Course Structure

- Evolution and history of crop production.
- Plant Morphology.
- Plant Growth Process.
- Plant breeding.

- Climate, Soils, Soils and Water.
- Nutrients and Fertilizer.
- Pests and Diseases.
- Agricultural production systems.
- Tillage, seeding, harvest, storage, marketing.
Factors which influence crop growth

- Environment
  - Irradiation, Day-length, Temperature, Gases, Water availability.
- Soil.
- Water.
- Nutrients.
- Pests & Diseases.
- Weeds.
US Topography
US Farm Land

Percent of land area used for crops:
- More than 40 percent
- 30 to 40 percent
- 20 to 30 percent
- 10 to 20 percent
- 5 to 10 percent
- Less than 5 percent
Factors which influence crop growth

- **Environment**
  - Irradiation, Day-length, Temperature, Gases, Water availability.
- Soil.
- Water.
- Nutrients.
- Pests & Diseases.
- Weeds.
Solar Energy
- Ozone in the upper atmosphere serves as a protective shield by absorbing most of the harmful ultraviolet radiation.

- Atmospheric gases do not absorb much of the sun’s radiation between 400 and 700 nm.

- This is notable because this band of radiation is called *photosynthetic active radiation*.

- This is the most important for life on Earth.
Light Intensity

Relationship between Photosynthesis and Respiration

- **CO₂ Exchange**
- **Light Intensity** (foot-candles)

- **Net Photosynthesis Rate**
- **Photosynthesis > Respiration**

- **Light Compensation Point** (light intensity where photo = resp)

Graph showing the relationship between light intensity and CO₂ exchange, with a line indicating net photosynthesis rate and a shaded area indicating photosynthesis > respiration.
Light Intensity

Photosynthesis Rate

Light Intensity - foot-candles

0

0.5

1.0

50

1,200

2,000

8,000

10,000

greenhouse in winter

Light Saturation Range for most plants

full sun in summer

Note: The graph shows the relationship between light intensity and photosynthesis rate, indicating the optimal range for most plants.
Sun Scald
Light Quality

- Light affects plant processes in the range of 380 to 800 nm.
- Photosynthesis requires a narrower band than this.
- Blue light (440 um) and red light (680 um) are more effective than green light (520 um).
- As a result green light is reflected more – hence green plants.
The fraction of the photosynthetically available radiation that was absorbed by land vegetation for photosynthesis.
The image is a map of the density of the plant canopy covering the ground.
Photomorphogenesis

- Seed germination in light sensitive seeds.
- De-etiolation, greening of young seedlings
- Stem growth in plants that are competing for light with their neighboring plants.
- Related to plant receptors called phytochrome.
Phytochrome

- Pigment that has two inter-convertible forms.
  - Red light absorbing (R)
  - Far-red light absorbing (FR).

- Red light is efficiently absorbed by chlorophyll while far red is reflected.

- Ratio of R:FR causes plant response.

- R:FR ratio is high (no competition) = compact plants with dark leaves.
R:FR ratio detected by a plant is dependant on how close and how big are neighboring plants (competition).

- R:FR ration is high (no competition) = compact plants with dark leaves.
- R:FR ratio is low (neighbor competition) = taller plants, with light green color, necrosis leaves, weak!
Corn Yield at Different Seeding Rates

[Graph showing the relationship between percent maximum yield and seeding rate per acre (x1000).]
Photoperiodism

- Day-length response in plants.
- Can affect:
  - Flowering
  - Bud dormancy in woody plants
  - Formation of vegetables (i.e. storage organs like rutabaga, potato, etc.)
Plants can be either:

- Long day plants (LDP), or short night plants.
- Short day plants (SDP), or long night plants.
- Day neutral plants (DNP), which are neutral to day (or night) lengths.

Day lengths plants have a critical day length (CDL) which must be satisfied in order that the plant will flower.
Chrysanthemum

- Chrysanthemum are short day plants (require long night period in order to flower).
- Propagators interrupt night period with high intensity light so plants do not flower until required.
- Similarly, in summer plants are covered to simulate long nights and hence do flower.
Onion varieties are day length sensitive regarding bulbing.

Classified according to length of day light hours required for bulbing to initiate.

- **Long Day Bulbs (14-16 hours);**
- **Intermediate Day Bulb (12-14 hours):**
- **Short Day Bulb (10-12 hours):**
Short Days           Long Days

Long Days           Short Days

Inter-node length

Long Days           Short Days

Long Days           Short Days
All plants have a minimum temperature below which there is no plant growth – often below 4°C (39°F).

Plants also have a maximum temperature limit whereby plants cease to function – usually no higher than 50°C (122°F).
US Rainfall and Temperature
Precipitation and Temperature
Moscow, Idaho

Precipitation (cm)

Temperature (° C)
Frost Free Growing Days
Accumulated Degree Days
Cool Season Plant
A plant that grows best at daytime temperatures ranging from 50-64°F (15-18°C) and is frost tolerant.

Warm Season Plant
A plant that grows best at daytime temperatures ranging from 64-80°F (18-27°C) and is frost intolerant.
Average Temperature by Month

- Florida
- Mississippi
- Iowa
- North Dakota

Jan  Feb  Mar  Apr  May  June  July  Aug  Sept  Oct  Nov  Dec
## Optimum Root and Shoot Growth Temperatures

<table>
<thead>
<tr>
<th>Crop</th>
<th>Root Growth</th>
<th>Shoot Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>43 to 55 °F</td>
<td>60 to 69 °F</td>
</tr>
<tr>
<td>Wheat</td>
<td>64 to 68 °F</td>
<td>64 to 72 °F</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>68 to 82 °F</td>
<td>68 to 86 °F</td>
</tr>
<tr>
<td>Corn</td>
<td>77 to 86 °F</td>
<td>77 to 86 °F</td>
</tr>
<tr>
<td>Cotton</td>
<td>82 to 86 °F</td>
<td>82 to 88 °F</td>
</tr>
</tbody>
</table>
Low temperature damage is either chill injury or freeze injury depending on cold severity.

Windmills in orchards and vineyards can be used to mix air to prevent chill damage.

Low temperature damage can also be prevented using (snow) mulches, covering with plastics, and cold frames.
Beneficial Cold Treatment

- Stratification
- Vernilization
- Dormancy breaking
Gases

- Atmospheric gasses are composed of 78% nitrogen ($N_2$) = 780,000 ppm.
- 21% oxygen ($O_2$) = 210,000 ppm.
- 0.035% carbon dioxide ($CO_2$) = 350 ppm.
Global Average Temperature and Carbon Dioxide Concentrations, 1880 - 2004

- Global Temperatures
- CO2 (ice cores)
- CO2 (Mauna Loa)
Atmospheric CO₂ Levels
Interaction between CO$_2$ and light intensity

Normal CO$_2$
350 ppm

High CO$_2$
3,000 ppm
How global warming works

Carbon Dioxide (CO₂)

Fossil fuels (coal, oil, natural gas)
Global Warming Contributors

USA: 23.8%
PRC: 14.6%
India: 4.6%
Japan: 5.0%
Everyone else: 59.8%
USA Temperature Change

1990

2006
Global warming: Causes and effects

Earth's temperature has risen about 1 degree Fahrenheit in the last century. The past 50 years of warming has been attributed to human activity.

Burning fuels such as coal, natural gas and oil produces greenhouse gases in excessive amounts.

Greenhouse gases are emissions that rise into the atmosphere and trap the sun's energy, keeping heat from escaping.

The United States was responsible for 20 percent of the global greenhouse gases emitted in 1997.

Most of the world's emissions are attributed to the United States' large-scale use of fuels in vehicles and factories.

Some predictions for local changes include increasingly hot summers and intense thunderstorms.

Damaging storms, droughts and related weather phenomena cause an increase in economic and health problems. Warmer weather provides breeding grounds for insects such as malaria-carrying mosquitoes.

During the past 100 years global sea levels have risen 4 to 8 inches.
Positive benefits of global warming
90% of the total photosynthesis in the world comes from ocean and fresh water algae.
World Sea Temperature Change

Change in Ocean Temperature (°C)

Change in Ocean Production (%)

[Map showing the change in ocean temperature and production across the world's oceans.]
Researcher looks at big picture

Climate change work, cooperation help scientist "reinvent the box"

By MATTHEW WEaver
Capital Press

MOSCOW, Idaho — Sanford Eigenbrode first fell in love with entomology when he was a boy.

"I can remember my surprise as a little kid discovering every day you could find an insect you hadn't seen before," he said. "You could do that for the rest of your life."

Eigenbrode was drawn by the diversity and the alien beauty of the insect world.

"If everyone had a microscope instead of a television, everyone would be an entomologist," he said. "You just look at them and see them completely differently, realize you're sharing the planet with something totally fantastic and beautiful in a way we're not used to thinking about."

As a youth, Eigenbrode worked on dairy farms in upstate New York in the summer, becoming familiar with agriculture, and becoming aware of the changing face of science.

More recently, he's expanded his approach to think about issues on a broader scale, such as how entomology works with other disciplines to encompass science-based approaches for agriculture.

Eigenbrode was selected last year to lead the $20 million Regional Approaches to Climate Change in Pacific Northwest Agriculture project, which incorporates every aspect of the dryland cereal production system that is vulnerable to a changing climate.

The project's first annual meeting will be Feb. 29 to March 2 in Pendleton, Ore. Eigenbrode hopes to show how alternative cropping systems will perform in future climates so that growers can adopt them, increasing and carbon levels and nitrogen efficiency.

"We have the opportunity to think outside the box by essentially reinventing the box," he said.

The team plans to produce new Internet-based tools to help producers use climate information to make decisions. Eigenbrode also hopes to improve on the transfer of information between researchers and producers.

"Not only is he a respected scientist in his own right, he's also a recognized expert in this art of pulling scientists together to focus on a societal objective," said Frankly Beets, assistant director of the Institute of Bioenergy, Climate and Environment for the National Institute of Food and Agriculture.

Eigenbrode's research on aphids is slated to end in the fall. The virus the insects carry can reduce yields by 20 percent, and Eigenbrode is determining how producers can best combat them.

Information he gathered for peas as part of his project can be applied to cereal crops, Eigenbrode said. Eigenbrode will post calculators on his aphid tracker website in the next few weeks to help farmers decide on early and mid-season treatments for aphids.

Todd Scholz, director of research and information for the U.S. Dry Pea and Lentil Council, said Eigenbrode applied several years for funding from the council to research pea cress mosaic virus but was rejected.

"And then we had the virus infection and we said, "Oh, maybe that wasn't such a good idea,"" Scholz said. "He never gave up."

Eigenbrode's efforts have led to tools that help farmers reduce the aphid's impact, Scholz said. "We know more than we ever did, and we can build on that."

Western innovator
Sanford
Eigenbrode
Job: Professor of Entomology, University of Idaho
Age: 53
Hometown: Ithaca, N.Y.
Current location: Moscow, Idaho
Education: Bachelor's, master's and doctorate degrees from Cornell University
Family: Wife and daughter

Online
Regional Approaches to Climate Change in Pacific Northwest Agriculture:
www.uidaho.edu/ fracnapan
Aphid Tracker:
www.caia.uidaho.edu/aphidtracker

University of Idaho entomologist Sanford Eigenbrode demonstrates the ability to map and track aphids and virus risk on the university campus in Moscow, Idaho, on Oct. 5.