INDEX

Foreword .................................................................................................................. 3

Nutrient Management .......................................................................................... 4
  Basics of Soil Fertility
  Nitrogen
  Phosphorus
  Potassium
  Secondary and Micronutrients
  Soil and Plant Sampling Analysis

Soil and Water Management ............................................................................... 9
  Soils and Landscapes
  Soil Properties
  Soil Erosion
  Tillage
  Residue Cover

Pest Management .................................................................................................. 12
  General Pesticide Use
  Weed Management
  Plant Disease Management
  Insect and Mite Management

Crop Management .................................................................................................. 18
  Crop Establishment, Growth and Development
  Biotechnology
  Data Analysis
FOREWORD

These performance objectives provide guidance to individuals preparing for the Iowa Certified Crop Adviser Exam. They supplement the International Performance Objectives and emphasize certain aspects of nutrient, soil and water, pest, and crop management principles that are of particular importance in the Iowa. Exam questions are based on these performance objectives and the International Performance Objectives as they apply to providing advice to crop producers in this State.

As is true of the International Performance Objectives, the Iowa Performance Objectives outline the knowledge and skill areas that Certified Crop Advisers in this state have indicated they need in order to effectively carry out their duties. Performance objectives cover the minimum level of fundamental principles considered essential for effective crop advising. Continuing education programs pursued after individuals achieve certification expand upon these principles and cover with greater rigor the four technical areas as well as changes in science and technology, and topics important to development as a professional. Thus performance objectives are a first step in the continuing process of professional development.
NUTRIENT MANAGEMENT

Competency Area 1. Basics of Soil Fertility

1. Know the following elements essential for plant growth (listed below). Understand which elements are mobile in the plant.
   b. Secondary Nutrients: Ca, Mg, S
   c. Micronutrients: B, Cl, Cu, Fe, Mn, Mo, Zn

2. Know the ionic form in which essential elements are taken up by plants from the soil.

3. Define cation exchange capacity (CEC) and understand its relationship with soil properties and base saturation. Understand the relationship between CEC and mobility and plant availability of nutrients in the soil.

4. Understand how the factors listed below influence nutrient movement and availability.
   a. Soil texture, structure/aggregate, and bulk density
   b. Soil pH
   c. Drainage – surface and subsurface
   d. Soil slope
   e. Crop residue cover
   f. Nutrient form – cations and anions
   g. Rate of nutrient application
   h. Time/source/rate/placement of nutrient application
   i. Precipitation – amount and distribution
   j. Organic matter
   k. Temperature

5. Understand the nutrients available from materials other than commercial fertilizers, including the following:
   a. Manures
   b. Legumes
   c. Sludges
      i. Municipal Biosolids
      ii. Industrial Biosolids
   d. Organic By-products
      i. Wastewater
   e. Cover crops

6. Understand the effect of soil pH on nutrient availability and suitability of growing specific crops. Understand the relationship between soil pH and buffer pH.

7. Understand the effect of different fertilizer materials and amendments on soil pH.
8. Understand the effects of the following factors on liming practices and be able to calculate lime application rates for a particular crop and soil.
   a. Soil characteristics
   b. CEC
   c. Liming material and quality
   d. Depth of incorporation
   e. Cropping system
   f. ECCE

9. Understand the composition and role of gypsum, dolomitic limestone, calcitic limestone, etc. used in soil management.

10. Recognize deficiency symptoms of the following nutrients in corn, soybean, alfalfa and small grains.
    a. Nitrogen
    b. Phosphorous
    c. Potassium
    d. Magnesium
    e. Sulfur
    f. Iron
    g. Boron
    h. Zinc

**Competency Area 2. Nitrogen**

1. Understand the nitrogen cycle in soils and know the mechanisms and the nitrogen forms involved in each of the following processes:
   a. Mineralization
   b. Nitrification
   c. Immobilization
   d. Symbiotic fixation
   e. Industrial fixation
   f. Wet and dry deposition
   g. Plant uptake

2. Understand the nitrogen loss pathways and how to minimize nitrogen loss by choosing the right source (including nitrification and urease inhibitors), applying the right rate at the right time in the right place.
   a. Leaching
   b. Denitrification
   c. Volatilization from soils, plants, manure, and fertilizers
   d. Crop removal
   e. Soil erosion/overland flow
3. Understand the availability of nitrogen from common organic sources (crops, manures, compost, biosolids) and how C/N ratio affects nitrogen availability.

4. Recognize the factors that determine appropriate nitrogen fertilization rates. For example:
   a. Application to 4R Nutrient Management
   b. Maximum Return to Nitrogen methodology
   c. Crop, cost of N
   d. Value of crop
   e. Area of state (precipitation)

5. For the following nitrogen fertilizers:

<table>
<thead>
<tr>
<th>Anhydrous</th>
<th>Urea</th>
<th>Ammonium sulfate</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAP and DAP</td>
<td>UAN solutions</td>
<td>Manure (by species)</td>
</tr>
</tbody>
</table>

   a. Recognize the analysis, physical form, and handling precautions of each
   b. Understand their effect on soil pH
   c. Nitrogen timing and availability from each source.
   d. Understand the products advantages and disadvantages in different situations.

6. Understand the proper methods, benefits and limitations of in-season and end-of-season tests used to assess nitrogen needs or availability including but not limited to
   a. Late-spring soil nitrate
   b. Fall cornstalk nitrate test
   c. Greenness/chlorophyll readings

7. Understand the potential for nitrogen to contaminate surface and groundwater and practices to avoid, control, and trap nitrogen.

**Competency Area 3. Phosphorus**

1. Recognize how each of the following factors affect phosphorus fertilization:
   a. Soil properties
   b. Cropping system
   c. Availability of soil phosphorus
   d. Soil test level
   e. Crop grown
   f. Environmental concerns
   g. Iowa Phosphorus Index
   h. Availability of capital
   i. Crop removal
   j. Manure history
2. Recognize how each of the following factors affect soil retention of phosphorus and related losses through erosion.
   a. Soil clay type
   b. Soil pH
   c. Soil texture
   d. Crop residue
   e. Tillage system
   f. Slope and length of slope
   g. Precipitation
   h. Proximity to surface water bodies

3. For each of the following phosphorus fertilizer materials:

<table>
<thead>
<tr>
<th>Diammonium phosphate (DAP)</th>
<th>Monoammonium phosphate (MAP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triple superphosphate</td>
<td>Ordinary superphosphate</td>
</tr>
<tr>
<td>Ammonium polyphosphate (10-34-0)</td>
<td>Manure (by species)</td>
</tr>
</tbody>
</table>

   a. Recognize the analysis, physical form, storage, handling precautions
   b. Understand the phosphorus availability of each fertilizer materials
   c. Understand the advantages and disadvantages of their use in different systems
   d. Understand the advantages and disadvantages of different application methods

4. Understand the potential for phosphorus to contaminate water and practices to avoid, control, and trap phosphorus.

**Competency Area 4. Potassium**

1. Recognize how each of the following factors affects potassium fertilization.
   a. Soil properties
   b. Availability of soil potassium
   c. Soil test level
   d. Cropping system
   e. Tillage system
   f. Crop grown
   g. Availability of capital
   h. Crop removal
   i. Manure history

2. For each of the following potassium fertilizer materials:

<table>
<thead>
<tr>
<th>Potassium chloride</th>
<th>Potassium nitrate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potassium sulfate</td>
<td>Manure (by species)</td>
</tr>
</tbody>
</table>

   a. Recognize the analysis, physical form
   b. Handling precautions
   c. Potassium availability
Competency Area 5. Secondary and Micronutrients

1. Identify plant deficiency symptoms of each of the following secondary and micronutrients in corn, soybean, alfalfa, and small grains. Recognize soil properties and nutrient interactions affecting their availability to plants. Recognize the potential and limitations of soil and tissue testing and interpretations.
   a. Magnesium
   b. Sulfur
   c. Zinc
   d. Iron
   e. Boron

2. Understand the advantages and disadvantages of each of the following practices for identifying and correcting micronutrient deficiencies and toxicities. Know amendments such as
   a. Foliar application
   b. Soil application
   c. Adjusting soil pH

Competency Area 6. Soil and Plant Sampling Analysis

1. Understand Iowa State University (ISU), recommended soil sampling and handling procedures and the effect of the following factors on soil test results and interpretations:
   a. Taking consistent, representative samples
   b. Time of sampling
   c. Depth of sampling
   d. Sample location (within the fields) using soil maps, management zones and grid patterns
   e. Frequency of sampling
   f. Sampling density (number of samples per acre)
   g. Number of cores, location of cores, and mixing
   h. Sample packaging, information sheet, labeling, and shipping
   i. Choosing laboratory tests to be done
   j. Use of a certified soil testing laboratory
   k. Soil sample record keeping

2. Interpret laboratory soil and plant test reports for the following:
   a. Degree of nutrient deficiency or adequacy
   b. Expected crop response to applied nutrients by soil test category
   c. Units of measure
   d. Conversion between different units
   e. Determine a realistic yield potential and estimate nutrient removal amounts
   f. The effect of the following extractants on soil test P results
      i. Bray P-1
      ii. Mehlich-3P
      iii. Mehlich-3 ICP
      iv. Olsen P
g. Effect of time of year sample is taken, soil sample moisture and soil texture on K results
h. Effect of crop and crop rotation on nutrient recommendation

3. Know the appropriate plant parts and crop development stage to sample when determining the nutrient status of the following crops.
   a. Corn
   b. Soybean
   c. Alfalfa
   d. Small grains

SOIL AND WATER MANAGEMENT

Competency Area 1. Soils and Landscapes

1. Understand how to use Soil Survey maps and interpretations to identify the following:
   a. Soil properties
   b. Soil texture
   c. Soil slopes
   d. How these soil properties impact the suitability of soils for specific purposes

2. Understand the relationships among the following:
   a. Soil series
   b. Soil map unit (composition and complexes)
   c. Soil phase
   d. Understand the management implications of the soil map unit (composition and complexes)

3. Understand the major sources of soil parent materials, Major Land Resource Areas (MLRAs), in Iowa. Recognize general management considerations associated with different soil parent materials (loess, glacial till, alluvium, etc.).

Competency Area 2. Soil Properties

1. Understand how the following soil properties influence nutrients, water and herbicide retention, crop productivity, erosion and compaction.
   a. Soil texture
   b. Organic matter
   c. Soil structure
   d. Parent material
   e. Bulk density
2. Recognize the effects of soil structure, plant cover, plant residue, and tillage system on
   a. Water infiltration
   b. Water retention
   c. Soil erosion
   d. Soil temperature
   e. Soil moisture

3. Understand the differences between saturated and unsaturated water flow.

4. Understand the advantages and disadvantages of using surface and subsurface drainage
to manage excess water.

**Competency Area 3. Soil Erosion**

1. Understand the different phases of water erosion.
   a. Detachment
   b. Transportation
   c. Deposition

2. Understand the different types of wind erosion.
   a. Saltation
   b. Surface creep
   c. Suspension

3. Understand the relationship between the slope and slope length on erosion losses.

4. Identify and understand the following erosion control practices recommended for use in Iowa.
   a. Crop rotation
   b. Residue management
   c. Tillage systems including no-till
   d. Cover crops
   e. Terracing
   f. Contour buffer strips
   g. Water and sediment control basins
   h. Grass waterways
   i. Crop rotation
   j. Vegetative filter strips
   k. Riparian forest buffers
   l. Windbreaks
   m. Contouring
5. Understand the variables used in RUSLE2 (or Water Erosion Prediction Project (WEPP) for exams 2019 and after) and the Iowa P Index to assess the risk of erosion and phosphorous losses and how these tools are used.

6. Understand how to estimate ephemeral gully erosion and practices to control ephemeral gullies.

**Competency Area 4. Tillage**

1. Recognize how each of the following factors influence the selection and use of tillage systems.
   a. Crop rotation/field history, compaction
   b. Crop and cover crop residues
   c. Landscape and slope shape
   d. Soil properties
   e. Field design (terrace and waterway spacings, point rows, etc.)
   f. Governmental program requirements (HEL, nonHEL)
   g. Erosion control
   h. Soil health management

2. Describe the influence of tillage systems and tillage implements on each of the following:
   a. Soil disturbance/compaction/bulk density
   b. Long-term effects of tillage and no-till on soil properties
   c. Crop residue on the soil surface
   d. Incorporation of fertilizers, lime, and pesticides
   e. Weed control
   f. Soil organic matter
   g. Soil microbiology

3. Define and understand how to calculate and use the Soil Tillage Intensity Rating (STIR) and Soil Conditioning Index (SCI).

**Competency Area 5. Residue Cover**

1. Recognize how each of the following factors affect soil residue cover.
   a. Crop rotation
   b. Cover crops
   c. Harvesting methods
   d. Weather
   e. Tillage system
   f. Fertilizer and manure application
   g. Post-harvest stover removal
   h. Harvest equipment settings

2. Know how to measure soil residue cover and how to apply the results in a management system.
PEST MANAGEMENT

Competency Area 1. General Pesticide Use

1. Know the differences between Unclassified and Restricted use pesticides.

2. Understand the basic parts of a pesticide label.

3. Understand label restrictions:
   a. Restricted-entry intervals (R.E.I.s)
   b. Pre-harvest intervals (P.H.I.s)
   c. Worker protection standards (WPS)
   d. Crop rotation intervals
   e. Forage and grazing restrictions

4. Understand how pesticide resistance develops and where you can find resistance management information on the label.

5. Be familiar with pesticide and pesticide container disposal and pesticide spill cleanup.

6. Be familiar with laws and regulations and terminology related to pesticide use (for example: FIFRA and pesticide registration).

7. Understand the procedures required by the Iowa Bee Rule.

8. Use information found on pesticide labels to determine appropriate pesticide rates, additives and application timings.

9. Understand potential consequences of pesticides on non-target organisms and the environment.

10. Recognize how the following factors affect spray delivery, spray coverage, and off-target movement.
    a. Spray pressure
    b. Application speed
    c. Nozzle type and spacing
    d. Hoods and shields
    e. Boom height
    f. Spray droplet size
    g. Weather

11. Understand factors affecting volatility.

12. Explain the potential to damage nearby fields, gardens, pollinator habitat, and conservation areas.
13. Recognize how movement of pesticides in soil or into surface or groundwater may be affected by the following pesticide and soil properties.
   a. Soil texture/organic matter
   b. Erosion and erosion control practices
   c. Depth of water table
   d. Precipitation and runoff
   e. Pesticide application
   f. Pesticide degradation and persistence

14. Differentiate between point and non-point sources of pollution and describe practices that reduce point and non-point source contamination.
Competency Area 2. Weed Management

1. Identify the following weeds by common name at all growth stages. Know the characteristics of different life cycles. Classify each weed by life cycle.

<table>
<thead>
<tr>
<th>Grass family:</th>
<th>Smartweed family:</th>
<th>Pigweed family:</th>
</tr>
</thead>
<tbody>
<tr>
<td>barnyardgrass</td>
<td>curly dock</td>
<td>Palmer amaranth</td>
</tr>
<tr>
<td>downy brome</td>
<td>Pennsylvania smartweed</td>
<td>redroot pigweed</td>
</tr>
<tr>
<td>fall panicum</td>
<td>smooth dock</td>
<td>smooth pigweed</td>
</tr>
<tr>
<td>field sandbur</td>
<td>swamp smartweed</td>
<td>waterhemp</td>
</tr>
<tr>
<td>giant foxtail</td>
<td>wild buckwheat</td>
<td></td>
</tr>
<tr>
<td>green foxtail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>large crabgrass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>quackgrass</td>
<td>leafy spurge</td>
<td>wild mustard</td>
</tr>
<tr>
<td>shattercane</td>
<td>toothed spurge</td>
<td></td>
</tr>
<tr>
<td>wirestem muhly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>witchgrass</td>
<td>Lambsquarter family:</td>
<td>velvetleaf</td>
</tr>
<tr>
<td>woolly cupgrass</td>
<td>kochia</td>
<td>Venice mallow</td>
</tr>
<tr>
<td>yellow foxtail</td>
<td>lambsquarters</td>
<td></td>
</tr>
<tr>
<td></td>
<td>russia thistle</td>
<td>Carrot family:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>poison hemlock</td>
</tr>
<tr>
<td>Morningglory family:</td>
<td></td>
<td>Milkweed family:</td>
</tr>
<tr>
<td>field bindweed</td>
<td></td>
<td>wild carrot</td>
</tr>
<tr>
<td>hedge bindweed</td>
<td>common milkweed</td>
<td>wild parsnip</td>
</tr>
<tr>
<td>tall morningglory</td>
<td>hemp dogbane</td>
<td></td>
</tr>
<tr>
<td>Sunflower family:</td>
<td>Other weeds:</td>
<td>Nightshade family</td>
</tr>
<tr>
<td>bull thistle</td>
<td>Asiatic dayflower</td>
<td>black nightshade</td>
</tr>
<tr>
<td>cocklebur</td>
<td>common mullein</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>henbit</td>
<td>smooth groundcherry</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>common sunflower</td>
<td></td>
<td></td>
</tr>
<tr>
<td>common ragweed</td>
<td>horsetail</td>
<td></td>
</tr>
<tr>
<td>Canada thistle</td>
<td>Sericea lespedeza</td>
<td></td>
</tr>
<tr>
<td>dandelion</td>
<td>scouring rush</td>
<td></td>
</tr>
<tr>
<td>giant ragweed</td>
<td>wild hemp</td>
<td></td>
</tr>
<tr>
<td>horseweed</td>
<td>yellow nutsedge</td>
<td></td>
</tr>
<tr>
<td>musk thistle</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Understand the value of some “weeds” in the ecosystem, e.g., milkweed for monarch butterflies.

3. Understand the following principles relating to weed management:
   a. Weed seed bank
   b. Competitive interactions between crops and weeds

4. Understand the effects of tillage on weed populations and herbicide effectiveness.
5. Understand the factors that affect the effectiveness of rotary hoeing and inter-row cultivation and their roles in weed management.

6. Understand the interactions between herbicides, soil colloids and water in determining the effectiveness and fate of herbicides in the soil.

7. Understand the advantages and disadvantages of herbicide application timing:
   a. Early preplant
   b. Preplant incorporated
   c. Preemergence
   d. Postemergence

8. Understand how environment and spray additives influence the effectiveness of postemergence herbicides.

9. Know the factors that influence the development of herbicide resistance and ways to reduce the risk of selecting herbicide resistant weed biotypes.

10. Understand herbicide site of actions and their importance in resistance management.

11. For the following herbicide groups, be able to identify injury symptoms, carryover potential, off-target injury potential, and major factors that influence their performance. Know the major herbicides from these classes, how they are used, and their site of action.
    
    Group 1 (ACCase inhibitors)  Group 2 (ALS inhibitors)
    Group 3 (dinitroanilines)    Group 4 (growth regulators)
    Group 5 (triazines)         Group 9 (glyphosate)
    Group 14 (PPO inhibitors)   Group 15 (amide, etc.)
    Group 27 (HPPD inhibitors)
Competency Area 3. Plant Disease Management

1. Identify each of the following diseases and nematodes and how and when it infects crop plants (corn, soybean and forage alfalfa). Recognize host-plant symptoms, classify each by type of causal organism, and know when and how to scout. Know what environmental conditions favor each disease.

<table>
<thead>
<tr>
<th>Corn</th>
<th>Soybean</th>
<th>Forage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthracnose:</td>
<td>Bacterial blight</td>
<td>Anthracnose</td>
</tr>
<tr>
<td>-Leaf spot</td>
<td>Bacterial pustule</td>
<td>Black stem</td>
</tr>
<tr>
<td>-Root rot</td>
<td>Bean pod mottle virus</td>
<td>Pythium</td>
</tr>
<tr>
<td>-Stalk rot</td>
<td>Brown spot (Septoria)</td>
<td>Rhizoctonia</td>
</tr>
<tr>
<td>-Top dieback</td>
<td>Brown stem rot</td>
<td></td>
</tr>
<tr>
<td>Common rust</td>
<td>Cercospora leaf spot</td>
<td></td>
</tr>
<tr>
<td>Corn nematodes</td>
<td>Charcoal rot</td>
<td></td>
</tr>
<tr>
<td>Crazy top</td>
<td>Colletotrichum</td>
<td></td>
</tr>
<tr>
<td>Eyespot</td>
<td>“Damping-off”</td>
<td></td>
</tr>
<tr>
<td>Goss’s wilt</td>
<td>Downy mildew</td>
<td></td>
</tr>
<tr>
<td>Gray leaf spot</td>
<td>Frogeye leaf spot</td>
<td></td>
</tr>
<tr>
<td>Northern leaf</td>
<td>Fusarium</td>
<td></td>
</tr>
<tr>
<td>Pythium</td>
<td>Phytophthora</td>
<td></td>
</tr>
<tr>
<td>Southern rust</td>
<td>Pythium</td>
<td></td>
</tr>
<tr>
<td>Stalk rots</td>
<td>Soybean cyst nematode</td>
<td></td>
</tr>
<tr>
<td>Stewart's wilt</td>
<td>Soybean mosaic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Soybean rust</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sudden death syndrome</td>
<td></td>
</tr>
<tr>
<td></td>
<td>White mold</td>
<td></td>
</tr>
</tbody>
</table>

2. Recognize cultural techniques that can influence plant diseases and may be used for management of plant diseases, for example:
   a. Tillage
   b. Crop rotation
   c. Timing of planting

3. Know the difference among general resistance, race-specific resistance and tolerance and the role that they play in plant disease management.

4. Know the fungicide families and primary fungicides used to manage crop diseases in Iowa.

5. Understand the action threshold and timing of applications. Know the difference between preventative and curative applications.

6. Understand crop tolerance or response concerns with different fungicide families using adjuvants and fertilizer additives.
Competency Area 4. Insect and Mite Management

1. Identify each of the following field crop insects and mites, recognize each of their associated crop injury symptoms, and understand each of their life cycles. Identify the management strategies for the pests indicated by an asterisk (*).

<table>
<thead>
<tr>
<th>Corn</th>
<th>Soybean</th>
<th>Alfalfa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armyworm</td>
<td>Bean leaf beetle*</td>
<td>Alfalfa weevil*</td>
</tr>
<tr>
<td>Colaspis beetles</td>
<td>Green cloverworm</td>
<td>Aphids (pea &amp; cowpea)</td>
</tr>
<tr>
<td>Corn earworm</td>
<td>Grasshoppers*</td>
<td>B miner</td>
</tr>
<tr>
<td>Corn leaf aphid</td>
<td>Japanese beetles</td>
<td>Cloverleaf weevil</td>
</tr>
<tr>
<td>Corn rootworms*</td>
<td>Potato leafhopper</td>
<td>Grasshoppers*</td>
</tr>
<tr>
<td>Cutworms (black* &amp; dingy)</td>
<td>Seedcorn maggot</td>
<td>Plant bugs</td>
</tr>
<tr>
<td>European corn borer*</td>
<td>Soybean aphids*</td>
<td>Potato leafhopper*</td>
</tr>
<tr>
<td>Fall armyworm</td>
<td>Spider mites*</td>
<td>Spittlebugs</td>
</tr>
<tr>
<td>Grasshoppers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seedcorn maggot</td>
<td>Thistle caterpillar</td>
<td></td>
</tr>
<tr>
<td>Stalk borer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spider mites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seedcorn beetles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western bean cutworm*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Describe standard scouting procedures for pests indicated with an asterisk in the table above.

3. Identify common predators and parasitoids and their potential impact on pest insects.
   a. Beetles
   b. Lacewings
   c. Flies
   d. Wasps

4. Relate the degree-day concept to insect development and calculate degree-days for insect development. Understand how degree-days are used in insect management.

5. Know the concepts of economic threshold and economic injury level and how they are used in decision-making for insect control.
   a. Know how resistance management concepts relate to decisions regarding economic threshold or prophylactic treatments.

6. Recognize how cultural practices (e.g. crop rotation, date of planting, tillage, weed infestations, refuges, transgenic traits, etc.) can influence the potential for the occurrence of insects in crops.
CROP MANAGEMENT

Competency Area 1. Crop Establishment, Growth and Development

1. Understand how the following factors influence and affect success in crop establishment and growth.
   a. Planting date
   b. Soil conditions
   c. Cover crop management
   d. Weather
   e. Planting depth
   f. Variety selection
   g. Seed quality
   h. Seed treatment

2. Describe crop responses to row spacing and plant populations (seeding rates). Understand how to calculate seeding rates and crop stands, and determine planting depth.

3. Determine pure live seed (PLS) from seed sample analyses and know how to calculate desired seeding rates.

4. Relate the growing degree day concept (GDD) to crop development, recognize its function in production systems, and be able to calculate growing degree days for corn.

5. Understand the different root, vegetative and reproductive stages of corn and soybean.

6. Identify the growth stages during which crops are most susceptible to environmental stress or pest related injury.

7. Identify damage to agronomic crops from hail, frost, flooding, drought, and wind. Understand the impact of this damage on future development of the crop.

8. Determine crop damage levels that justify replanting and interpret the following factors that influence replant decisions:
   a. Calendar date
   b. Environmental conditions
   c. Stand count
   d. Uniformity of stand
   e. Plant stage
   f. Soil conservation management

9. Understand the benefits and drawbacks of various crop rotations.

10. Understand the influence of harvest factors on crops and forages.
**Competency Area 2. Biotechnology**

1. Understand the differences between traditional crop breeding and the use of genetic engineering to improve crop varieties.

2. Understand the factors that influence movement of traits among different populations of plants (gene flow).

3. Know the following terms and their significance to biotechnology in agriculture:

<table>
<thead>
<tr>
<th>DNA</th>
<th>chromosome</th>
<th>gene</th>
</tr>
</thead>
<tbody>
<tr>
<td>gene expression</td>
<td>gene flow</td>
<td>hybrid</td>
</tr>
<tr>
<td>outcrossing</td>
<td>protein</td>
<td>recombinant DNA</td>
</tr>
<tr>
<td>species</td>
<td>transgenic organism</td>
<td>mutation</td>
</tr>
<tr>
<td>yield drag</td>
<td>yield lag</td>
<td>identity preservation</td>
</tr>
<tr>
<td>Genetically Modified Organism (GMO)</td>
<td>non-GMO</td>
<td>plant patent</td>
</tr>
<tr>
<td>RNA interference</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Competency Area 3. Data Analysis**

1. Understand how to interpret data and basic statistics, e.g. mean, median, variance, significance, confidence intervals, LSDs, etc.

2. Understand how to interpret basic graphic displays of data.

3. Understand the relative value of anecdotal evidence.