Weed Science Mini-Lecture Field IPM Techniques

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Agronomy

What Are Weeds?

- plant out place - using this definition, almost any plant can be a weed
  - Melaleuca--native tree in Australia, but weed in south Florida
  - Corn--crop when it is planted, but weed when volunteer plants come up the next year
  - Most “weeds” are non-cultivated native or non-native plants
- plants that interfere with human activity

When did weeds appear?

- When humans first became dependent on agriculture for food

Characteristics of Weeds

- Fast growing, quick invasion potential
- reproduce quickly through lots of seeds
- easily spread through a variety of dispersal mechanisms

How do plants become weeds?

- Highly adaptive to selection pressure - human imposed environmental conditions

Why are weeds a problem?

- crop production (compete with desired plants)
- ecology - natural areas, aquatics
- aesthetics, poisonous
- harbor insects, diseases

Lygodium microphyllum
Old World climbing fern
Photo by Vic Ramey

Why Weed ID?

- Weeds are prominent pests in crops
  - Control methods almost always required
    - Mechanical
    - Cultural
    - Chemical (herbicides)
- Also important pests of natural areas
  - Invasive weeds
    - Brazilian pepper, old world climbing fern, Australian pine, etc.

Categories of Weeds

- Annual
  - Reproduces in one year (pigweed, crabgrass)
- Biennial
  - Vegetative in fall, flowers in spring (dock, onion)
- Perennial
  - persist over several years
  - taproot, rhizome, bulbs, tubers,
  - trees, vines

Initial ID Steps

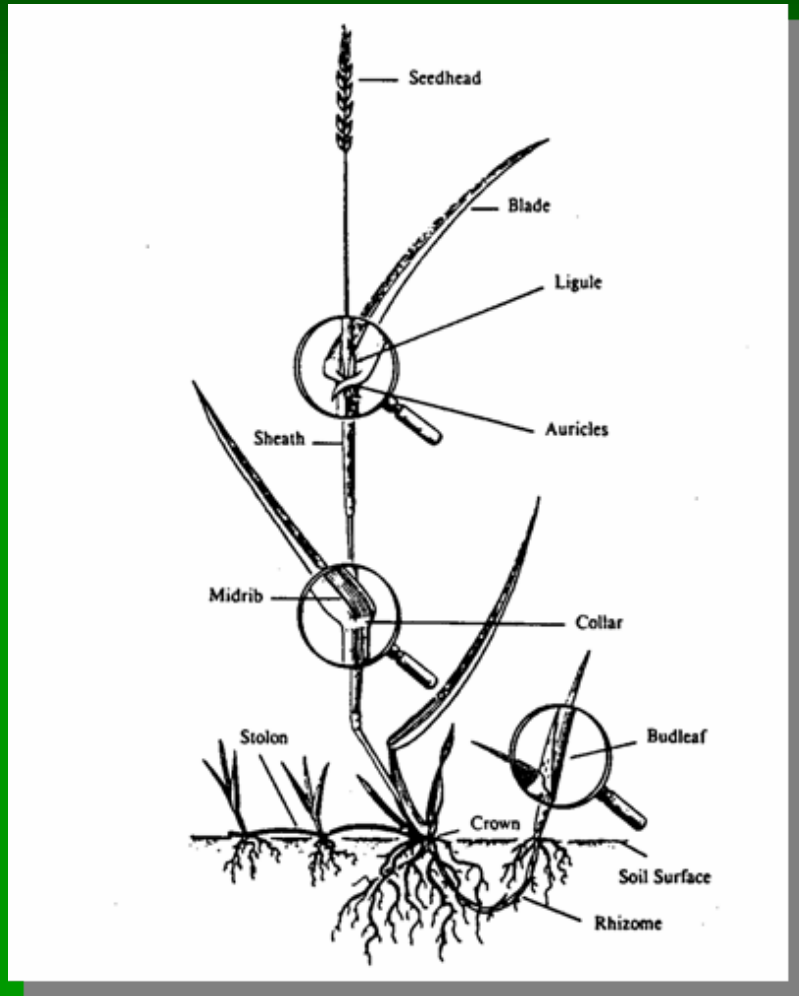
- Morphology - structure, shape, and orientation.
  - broadleaf vs grass vs sedge
  - leaf ranking - grass vs sedge
  - ligule and vernation - grasses
  - inflorescence - if present!!!

Vegetative parts of ***grasses*** often used to aid in identification:

- leaf blade, blade margin
- collar margin
- midrib
- ligule - structure which occurs in grasses at point where the leaf sheath and blade meet
- auricle - projections where sheath and blade meet
- sheath margins - split with overlapping margins or united

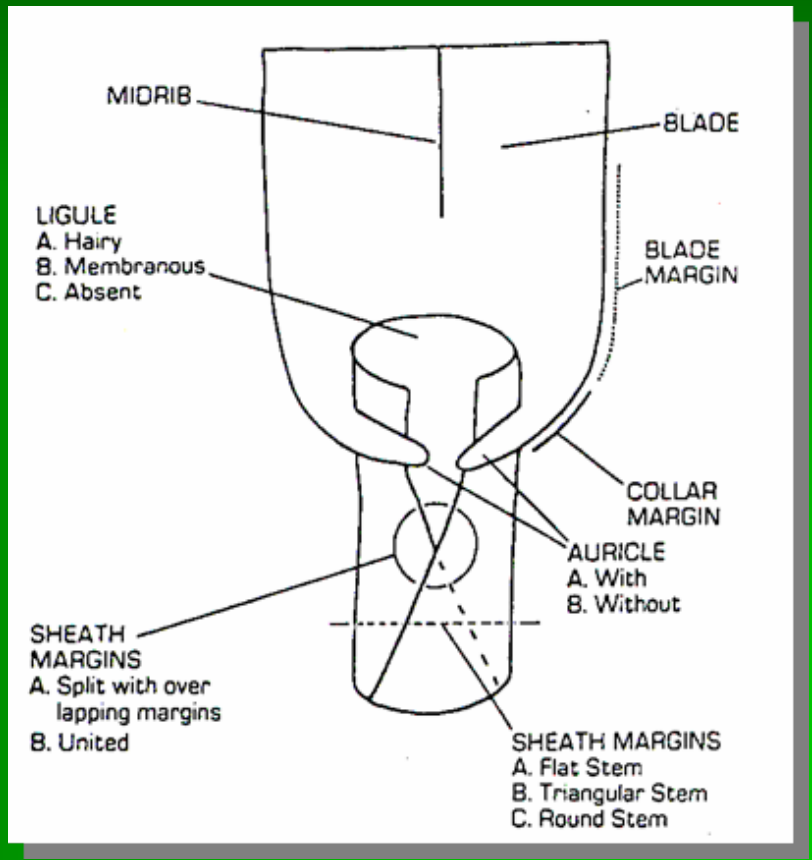
Diagnostic Grass Structure

- Primary leaf structures used to ID grass
  - ligule
  - auricle
  - collar
  - sheath



Vegetative Characteristics

- Blade
- Midrib
- Ligule
- Collar
- Sheath
- Auricle

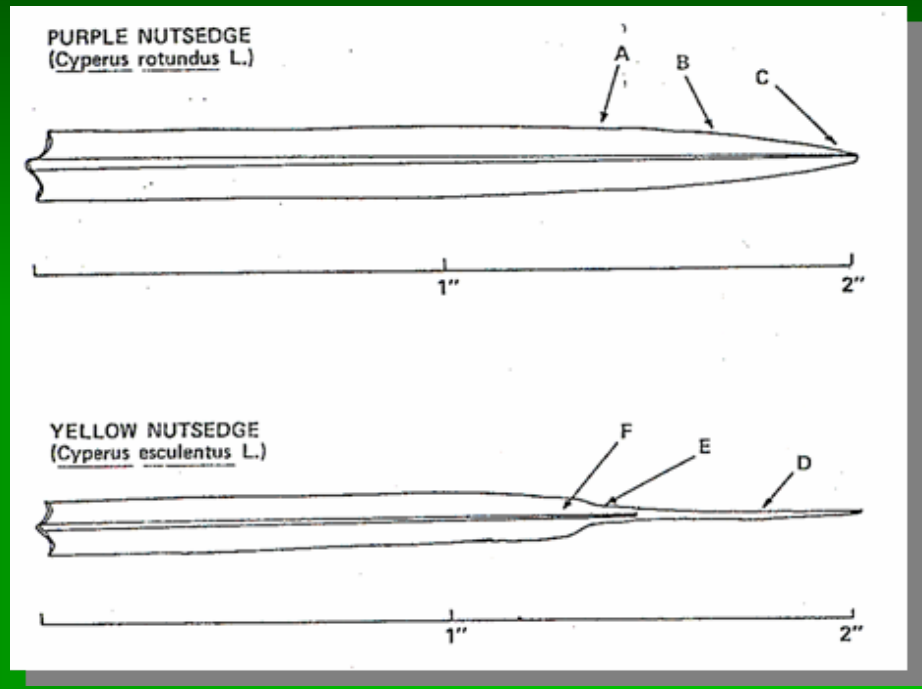


Differences between grasses and sedges:

- Sedges have a solid, triangular in cross section, stem. Leaves are arranged in threes (extend in three directions).
- Grass stems may be round or flattened.

Purple vs Yellow Nutsedge Leaf Characteristics

- Purple
  - boat shaped tip
  - constriction absent at tip
  - midrib groove continues to leaf tip
- Yellow
  - sharp or needle-like tip
  - constriction 0.5-1.5 inches from tip
  - midrib groove absent

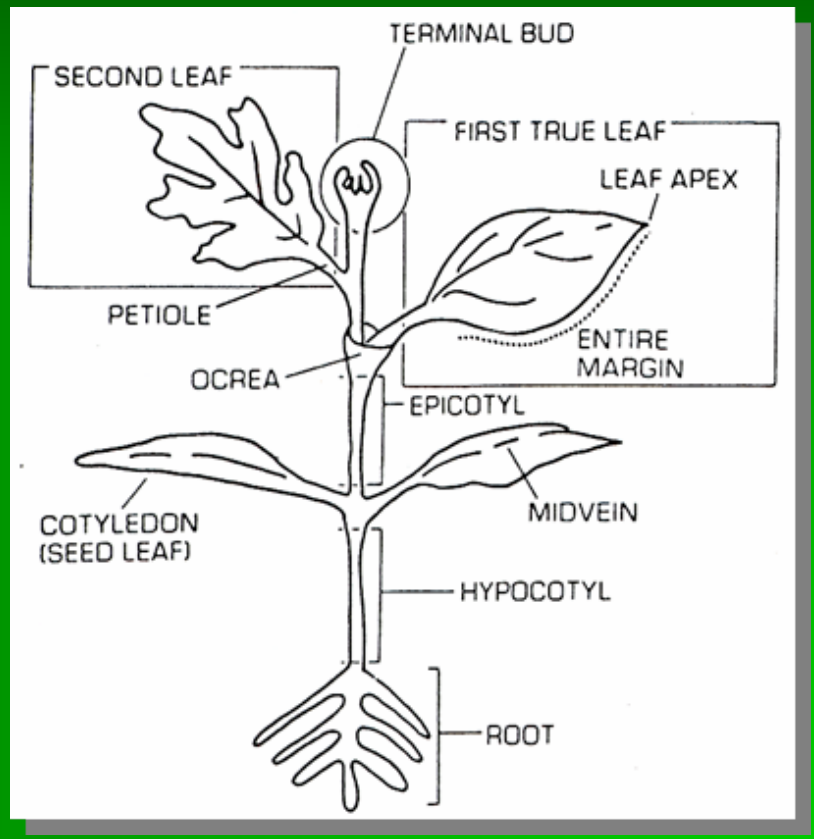


Vegetative parts of ***broadleaf*** weeds often used to aid in identification:

- cotyledons - seed leaves
- first true leaf and older leaves
- midvein
- leaf apex and margin
- terminal bud

Broadleaf Weed Structure

- Cotyledon
- Leaf
  - midvein
  - margin
  - shape
  - arrangement



Taxonomic Keys

- Botanically based on plant family
  - Vascular Flora of the Carolinas
  - Guide to the Vascular Plants of Central FL
  - Trees, Shrubs and Woody Vines of Northern Florida and Adjacent GA & AL
    - Often used throughout the southeast
    - Must have plants with flowers or fruit
    - Very challenging – must have knowledge of plant family characteristics

Web Picture/Taxonomic Sites

- PLANTS National Database (USDA)
  - Good information, some pictures
  - Searchable format
  - http://plants.usda.gov/

Web Picture/Taxonomic Sites

- Atlas of Florida Vascular Plants (University of South Florida)
  - Taxonomic information, distribution maps
  - http://www.plantatlas.usf.edu/

Web Picture/Taxonomic Sites

- Center for Aquatic and Invasive Plants University of Florida
  - Excellent pictures and information
  - http://aquat1.ifas.ufl.edu/photos.html
- Weed Identification and Control in Southern Turfgrasses (Univ. of Georgia)
  - Pictures, descriptions
  - http://www.griffin.peachnet.edu/cssci/TURF/turf.htm

Web Picture/Taxonomic Sites

- Many, many more sites
  - Many universities, public agencies
  - Buyer beware - some incorrect information on the web!

Books, Fact Sheets, Etc.

- **Wildflower books**
  - Good for plants with prominent flowers
- **Area-specific books**
  - Many exist, varying quality of information
- **Southern Weed Science Society ID Guide**
  - Excellent resource, very thorough
  - Limited to crop, turf - few non-crop species

History of Weed Management

- Burning (Native Americans - Great Plains)
- Orient - flooding practiced for centuries
- Jethro Tull - defined concept of rows for cultivation
- copper sulfate in 1821, sulfuric acid 1855
- arsenicals in early 1900’s
- 2,4-D in 1944 - beginning of herbicides

Methods of Weed Management

- prevention - weed-free seed
- hand hoeing, pulling
- mechanical cultivation
- burning, flooding
- mulches
- biological
- chemical

Chemical Weed Management

- used on majority of U.S. production
- herbicides account for 55% of pesticide use
  - –insecticides 32%
  - –fungicides 7%

How herbicides work

- Controlled/selective plant poisoning
  - applied to soil (root uptake) and/or leaves
  - contact or systemic
  - selective vs. non-selective
- each herbicide has unique properties, some more environmentally friendly

Application Methods

- pre-plant, pre-plant incorporated, preemergence
- at-cracking, early postemergence
- mid-post, late post, layby, *salvage*
- post-directed, shielded sprays, ropewick
  - Two objectives – kill weed, not kill crop

Plant Processes

- photosynthesis
- amino acids and proteins
- growth inhibition
- cell membranes
- pigment synthesis
- growth regulation

Mode vs. Mechanism

- **mode-of-action** -- symptoms that occur after herbicide application leading to plant death
- **mechanism-of-action** -- actual biochemical site of herbicide activity
  - generally enzyme or co-factor
  - in some cases actual ‘site’ is unknown

Photosynthesis

- process where the plant uses light energy to convert CO_2 and H_2O to sugars, release O_2
- Light reactions
  - chlorophyll absorbs light
  - passes energy down a biochemical chain
  - form intermediates to drive sugar formation

Herbicides - Photosynthesis

- block the flow of energy from chlorophyll to the intermediates
  - plant cannot make sugars - starves
  - chlorophyll continues to absorb light and this ‘excess’ energy forms toxic intermediates
- generally soil active, root uptake and movement through water stream to leaves

Amino acids and Proteins

- essential building blocks for plant growth and function
- unlike animals, plants make their own
- amino acids are the primary components of proteins and nucleic acids
- proteins are generally storage proteins or enzymes

Herbicides - Amino Acids

- generally target a specific enzyme
  - blocks a vital step in the formation of amino acids-- proteins, enzymes...
  - aromatic amino acids
  - branched chain amino acids
- dependent on plant growth for activity
  - better growth - better control, slow death
- systemic herbicides, some have soil activity

Growth Inhibition

- plants grow by making new cells
  - process of cell division, mitosis
- plants are particularly susceptible as emerging seedlings
  - both shoot and roots
- newly forming roots can be susceptible at most stages of plant growth

Herbicides - Growth Inhibition

- most growth inhibition herbicides are soil applied and generally affect seedling weeds
- most interfere w/ mitosis (mitotic poisons)
- others appear to prevent lipid (cell membrane) production
- some prevent cell wall formation
- soil active, little movement once absorbed

Cell Membranes

- maintain cell integrity
  - keep things in & out
- generate electrochemical gradients
  - allows for energy production
- maintain cell structure
  - turgor pressure maintains plant structure and helps the plant grow

Herbicides - Cell Membranes

- divert normal energy flow to form toxic intermediates
  - interact w/ membrane and cause disruption
- cause the membrane to become “leaky”
  - gradients cannot be formed, no energy for cellular functions - **endothall**
- generally contact, little movement in plant

Pigment Synthesis

- absorb light energy for photosynthesis
- also protect plant from excess light
- types of pigments
  - chlorophyll
  - carotenoids
  - flavenoids
  - anthocyanins

Herbicides- Pigment Synthesis

- block the formation of chlorophyll
- block the formation of carotenoids
  - carotenoids accept excess energy
  - when absent, chlorophyll dissinegrates
- generally slow death, plant starves
- soil active, movement through water stream

Growth Regulation

- hormones control plant growth and developmental changes, always present
- grouped into 5 types - but highly interactive
  - auxins (light responses, apical dominance)
  - giberrelins (elongation, flowering)
  - cytokinins (growth, development)
  - abscisic acid (leaf senescence, propagule form.)
  - ethylene (leaf senescence, counteract auxin)

Herbicides - Growth Regulation

- auxin mimics - cause uncontrolled growth
  - auxin transport inhibitors
  - prevent the normal distribution of auxin
- indirectly, all herbicides can be regulators
  - **Sonar** (fluridone) blocks abscisic acid
  - **glyphosate** inhibits auxin regulation
- soil and foliar applied, systemic throughout

Why biotechnology?

- Industry: “These crops will reduce the use of herbicides, therefore it is environmentally beneficial and will lead to more sustainable agriculture.”

Why biotechnology?

- Critics: "Short-term profit, no long term health of agriculture and environment."

Why biotechnology?

- Growers: Tremendous, non-selective weed control. Easy, convenient. However, the seed cost and technology fee are too demanding, expensive."

Evolution of Biotechnology in Herbicide Resistant Crops

- Imi-tolerant corn - 1980’s
- BXN cotton - 1995
- Roundup Ready soybeans - 1996, cotton - 1997, corn - 1998
- Liberty-Link corn - 1997

World Population and Food

- Today, all the farmland in the world would cover an area the size of North America.
- World population is expected to double in 50 years
- to feed 10 billion people using today's methods it would take an area the size of North and South America

Ecological Benefits

- statistics show a million kilogram reduction in pesticide use since genetically modified soybeans, corn and cotton were introduced to southern Mississippi five years ago
  - Charles Arntzen, Boyce Thompson Institute for Plant Research

The Image of Agriculture?

- image of the hard-working farmer with a hoe is being replaced by an image of a rural tycoon on a big tractor
- fear of famine is being replaced by a more vivid fear of overpopulation
- today's consumer is distressed that farmers don't treat hens and confinement sows like family pets