Iowa Certified Crop Adviser

Performance Objectives

September 2023

Iowa Certified Crop Advisor Performance Objectives

Table of Contents

Front picture courtesy of the Iowa Department of Agriculture and Land Stewardship

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 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 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.
    a. Macronutrients: C, H, O, N, P, K
    b. Secondary Nutrients: Ca, Mg, S
    c. Micronutrients: B, Cl, Cu, Fe, Mn, Mo, Zn

2. Contrast 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 among CEC, mobility, and plant availability of nutrients in the soil.

4. Assess how the factors listed below influence nutrient movement and availability.
    a. Soil texture and structure/aggregate
    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
    l. Tillage system

5. Understand the nutrients available from materials other than commercial fertilizers, including the following:
    a. Manures
    b. Legumes
    c. Sludges – municipal and industrial biosolids
    d. Organic (biofuel, food, etc.) byproducts
    e. Wastewater
    f. Cover crops

6. Evaluate the effect of soil pH on nutrient availability and suitability of growing specific crops.

7. Determine the relationship between soil pH and buffer pH and the use of each to make lime recommendations.

8. Understand the effect of different fertilizer materials and amendments on soil pH.

9. Distinguish 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

10. Understand the composition and role of dolomitic limestone, calcitic limestone, gypsum, and other amendments used in soil management.

11. Recognize deficiency symptoms of the following nutrients in corn, soybean, and alfalfa:
    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. Describe 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. Computer models that match soil nitrogen availability to crop needs
    d. Crop, cost of N
    e. Value of crop
    f. Precipitation received

5. For the following nitrogen fertilizers:

Anhydrous ammonia	Urea	Ammonium sulfate
MAP and DAP	UAN solutions	Manure (by species)

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

6. Assess the proper methods, benefits and limitations of in-season and end-of-season methods used to assess nitrogen needs or availability including but not limited to:
    a. Late-spring soil nitrate
    b. Tissue testing
    c. NDVI
    d. Computer models that match soil nitrogen availability to crop needs
    e. Fall cornstalk nitrate test

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. Economics
    i. Crop removal
    j. Manure history

2. Evaluate 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:

Diammonium phosphate (DAP)	Monoammonium phosphate (MAP)
Ammonium polyphosphate (10-34-0)	Manure (by species)
MESZ (nitrogen, phosphate, sulfur, zinc)	

    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.
    a. P attached to soil particles (particulate P)
    b. dissolved P

Competency Area 4. Potassium

1. Determine how each of the following factors affects potassium fertilization:
    a. Soil properties (parent material, cation exchange capacity, type of clay particles, drought potential)
    b. Availability of soil potassium
    c. Soil test level
    d. Cropping system
    e. Tillage system
    f. Crop grown
    g. Economics
    h. Crop removal
    i. Manure history

2. For each of the following potassium fertilizer materials:

Potassium chloride	Manure (by species)
Potassium sulfate	

    a. Recognize the analysis, physical form
    b. Handling precautions
    c. Potassium availability

Competency Area 5. Sulfur

1. Define the sulfur cycle in soils and know the mechanisms and sulfur forms involved in each of the following processes:
    a. Mineralization
    b. Oxidation
    c. Immobilization
    d. Atmospheric deposition
    e. Plant uptake
    f. Leaching
    g. Crop removal
    h. Loss from soil erosion

2. Describe the factors that determine appropriate sulfur fertilization rates. For example:
    a. Crop grown
    b. Cropping system
    c. Soil texture and organic matter
    d. Atmospheric deposition
    e. Sulfur in irrigation water
    f. Fertilizer used

g.   Application method and timing
h.   Precipitation
i.   Economics

3.   For each of the following sulfur fertilizer materials:

Elemental sulfur	Gypsum (calcium sulfate)
Potassium sulfate	Potassium thiosulfate
Ammonium sulfate	Ammonium thiosulfate
Sulfur-coated urea	Manure (by species)

a.   Recognize the analysis, physical form, and availability
b.   Explain advantages and disadvantages in different situations
c.   Describe application methods and timing

Competency Area 6. Secondary and Micronutrients

1.   Identify plant deficiency symptoms of each of the following secondary and micronutrients in corn, soybean, and alfalfa. Recognize soil properties and nutrient interactions affecting their availability to plants. Determine 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 7. Manure

1.   Explain how manure analysis, availability, and volatilization affect nutrients available for crop uptake.

2.   Recognize the relative nutrient value of manure based on animal species as well as collection, storage, and application practices.

3.   Match nutrients from manure to crop requirements and the need for additional fertilizer inputs.

4. Know how Phosphorus Index calculations are used to determine the maximum manure application rate that can be applied to a field in Iowa.

5. Describe manure application methods that protect against surface and groundwater contamination.

6. Understand the importance of separation distances from designated areas for manure applications.

Competency Area 8. 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. Establishing a realistic yield potential and estimating nutrient removal with crop harvest
   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 recommendations

3. Know the appropriate plant parts and crop development stage to sample when determining the nutrient status of corn, soybean, alfalfa, and small grains.

Competency Area 9. Nutrient Reduction

1. Explain how the Iowa Nutrient Reduction Strategy is used to assess and reduce nutrients in Iowa waters and the Gulf of Mexico.

2. Define point and nonpoint sources of nutrients in surface waters.

3. Describe how the following can be used to reduce nitrogen loss from farm fields to surface waters:
    a. Application timing
    b. Nitrogen source
    c. Application rate
    d. Nitrification inhibitor
    e. Cover crops
    f. Living mulches
    g. Perennial crops
    h. Wetlands
    i. Bioreactors
    j. Buffers
    k. Saturated buffers

4. Describe how the following can be used to reduce phosphorus loss from crop fields to surface waters:
    a. Soil testing
    b. Phosphorus source
    c. Application rate
    d. Fertilizer and manure placement
    e. Reduced tillage, strip-till, and no-till
    f. Extended crop rotations
    g. Cover crops
    h. Perennial crops
    i. Terraces
    j. Wetlands
    k. Buffers
    l. Sediment control
    m. Blind inlet

SOIL AND WATER MANAGEMENT

Competency Area 1. Soils and Landscapes

1. Know how to use digital Soil Survey maps and interpretations to identify the following:
    a. Soil properties
    b. Soil texture
    c. Soil slopes

2. Understand the following soil survey map conventions:
    a. Soil series
    b. Soil map unit (composition and complexes)
    c. Erosion phase
    d. Slope

3. Evaluate the major sources of soil parent materials in Iowa. Recognize general management considerations associated with different soil parent materials (loess, glacial till, alluvium, etc.).

Competency Area 2. Soil Properties

1. Determine 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, cover crops, 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. Compare the advantages and disadvantages of using surface and subsurface drainage to manage excess water.

Competency Area 3. Soil Erosion

1. Understand the processes leading to wind and water erosion.

2. Describe the relationship between the slope and slope length on erosion losses.

3. Identify and understand the following erosion control practices recommended for use in Iowa.
    b. Crop rotation
    c. Residue management
    d. Tillage systems including no-till
    e. Cover crops
    f. Terracing
    g. Contour buffer strips
    h. Water and sediment control basins
    i. Grass waterways
    j. Crop rotation
    k. Vegetative filter strips
    l. Riparian forest buffers
    m. Windbreaks
    n. Contouring

4. Evaluate how the variables in RUSLE2, and Water Erosion Prediction Project (WEPP)) are used to assess the risk of soil erosion and phosphorous losses.

5. Understand how the variables in the Iowa P Index are used to assess the risk of phosphorous losses from fields.

6. Know 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, non-HEL)
    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 on soil properties
   c. Crop residue on the soil surface and in the soil profile
   d. Incorporation of fertilizers, lime, and pesticides
   e. Weed control
   f. Soil organic matter
   g. Soil microbiology

3. Describe differences in soil properties between long-term and rotational no-till (no-till in only one phase of the crop rotation).

4. Define and understand how to interpret the following:
   a. Soil Tillage Intensity Rating (STIR)
   b. 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.

Competency Area 6. Soil Health

1. Identify the physical, chemical, and biological factors used to assess soil health.

2. Describe how the following contribute to soil health:
   a. Reducing tillage
   b. Continuous live plant cover
   c. Crop residues
   d. Maintaining appropriate soil pH and nutrient status
   e. Carbon sequestration

3.   Define the following terms related to carbon capture in the soil:
    a.   Carbon sequestration
    b.   Carbon credits
    c.   Carbon cost-share program

4.   Describe how each of the following affect the outcome of cover cropping:
    a.   Species planted
    b.   Planting date
    c.   Seeding rate
    d.   Pest management
    e.   Weather
    f.   Termination date
    g.   Termination method
    h.   Management of the subsequent crop

PEST MANAGEMENT

Competency Area 1. General Pesticide Use

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

2.   Locate the basic parts of a pesticide label.

3.   Understand label restrictions:
     a. Application rates (per application and maximum annual)
     b. Application date and/or crop growth stage cut offs
     c. Use precautions
     d. Restricted-entry intervals (R.E.I.s)
     e. Pre-harvest intervals (P.H.I.s)
     f. Worker protection standards (WPS)
     g. Crop rotation intervals
         i   Apply to the use of cover crops
     h. Forage and grazing restrictions
         i   Apply to the use of cover crops

4.   Evaluate 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.   Know the laws, 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:
     a.   Appropriate pesticide rates
     b.   Growth stage or size of pest to target
     c.   Additives
     d.   Application timings.

9.   Describe the potential consequences of pesticides on non-target organisms and the environment, and how to determine this for a pesticide from its label.

10. Explain how mixtures of pesticide active ingredients with differing sites of action are used to broaden the spectrum of pest control and slow the development of pesticide resistance.

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

12. Explain how the following influence the risk of pesticide drift into sensitive areas, including:
    a. Drift reduction agents
    b. Application method
    c. Wind speed and direction
    d. Air temperature
    e. Temperature inversion
    f. Humidity
    g. Buffers
    h. People, sensitive plants, and endangered species in areas adjacent to the application site

13. Recognize the factors affecting offsite movement from pesticide volatility, including:
    a. Vapor pressure
    b. Formulation
    c. Temperature
    d. Humidity
    e. Wind direction and speed
    f. Volatility reduction adjuvants

14. Explain the potential for pesticide applications to damage nearby fields, gardens, vineyards, pollinator habitat, and conservation areas.

15. 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

16. 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.

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

2. Asses 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
    c. Cover cropping
    d. Critical weed free period
    e. Noxious weeds

4. Understand the effects of tillage on weed populations and herbicide effectiveness.

5. Evaluate the factors that affect the effectiveness of rotary hoeing and inter-row cultivation and their roles in weed management.

6. Recognize 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
    e. Fall residual

8. Recognize 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. Evaluate 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 herbicide active ingredients from these classes, how they are used, and their site of action.

Group 1 (ACCase inhibitors)	Group 9 (EPSP synthase inhibitor)
Group 2 (ALS inhibitors)	Group 10 (glutamine synthetase inhibitor)
Group 3 (microtuble assembly inhibitors)	Group 14 (PPO inhibitors)

Group 4 (synthetic auxins)	Group 15 (very long-chain fatty acid synthesis inhibitor)
Group 5 (photosystem II inhibitors)	Group 27 (HPPD inhibitors)

12. Determine how cover crops can play a role in weed management.

Competency Area 3. Plant Disease Management

1. Identify each of the following diseases as well as how and when it infects crop plants (corn, soybean, and 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.

Corn	Soybean	Alfalfa
Anthracnose:	Anthracnose (Colletotrichum)	Anthracnose
-Leaf spot	Bacterial blight	Black stem
-Root rot	Bacterial pustule	Pythium
-Stalk rot	Bean pod mottle virus	Rhizoctonia
-Top Dieback	Brown spot (Septoria)	
Common rust	Brown stem rot	
Crazy top	Cercospora leaf spot	
Eyespot	Charcoal rot	
Goss's wilt	"Damping-off"	
Gray leaf spot	Diaporthe/Phomopsis Fungi Complex	
Northern leaf blight	Downy mildew	
Pythium	Frogeye leaf spot	
Southern rust	Fusarium	
Stalk rots	Phytophthora	
Stewart's wilt	Pythium	
Tar spot	Soybean mosaic	
	Sudden death syndrome	
	White mold	

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. Planting date
    d. Proper fertilization

3. Recognize the differences among general resistance, race-specific resistance, and tolerance within crop genetics as well as the role they play in plant disease management.

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

5. Describe the use of biological actives as seed treatments for seedling diseases.

6. Understand the action threshold and timing of fungicide applications.

7. Compare the differences between preventative and curative applications.

8. Know what corn and soybean diseases are controlled by fungicides and those that are not.

9. Recognize crop tolerance or response concerns with different fungicide families when using adjuvants and fertilizer additives.

10. Describe how rotating sites of action within as well as between growing seasons and using mixtures of active ingredients slow the development of fungicide resistance.

11. Understand the effect cover crops can have on crop diseases.

Competency Area 4. Nematode Management

1. Identify soybean cyst nematode and the damage it causes to soybean plants.

2. Identify corn nematodes and the damage they cause to corn plants.

3. Know how to properly collect soil samples for soybean cyst and corn nematodes and interpret nematode test results.

4. Describe soil properties, weather conditions, and management practices influencing infection and severity of plant parasitic nematodes.

5. Understand the use of the following for managing plant parasitic nematodes:
   a. Rotation to non-host crops
   b. Resistant varieties (i.e. Peking and PI88788 resistance in soybeans)
   c. Periodically rotating with susceptible varieties to maintain a susceptible nematode population
   d. Seed treatments

Competency Area 5. 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 (*).

Corn	Soybean	Alfalfa
Armyworm	Bean leaf beetle*	Alfalfa weevil*
Colaspis beetles	Gall midge	Aphids (pea & cowpea)
Corn earworm	Green cloverworm	Blister beetles
Corn leaf aphid	Grasshoppers*	Cloverleaf weevil
Corn rootworms*	Japanese beetles	Grasshoppers
Cutworms (black* & dingy)	Potato leafhopper	Plant bugs
European corn borer*	Seedcorn maggot	Potato leafhopper*
Fall armyworm	Soybean aphids*	Spittlebugs
Grasshoppers	Spider mites*	
Seedcorn maggot	Stink bugs	
Stalk borer	Thistle caterpillar	
Spider mites	Whitefly	
Seedcorn beetles		
Western bean cutworm*		

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

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

4. Calculate degree-days for insect development and relate the degree-day concept to insect development and management.

5. Understand the concepts of economic threshold and economic injury level and how they are used in decision-making for insect control.

6. Know how resistance management concepts relate to decisions regarding economic threshold or preventative treatments.

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

8. Understand how the following factors are integrated to slow resistance to insect protection traits and insecticides:
    a. Crop rotation
    b. Trait pyramids
    c. Rotating transgenic insect protection traits
    d. Insecticidal seed treatments
    e. Using insecticides in combination with untraited seed
    f. Rotating insecticide sites of action

9. Explain the importance of selecting insecticides that control the targeted insect pest without adversely affecting beneficial insects and non-targeted organisms.

CROP MANAGEMENT

Competency Area 1. Crop Growth and Development

1.	Understand the different root, vegetative and reproductive stages of corn, soybean, alfalfa, and small grains.

2.	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.

3.	Describe how photoperiod and temperature combine to determine date of first flower in soybean.

4.	Identify the growth stages when corn, soybean, alfalfa, and small grains are most susceptible to environmental stress or injury from pests.

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

Competency Area 2. Crop Establishment and Management

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).

3.	Understand how to calculate seeding rates and assess crop stand density.

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

5.	Identify proper planting depth for corn, soybean, forage legumes, forage grasses, and small grains.

6. 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

7. Understand the benefits and drawbacks of continuous cropping, two-year crop rotation, and multi-year crop rotation.

8. Describe the use of:
   a. Nitrogen fixation
   b. Growth stimulants
   c. Nematicides
   d. Seed treatments

9. Understand the influence of harvest factors on crops and forages.

Competency Area 3. Biotechnology

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

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

DNA	chromosome	gene
gene expression	gene flow	hybrid
outcrossing	protein	recombinant DNA
species	transgenic organism	mutation
yield drag	yield lag	identity preservation
Genetically Modified Organism (GMO)	non-GMO	plant patent
RNA interference		

3.   Describe the importance of the Product Use Guide in obtaining requirements and guidelines for the use of seed products containing transgenic traits.

Competency Area 4. Data Analysis

1.   Know how to validate the effectiveness of seed, chemical, and biological products through credible field trials.

2.   Explain the importance of replication as well as multiple sites and years to validating performance of a product.

3.   Understand how to interpret data and basic statistics, such as mean, median, variance, significance, confidence intervals, LSDs, etc.

4.   Know how to interpret graphic displays of data.

5.   Assess the value of anecdotal evidence relative to empirical data obtained from research trials.

Competency Area 5. Digital Agronomy

1.   Describe how the following are used as digital crop and soil management tools:
     a.   Global positioning and geolocation
     b.   Mapping software
     c.   Geographic information systems
     d.   Yield maps
     e.   Soil maps
     f.   Imagery from satellites, airplanes, and unmanned aerial systems
     g.   Remote sensing
     h.   Proximate sensing
     i.   Crop and soil models
     j.   Soil and plant tissue testing
     k.   Variable rate equipment and technologies

2.   Explain the importance of precision, accuracy, and calibration to obtaining high-quality data for digital crop and soil management.

3.   Understand the concepts, costs, and benefits for managing crop fields using management zones.

4.   Describe how digital agronomy tools can be used to facilitate on-farm research.