Woody plant dormancy and cold acclimation Frost protection, site selection
		Problem set # 5
Mar.	9 11	Heat stress, global warming Quiz #2 on cold and warm temperature
		Problem set # 6
Mar.	16-18	Spring recess
	23 25	Global climatic change Light – duration, intensity, quality
		Problem set # 7
April	30 1	Light – duration, intensity, quality UV-B
April	6 8	Pollutant effects on horticultural crops Free radicals
		Problem set # 9
	13 15	Antioxidants and nutrients in fruits and vegetables Antioxidants and nutrients in fruits and vegetables
		Problem set # 10
	20 22	Quiz #3 on global climatic change, light, UV-B, pollutants, free radicals, antioxidants Organic production opportunities
	27 29	Organic production limitations Power point and poster presentations and discussion
May	4	Power point and poster presentations and discussion
May	6	Power point and poster presentations and discussion
May	10-14	Final (Exempt unless desired by students to improve grade)

Creative Thinking

! The earliest creative thinker to leave records of his method was Socrates. Basically, people are lazy when it comes to thinking. Creative thinking is driven by a problem "a thorn in the mind". Irritation or incentive motivation is required to stimulate creative problem solving.

First necessity of creative problem solving: A problem that bothers us so much we must do something about it.

Second necessity of creative problem solving: We must state the problem in a manner that will enable us to both understand it clearly and to solve it.

Third necessity of creative problem solving: Preparation by assembly of the essential elements.

"Creativity consists in forming new combinations of images and ideas previously gathered and deposited in memory. Nothing can come of nothing; so if we do not assemble new raw materials, we can produce no new combinations" Joshua Reynolds. Furthermore, knowledge, ideas and facts must be organized and classified. A disorganized mind full of haphazard notions seldom leads to creative thinking.

Sources of raw materials

- Our own past experience
- Past experiences of others stored in library books and papers
- By observing events happening around us
- By studying situations that are like ours and have been solved
- By conducting experiments
- By discussing the problem with others, stimulating creative group output

Fourth necessity of creative problem solving: Choose suitable bits from our storehouse of raw material and assemble in a new combination that will solve the problem.

Fifth necessity of creative problem solving: Subject the proposed solution to trial to prove its validity.

These steps can be stated in other ways, but the essence is: "**a methodical progression from a problem to a solution, from a thorn in the mind to a useful and usable solution**"

Helpful Hints

- Develop an ability to recognize a problem in the most general terms, then restate, analyze, and subdivide the problem
- Research is a creative problem solving activity. It is primarily a mental activity: creative thinking, followed by physical processes of investigation. Two key actions required for successful research are a keen sense of unbiased observation followed

by careful reasoning or deduction.

- There are at least two distinct approaches to research: (a) an empirical approach where large numbers of experiments or observations are generated to form a basis for development of a theory (Baconian-Edisonian); (b) an approach whereby a theory is first formulated based on previous knowledge and is then tested by experiments to prove or disprove it (Aristotle-Bancroft).
- Organized group thinking to focus on a problem generally produces better results than the sum of accomplishments from the same individuals working independently.
- A systematic approach where bits of a large problem are solved with progressive restatements of the problem usually is more productive than attempting to hit a home run the first time at bat.

A summary guide to increase problem solving effectiveness

1. State and restate the problem until it is in terms that make the solution possible. This means subdividing it into smaller units that can be handled instead of tackling it all at once. Maybe available resources will permit solution of only a small part of a bigger problem.
2. Concentrate on a small area and learn everything there is to know. Add new factual material to assist progression to the next step.
3. Use a systematic methodical approach in collecting, sorting, and recording facts. Facts are awarded on the basis of dates of unique events recorded in a permanent notebook. Also a paper trail of facts learned from the library or experiments make it easier to retrace and regroup when a step fails to work as predicted.
4. Find time to think. A few minutes of thinking about something else, even daydreaming may lead to an important idea that continuous concentration may not.
5. Seek a totally different point of view. Break the mold, employ a paradigm shift. Discuss with a colleague, read in a different field. A concept from physics may help solve a problem in horticulture by illuminating what may seem like a hope-less maize.

