

MINNESOTA



PERFORMANCE OBJECTIVES

2021

Prepared by: **The Minnesota Certified Crop Adviser Board**

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Introduction

The Certified Crop Adviser (CCA) program is a voluntary organization of professionals formed to establish a base standard of knowledge, skills, and abilities for individuals who advise farmers on crop management and production inputs. The goal of the CCA program is to demonstrate professionalism in providing economically and environmentally sound production advice to agronomic producers.

The CCA program is coordinated Internationally (U.S., Canada, and Mexico) by the American Society of Agronomy (www.certifiedcropadvisor.org). It is administered locally by a Minnesota Local Board composed of representatives from agri-business, agricultural consulting, University of Minnesota Extension, state and federal government agencies and farmers.

In addition to passing both an International and Local Board exams, the applicant must also demonstrate work experience and/or education requirements.

These Performance Objectives provide guidance to individuals preparing for the Minnesota 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 importance in Minnesota. Exam questions are based on these Performance Objectives and the International Performance Objectives as they apply to providing advice on crops grown in Minnesota.

The Minnesota Performance Objectives outline the knowledge and skill areas that Certified Crop Advisers in Minnesota have indicated they need to effectively carry out their duties. These Performance Objectives cover the minimum level of fundamental principles considered essential for effective crop advising. Continuing education through board approved courses as well as individual learning to increase the knowledge and proficiency of each CCA is required throughout their career. The scientific basis of these Performance Objectives needs to be acquired through critical study of valid sources. Individual CCAs are expected to be able to critically evaluate the science and validity of various sources and be able to apply sound science and useful recommendations to solve crop production problems in Minnesota.

*Cover Photo: University of Minnesota Extension

List of Major Crops in MN

- a. Alfalfa
- b. Barley
- c. Canning peas
- d. Canola
- e. Corn
- f. Dry edible beans
- g. Oats
- h. Orchard grass
- i. Red clover
- j. Reed canary grass
- k. Rye
- l. Potatoes
- m. Smooth brome grass
- n. Spring wheat
- o. Soybean
- p. Sugarbeet
- q. Sunflower
- r. Sweet corn
- s. Timothy
- t. Winter wheat

NUTRIENT MANAGEMENT

Competency Area 1. Basic Concepts in Soil Fertility

1. Identify the 16 elements essential for plant growth.
2. Characterize the essential nutrients (elements) as either mobile or immobile in soils.
3. Understand the effect of basic soil properties such as texture, bulk density and compaction pH, and soil drainage on the availability of nutrients to plants.
4. Describe, in general terms, the concept of cation exchange capacity.

Competency Area 2. Basic Concepts of Plant Nutrition

1. Understand the concepts of mass flow, diffusion, and root interception as the mechanisms for movement of plant nutrients to the surface of roots and root hairs.
2. Understand the importance of root hairs in nutrient uptake.
3. Describe how root structure has a major effect on nutrient uptake.
4. Relate nutrient uptake patterns of major crops of Minnesota in relation to stage of development.

Competency Area 3. Soil pH and Soil Amendments

1. Give a brief description of the concepts of soil pH, buffer pH, acid and calcareous soils.
2. Recognize how the following affect lime recommendations:
 - a. crop grown
 - b. soil texture
 - c. soil organic matter content
 - d. location in state
 - e. depth of sampling
 - f. tillage system
3. Describe how liming acid soil increases the soil pH.
4. Describe, in general, how soil pH affects nutrient availability.
5. Describe **E**ffective **N**eutralizing **P**ower (**ENP**).
6. Describe how characteristics of a liming material influence the rate of liming material recommended.
7. Describe the neutralizing value, physical properties and handling precautions of the following liming materials:
 - a. calcitic limestone
 - b. dolomitic limestone
 - c. quicklime (calcium hydroxide)

- d. slaked lime
 - e. fluid lime
 - f. marl
 - g. water treatment lime
 - h. wood ashes
8. List the benefits of liming for crop production.
 9. Understand the concept of soil test information required for variable rate lime application.
 10. Identify materials that may be used to lower soil pH of calcareous and saline soils.
 11. Distinguish between calcareous and saline soils.

Competency Area 4. Primary Plant Nutrients (N, P, K)

Nitrogen

1. Understand the function(s) of nitrogen in plants.
2. Identify the forms of nitrogen taken up by growing plants.
3. Describe how the following processes of nitrogen in soils are different from each other:
 - a. fixation
 - b. ammonification
 - c. nitrification
 - d. volatilization
 - e. denitrification
 - f. immobilization
 - g. leaching
4. Describe symbiotic nitrogen fixation and how the process is affected by:
 - a. soil pH
 - b. soil moisture
 - c. level of nitrogen in the soil
 - d. population of Rhizobia and other soil bacteria
5. Recognize how soil physical properties affect nitrogen fertilization.
6. Recognize how crops grown in rotation affect nitrogen fertilization.
7. Recognize how soil drainage, irrigation, rainfall, and potential for water contamination affect nitrogen fertilization practices.
8. Understand the difference between nitrification inhibitors and urease inhibitors and how to use them effectively.

9. Understand the analysis, physical form, and handling precautions for each of the following nitrogen fertilizer sources:
 - a. anhydrous ammonia (82-0-0)
 - b. urea (46-0-0)
 - c. urea-ammonium nitrate (28-0-0)
 - d. ammonium nitrate (34-0-0)
 - e. ammonium sulfate (21-0-0-24)
 - f. polymer coated urea
 - g ammonium thiosulfate
 - h MAP
 - i DAP
10. Describe the relationship of soil texture to movement of ammonium and nitrate-nitrogen through soils.

Phosphorus

1. Recognize how the soil affects the management of phosphate fertilizers.
2. Understand how the intended crop affects the placement of phosphate fertilizers.
3. Identify the appropriate soil properties that affect the choice for use of the Bray, Olsen, or Mehlich III extraction procedures.
4. List the analysis, physical form, and handling precautions, if any, for each of the following phosphate fertilizers:
 - a. rock phosphate
 - b. superphosphoric acid
 - c. triple superphosphate
 - d. monoammonium phosphate
 - e. diammonium phosphate
 - f. ammonium polyphosphate
5. Describe the differences in orthophosphate and polyphosphate and relate them to the effect on crop production.

Potassium

1. Understand the effect of soil physical and chemical properties on the availability of potassium and associated management of potash fertilizers.
2. Recognize how intended crop and choice of tillage system affect the management of potash fertilizers.

3. Describe the physical form and analyses of each of the following fertilizers that supply potassium:
 - a. potassium chloride
 - b. potassium sulfate
 - c. potassium nitrate
 - d. potassium/magnesium sulfate

Competency Area 5. Secondary and Micronutrients

Calcium and Magnesium

1. Recognize how the intended crop affects the management of soil amendments and/or fertilizers used to supply calcium and magnesium.
2. Understand how calcium and magnesium may interact with potassium in plants.
3. Describe the physical form and analysis of each of the following calcium and/or magnesium sources:
 - a. calcitic lime
 - b. dolomitic lime
 - c. gypsum
 - d. potassium/magnesium sulfate
 - e. Epsom salts

Sulfur

1. Understand the effect of soil physical and chemical properties on availability of sulfur in soils and management of sulfur fertilizers.
2. Recognize how the intended crop affects the management of sulfur fertilizers.
3. Understand the role of soil microorganisms on the availability of soil and fertilizer sulfur.
4. Understand sulfur cycle components and how they relate to plant availability of sulfur.
5. Describe the physical form, analysis, and handling precautions, if any, for each of the following sources of sulfur:
 - a. elemental sulfur
 - b. gypsum
 - c. ammonium sulfate
 - d. ammonium thiosulfate
 - e. potassium/magnesium sulfate

Micronutrients

1. Understand the effect of soil physical and chemical properties and the availability of micronutrient fertilizers.
2. List the essential micronutrients.
3. For Minnesota, identify the soil and cropping conditions where a specific micronutrient deficiency might be expected.
4. Be able to identify micronutrient deficiencies and toxicities on the major crops in MN.
5. Describe the physical form, water solubility, and handling precautions, if any, for the following two broad categories of micronutrient sources:
 - a. inorganic salts
 - b. organic chelated products
6. Describe advantages and disadvantages of fertilizer prills containing blends of various nutrients relative to single nutrient sources.

Competency Area 6. Soil Sampling

1. Recognize soil sampling as a management practice used for the following purposes:
 - a. a basis for fertilizer recommendations.
 - b. monitoring changes in soil test values as affected by crop production practices.
 - c. an aid in diagnosing nutrient deficiencies.
2. Describe the sampling procedure used for the Soil Nitrate Test used in either fall or spring.
3. Describe the advantages and disadvantages of grid sampling and zone sampling as a basis for understanding nutrient variability and fertilizer applications.
4. Recognize the effect of depth of sample collection on soil test values.
5. Describe changes in soil test values for various nutrients over time as affected by cropping system, soil properties, and nutrient mobility.
6. Understand that the pattern used in sample collection is affected by tillage system and placement of the immobile nutrients.
7. Understand the correct procedure for handling soil samples after they have been collected.
8. Understand the sampling techniques that are recommended for grid sampling and their potential impact on analytical results and subsequent fertilizer recommendation.
9. Understand the procedures for sampling an entire field including the number of cores needed and locations to avoid in the collection of the sample.
10. Understand how frequently fields should be sampled for measurement of the various nutrients.
11. Understand the importance of submitting samples to certified soil testing labs.

Competency Area 7. Fertilizer Recommendations

1. Know which nutrients are useful in setting realistic yield goals and are used to make accurate fertilizer recommendations.
2. Understand which nutrients are applicable to the following concepts:
 - a. crop sufficiency
 - b. soil building and maintenance
 - c. crop removal
3. Recognize the economic and environmental implications involved in making fertilizer recommendations.
4. Understand why correlation and calibration studies are fundamental to developing nutrient guidelines.
5. Understand the concept of relative soil test level as it relates to nutrient sufficiency and probability of response to applied immobile nutrients.
6. Given soil test information, realistic yield goal, and an understanding of the grower's goals and objectives, make economically and environmentally sound fertilizer recommendations.
7. Understand the concepts and rationale for nitrogen rate guidelines based on the Maximum Return to Nitrogen (MRTN).
8. Understand the possible relationships of cation exchange capacity to nutrient availability.
9. Interpret the results of laboratory analysis of soil samples.
10. Distinguish a soil test value for P and/or K as being low, medium, or high.
11. Understand the factors that should be considered in arriving at a realistic yield goal.

Competency Area 8. Plant Analysis

1. Understand the predictive and diagnostic purposes when using plant analysis.
2. Recognize how the following affect the results of analysis of tissue samples:
 - a. crop
 - b. crop growth stage
 - c. plant part
 - d. sample handling
3. Recognize how the following describe the level of plant nutrition:
 - a. critical value
 - b. sufficiency range
 - c. luxury consumption
 - d. toxic level

Competency Area 9. Fertilizer Materials and Application

1. Calculate rates of various fertilizer grades needed for optimum yield based on the analysis of the fertilizer, realistic yield goal, and the results of a soil test.
2. Understand how fertilizer placement is affected by:
 - a. soil test information
 - b. tillage systems
 - c. intended crop
 - d. nutrient mobility
 - e. fertilizer material used
3. Understand how fertilizer timing is affected by:
 - a. soil test information
 - b. tillage systems
 - c. intended crop
 - d. nutrient mobility
 - e. fertilizer material used
4. Define fertigation.
5. Understand the importance of equipment calibration.
6. Describe the following fertilizer placement methods:
 - a. deep banding
 - b. broadcast
 - c. surface band
 - d. fertigation
 - e. foliar application
 - f. sidedress
 - g. topdress
 - h. pop-up or seed placed
 - i. starter band

Competency Area 10. Manure Management

1. Calculate the value of nutrients in manure.
2. Recognize the factors that affect the nutrient content of manure.
3. Understand how method and time of application affect the nutrient value of manure.
4. Describe manure sampling and handling procedures.
5. Understand the procedure to be followed in the calibration of a manure spreader.

6. Understand the importance and magnitude of nutrient losses associated with the different methods of manure storage and application.
7. Describe the effect of manure on:
 - a. soil tilth
 - b. nutrient supply to crops
 - c. microbial activity
8. Understand how variability in applications can be affected by:
 - a. storage
 - b. handling
 - c. agitation
 - d. patterns of application in the field

Competency Area 11. Diagnosis of Nutrient Deficiencies in Crops

1. Understand the advantages and disadvantages of using a soil analysis, plant samples, and/or canopy sensing/imagery for the purpose of determining nutrient deficiencies.
2. Know nutrient mobility within the crops and recognize the deficiency symptoms in major Minnesota crops for:
 - a. nitrogen
 - b. phosphorus
 - c. potassium
 - d. calcium
 - e. magnesium
 - f. sulfur
 - g. micronutrients

Competency Area 12. Nutrient Management Planning

1. Construct a realistic yield goal on either a field or whole farm basis based on:
 - a. production history
 - b. soil survey information
 - c. level of management of the grower
2. Use the results of a soil-testing program, realistic yield goal, sources of nutrients and an appropriate analysis of each to design a nutrient management plan that is both economically and environmentally sound.
3. Understand the Best Management Practices (BMPs) for nitrogen and how they are used as guidelines for the application of nitrogen.

4. Understand the guidelines for effective use of phosphorus fertilizers.
5. Be familiar with the following components of a NRCS Nutrient Management Plan:
 - a. soil survey map
 - b. field map
 - c. sensitive features of the landscape
 - d. practices to be used for sensitive features
 - e. practices to be used to address **Soil Test Phosphorus (STP)** levels at or greater than 21 ppm (Bray) or 16 ppm (Olsen)
 - f. crop rotation and planned crop
 - g. schedule of nutrient applications
 - h. calculations and data used to develop the schedule of nutrient applications including nutrient budgets
 - i. operation, maintenance, and record keeping
 - j. uses of manure as a nutrient source

SOIL AND WATER MANAGEMENT

Competency Area 1. Basic Physical Properties of Soils

1. Provide a brief description of the following terms:
 - a. soil texture
 - b. soil structure
 - c. soil organic matter content
 - d. pore space (porosity)
 - e. bulk density
 - f. water holding capacity
 - g. rate of water infiltration
 - h. drainage category
 - i. field capacity
 - j. wilting point
 - k. free water
 - l. available water
 - m. evapotranspiration

Competency Area 2. Soil Erosion

1. Briefly describe the various types of soil erosion and cause of each:
 - a. sheet
 - b. rill
 - c. wind
 - d. gully
 - e. ephemeral
2. Understand the role of the following practices in reducing soil erosion:
 - a. crop rotations that include a perennial legume
 - b. residue management
 - c. contour strips
 - d. grass waterways
 - e. field windbreaks
 - f. terraces, water diversions, and sediment control basins
 - g. plants as wind barriers
 - h. grass filter strips
 - i. various tillage systems
3. Understand the phrase, “tolerable soil loss.”

Competency Area 3. Tillage and Residue Management

1. List advantages, disadvantages, and limitations of the following tillage systems:
 - a. mulch tillage
 - b. strip tillage
 - c. ridge till
 - d. no-till
2. Describe how the following affect the selection of a tillage system:
 - a. crop and rotation
 - b. soil physical properties
 - c. climate
 - d. costs of production and anticipated returns
 - e. expected reduction in soil and wind erosion
 - f. pest management
 - g. cost of equipment
3. Understand the methodology used in measuring residue cover and the calculations involved.

Competency Area 4. Soil Compaction and Restrictive Layers

1. Identify and briefly describe the characteristics of the following restrictive layers:
 - a. subsurface compaction
 - b. surface compaction
 - c. crusting
2. Describe how to mitigate soil compaction and restrictive layers.

Competency Area 5. Drainage

1. Recognize how soil physical properties affect movement of water through soils.
2. Describe the process of water removal from the landscape via tile drainage.
3. Describe how excessive soil water affects:
 - a. root growth and development
 - b. nutrient availability
 - c. nutrient uptake by plants
 - d. loss of nitrogen from the root zone
 - e. crop yield for various crops
 - f. choice of tillage systems
4. Identify the various materials that have been and are now used for tile drainage systems.
5. Understand how the depth and spacing affect the effectiveness of tiling systems.

6. Describe a “pattern tile” system.
7. Have a general knowledge of agencies that regulate and manage drainage in Minnesota.

Competency Area 6. Water Quality

1. Describe how the following factors might affect loss of pesticides from the landscape via movement of surfaced and/or drainage water:
 - a. solubility of the pesticide
 - b. half-life
 - c. ability to adsorb to soil particles
 - d. soil texture
 - e. drainage category
 - f. soil organic matter percentage
 - g. soil and water conservation
 - h. rainfall intensity
 - i. rainfall amount
 - j. snow melt
 - k. soil microbial populations
 - l. plant root growth
 - m. slope characteristics
2. Understand how the following affect loss of nitrogen from the landscape:
 - a. soil texture
 - b. nitrogen chemistry
 - c. soil drainage category
 - d. rainfall amount and intensity
 - e. tile spacing
 - f. soil conservation practices
 - g. snow melt
 - h. slope characteristics
 - i. rate and time of irrigation
3. Understand relative loss of phosphorus via surface flow or tile water.
4. Describe how placement of fertilizer and/or manure affect loss of nitrogen and phosphorus via surface flow.
5. Understand how the following practices can affect both sediment and nutrient loss from the landscape:
 - a. control of soil erosion

- b. grass waterways
 - c. wetland management
 - d. residue management
 - e. tillage systems
 - f. crop rotation
 - g. use of cover crops
 - h. saturated buffers
 - i. bioreactors
 - j. multi-purpose drainage
6. Understand the meaning of the term, "Total Maximum Daily Load" (TMDL).
 7. List soil physical properties that may have a positive or negative effect on "soil health".
 8. List soil physical properties that might affect management of irrigated crops.
 9. Describe how the following will affect the timing of application of fertilizer and manure:
 - a. soil moisture content
 - b. soil texture
 - c. soil temperature
 - d. snow cover

PEST MANAGEMENT

Competency Area 1. Weed Management and Herbicides

Weed Identification and Biology

1. Classify each weed listed below by its life cycle (annual, biennial or perennial).
 - a. barnyardgrass
 - b. Canada thistle
 - c. cocklebur
 - d. common dandelion
 - e. common lambsquarters
 - f. common ragweed
 - g. eastern black nightshade
 - h. giant foxtail
 - i. giant ragweed
 - j. green foxtail
 - k. horseweed
 - l. large crabgrass
 - m. Palmer amaranth
 - n. Pennsylvania smartweed
 - o. Powell amaranth
 - p. quackgrass
 - q. redroot pigweed
 - r. tall waterhemp
 - s. velvetleaf
 - t. wild buckwheat
 - u. wild mustard
 - v. wild oat
 - w. wild proso millet
 - x. woolly cupgrass
 - y. yellow foxtail
 - z. yellow nutsedge
2. Define weed competition and factors that influence competition.
3. Describe how weeds reproduce and spread.
4. Define seed dormancy and describe how seed dormancy influences weed management.

Weed Control

1. Define cultural weed control.
2. Define chemical weed control.
3. Define mechanical weed control.

Herbicide Persistence in the Environment

1. Recognize what factors affect herbicide carryover and why.

Herbicide Resistance

1. Recognize how herbicide resistance develops and how to prevent resistance.
2. Differentiate herbicide resistance from other factors that affect herbicide performance.

Herbicide Mode of Action

1. Define Herbicide Mode of Action as it relates to weed control.
2. Identify the four key steps in the herbicide mode of action process.
3. Define what it means for a herbicide to be systemic or non-systemic (contact) and how it relates to herbicide injury and potential for recovery from herbicide-induced injury.
4. Define what it means for a herbicide to be systemic or non-systemic (contact) and how it relates to control of annual and perennial weeds.

Herbicide Injury

1. Describe how the following factors can influence the likelihood and severity of herbicide injury.
 - a. time and method of application
 - b. environmental factors
 - c. stage of plant development
 - d. genetic make-up of plant

Herbicide Application

1. List factors influencing soil applied herbicides.
2. List factors influencing postemergence herbicides.

Competency Area 2. Plant Disease Management and Fungicides

Disease Diagnosis and Causal Organisms

1. Describe the basic steps in diagnosis of plant diseases.
2. Describe the differences between symptoms and signs of plant disease.
3. Identify each of the crop diseases listed below by host plant symptoms and signs.

4. List the crops affected by each of the diseases listed below.
5. Classify each disease listed below by the type of causal organism (bacteria, virus, fungus, nematode, other) and how it relates to disease management.
 - a. bacterial blight (leaf)
 - b. barley yellow dwarf
 - c. bean pod mottle virus
 - d. brown stem rot
 - e. cercospora leaf spot
 - f. common leaf spot of alfalfa
 - g. common smut
 - h. corn root nematodes
 - i. corn stalk rots
 - j. fusarium head blight
 - k. Goss's leaf blight and wilt
 - l. grey leaf spot of corn
 - m. leaf rust
 - n. loose smut
 - o. northern corn leaf blight
 - p. phytophthora root rot
 - q. potato early blight
 - r. rhizoctonia crown rot
 - s. rhizoctonia root rot
 - t. Sclerotinia white mold
 - u. soybean cyst nematode
 - v. stem rust
 - w. sudden death syndrome
 - x. tan spot

Biology of Plant Pathogens and Plant Diseases

1. Give examples of simple disease cycles and how they relate to disease management.
2. Provide basics of factors affecting survival and spread of plant pathogens.

Disease Management for Common Diseases

1. Describe these important fundamentals of disease management for diseases of common crops:
 - a. avoidance
 - b. resistance
 - c. exclusion
 - d. chemicals
2. List pros and cons of using resistance and chemicals to manage disease.

Disease Resistance

1. Define the differences between disease resistance and tolerance.
2. Explain possible reasons why a crop variety labeled as resistant to a disease becomes affected by that disease.
3. Describe how different races of a pathogen such as the soybean cyst nematode or Phytophthora and how pathogens affect resistance functions.

Agronomic Fungicide Characteristics and Application

1. Define Fungicide Mode of Action for common fungicides.
2. Describe the differences between contact and systemic fungicides and provide examples of each.
3. Describe how time and method of application, environmental factors, and stage of plant and disease development can influence the efficacy of a fungicide application.
4. Describe differences between preventative and curative fungicides and why most fungicides are most effective when applied as a preventative.
5. Explain potential reasons why a fungicide application may not be effective at reducing disease severity.

Relationships Between Agronomic Practices and Plant Diseases

1. Describe how tillage and crop rotation can influence plant diseases.
2. List several agronomic practices that affect plant disease development and provide examples of specific agronomic practices that affect some specific diseases (for example, decreased planting density or increased row width may reduce white mold in soybeans).

Competency Area 3. Insect Management and Insecticides

Insect Identification and Biology

1. Understand the importance of these insects and mites and management of these in the major Minnesota crops:
 - a. alfalfa weevil
 - b. armyworm
 - c. bean leaf beetle
 - d. black cutworm
 - e. Colorado potato beetle
 - f. corn earworm
 - g. corn leaf aphid
 - h. dingy cutworm
 - i. English grain aphid
 - j. European corn borer
 - k. grasshoppers
 - l. greenbug
 - m. green peach aphid
 - n. northern corn rootworm
 - o. pea aphid
 - p. potato leafhopper
 - q. seed corn maggot
 - r. soybean aphid
 - s. stem maggot
 - t. two-spotted spider mites
 - u. western corn root worm
 - v. wheat sawfly
 - w. wireworm
 - x. white grubs
2. Describe the life cycle of the insects and mites listed above:
 - a. Specify the type of metamorphosis (gradual, complete), number of generations per year, and reproduction (sexual, asexual).
 - b. List the over-wintering stage (if any) in Minnesota and how that relates to seasonal appearance of these insects in crops.
 - c. Identify colonization and infestation of crop fields.

3. Characterize the feeding injury and damage to crops of each insect and mite listed above:
 - a. Describe the host range of each insect and list the crop(s) that it attacks.
 - b. Classify feeding mechanisms of each insect.
 - c. Recognize and diagnose the feeding injury of each pest and associated crop symptoms.

Insect Control

1. Define the following key concepts in insect management:
 - a. economic damage
 - b. economic injury level
 - c. economic threshold
 - d. action level
2. Describe the following control options:
 - a. biological control
 - b. cultural control
 - c. host plant resistance
 - d. transgenic crops
 - e. insecticides
 - i. foliar applications
 - ii. seed treatments
 - iii. soil applications
3. Compare and contrast cultural, biological, and chemical control options for the insects and mites listed above.
4. Describe principles of scouting/monitoring and decision making for insect and mite pests.
 - a. Indicate types of scouting or monitoring for different types of pests.
 - b. List life stages scouted and seasonal window of scouting for different types of pests.
 - c. Explain what economic thresholds and action levels are and how they are used.

Insecticide Resistance

1. Recognize why/how insect resistance develops and explain the role of selection pressure.
2. Provide Minnesota examples of resistance developing against:
 - a. cultural control (crop rotation)
 - b. host plant resistance
 - c. insecticides
 - d. transgenic crops

3. Describe how to prevent or delay resistance.
4. Explain current insect resistance management plans for transgenic crops.

Insecticide Mode of Action

1. Describe how several key insecticide groups kill insects:
 - a. nerve toxins (pyrethroids, neonicotinoids, organophosphates)
 - b. growth regulators
 - c. gut disruption (Bt)

Insecticide Application

1. List factors influencing insecticide performance:
 - a. soil applied
 - b. foliar applied
 - c. seed applied
2. Recognize physical characteristics of various insecticide formulations and how those characteristics affect application methods, timing, and efficacy of control.
 - a. weed control
 - b. disease control
3. Select appropriate insecticide(s) for each insect or mite pest listed above based on a consideration of effectiveness, cost, safety, and environmental risks.
4. Identify human and landscape features of fields that applicators should consider during insecticide application.

Competency Area 4. Integrated Pest Management

Principles of Integrated Pest Management

1. Define Integrated Pest Management (IPM) and explain why it is important.
2. Use given information to make economically and environmentally sound pesticide recommendations.

Competency Area 5. Pesticide Use

Laws and Regulations

1. Describe federal and local regulations regarding pesticide use outlined in the Federal Insecticide, Fungicide and Rodenticide Act along with its 40 CFR regulations and the Minnesota Pesticide Control Law (Minn. Stat. 18B):
 - a. pesticide distribution, use, storage, transportation, and handling

- b. disposal of pesticides, rinsates, and containers
- c. applicator licensing requirements
- d. applicator recordkeeping requirements
- e. Restricted-Use pesticide requirements
- f. posting and field re-entry restrictions for treated areas

Pesticide Labels and Labeling Comprehension

1. Recognize the types of information on the label:
 - a. Safety information including Child Hazard Warning, Signal Word, Hazards to Human & Domestic Animals, Protective Clothing & Equipment, and Statement of Practical Treatment.
 - b. Environmental Hazard Information including setback requirements for use.
 - c. Product information including Restricted-Use Classification, Brand Name Formulation, Ingredient Statement, Product Registration Number, EPA Establishment Number, Weight, and Physical & Chemical Hazard.
 - d. Use information including Misuse Statement, Storage & Transportation, Container Rinsing & Disposal, Restricted Entry Statements, and Directions for Use.
 - e. Bee and pollinator safety.
2. Read and follow all product label directions and precautions.

Pesticide Safety

1. Select the proper pesticide for a given situation.
2. Describe the procedures for handling a pesticide spill.
3. Describe disposal procedures for waste pesticides and empty containers.
4. List setback requirements when mixing and loading.
5. Describe how to prevent back-siphoning.
6. Describe proper storage and security of pesticides.
7. Recognize Worker Protection Standards – worker and handler requirements:
 - a. handling, mixing and loading
 - b. re-entry precautions, posting and decontamination
 - c. protective clothing, equipment and maintenance procedures
 - d. pesticide poisoning effects, symptoms and first aid procedures
 - e. pesticide toxicity knowledge
 - f. minimizing exposure—risk assessment
 - g. personal safety and hygiene

Environmental Considerations

1. Describe the environmental fate of pesticides as it relates to:
 - a. drift to non-target sites
 - b. pesticide accumulation
 - c. pesticide persistence
 - d. treated seed handling and disposal
2. Recognize pesticides that are a concern for ground and surface water.
3. List pesticide and site characteristics affecting off-site movement.
4. Describe state-established pesticide voluntary Best Management Practices (BMPs).

Pesticide Application Equipment and Calibration

1. List and understand pros and cons of ground or aerial foliar application equipment.
2. Understand pro and cons of planter applied pesticides.
3. Recognize equipment parts and select appropriate nozzles for efficacy and drift management.
4. Describe sprayer maintenance and cleaning procedures.
5. Define pesticide transfer.
6. Understand calibration factors and methods.
7. Calculate rates and volumes for mixing.

CROP PRODUCTION

Competency Area 1. Identification of Crops

1. Have knowledge of the production practices for the following Minnesota crops:
 - a. alfalfa
 - b. barley
 - c. canning peas
 - d. canola
 - e. corn
 - f. dry edible beans
 - g. oats
 - h. orchard grass
 - i. potatoes
 - j. red clover
 - k. reed canary grass
 - l. rye
 - m. smooth brome grass
 - n. soybean
 - o. spring wheat
 - p. sugarbeet
 - q. sunflowers
 - r. sweet corn
 - s. timothy
 - t. winter wheat

Competency Area 2. General Crop Adaptation

Soil Adaptations

1. Describe how crops respond to the following factors:
 - a. soil fertility levels
 - b. soil pH
 - c. soil drainage and texture
 - d. soil temperature
 - e. soil moisture

Climatic Adaptations

1. Describe the adaptation of agronomically important crops to extremes of precipitation.
2. Describe the adaptation of agronomically important crops to ambient temperature.
3. Be able to describe the components of **G**rowing **D**egree **U**nits (**GDU**) and be able to calculate GDUs for crops given the appropriate information.

Competency Area 3. Anatomy, Growth, and Developmental Stages of Major Agronomic Crops

Plant Staging – Grain Crops and Soybeans

1. Describe the systems used to stage corn, soybeans, and small grains.
2. Use the staging systems to identify the stage of growth at any time between emergence and physiological maturity.
3. Describe the environmental critical periods for yield formation in corn, soybean, and small grains.

Plant Staging – Forage Legumes and Grasses

1. Describe the systems used to stage forage legumes and grasses.
2. Use the systems to identify growth stages of forage legumes and grasses.
3. Describe how forage legumes and grasses are affected by environmental stresses for yield formation.

Harvesting Forages and Ensiles

1. Describe how frequency of harvest is related to forage yield and quality.
2. Describe how frequency and timing of harvest affects stand longevity, food reserves, and stand persistence.
3. Describe how crop maturity at harvest affects feed quality (**T**otal **D**igestible **N**utrients and Relative Feed Value).

Regrowth of Forage Crops after Harvesting

1. Describe the locations and functions of meristems used for regrowth in forage legumes and forage grasses.

Management Factors Related to Anatomy, Growth, and Development of Major Crops

1. Relate anatomical features of major crops to developmental stages.
2. Recognize relationships between the growth and development of major crops and management factors.

Competency Area 4. Seeding Date Factors

1. Describe factors that determine when to seed corn, soybeans, small grains, and forages.
2. Recognize consequences of seeding too early or too late.

Competency Area 5. Seeding Rates and Pattern Factors of Major Crops

1. List factors that influence the seeding rate of major crops.
2. List recommended row widths for major crops.
3. List factors that determine the seed placement at planting and its ramifications.
4. Recognize characteristics of major crops that make them adapted to high or low seeding rates.
5. List methods used to seed small grains and forage crops.
6. Explain why forage crop establishment is more difficult than the establishment of grain crops.
7. List recommended seeding rates for major crops.
8. List advantages and disadvantages of seeding pure grass or legume stands vs. mixed stands.
9. Recognize characteristics of corn and soybean that cause them to be better suited to narrow rows.
10. Describe the effect of within-row plant spacing on growth and yield of corn, soybean, and sugarbeet.

Competency Area 6. Seeding Depth Factors

1. List the recommended seeding depths for major crops.
2. Recognize how crops respond to depth of planting.
3. Recognize conditions that would cause recommended seeding depth to be altered.
4. Explain the importance of seed-to-soil contact for uniform germination.

Competency Area 7. Crop Damage, Mortality, and Factors Influencing Replanting Decisions

1. Describe why uneven crop emergence can occur and its effect on crop growth and yield.
2. Describe the type of damage that insects, disease, pesticides, seed quality, and acts of nature can cause to corn, soybean, small grain, and forage crops.
3. Describe the effect of pesticide use and crop rotation on replanting decisions.
4. Describe climatic and plant factors, which influence a plant's ability to resume growth after being damaged.
5. Determine when crop damage would economically justify replanting.

Competency Area 8. Cropping Systems

1. List advantages and limitations of growing cover crops and companion crops in a cropping system.
2. Compare and contrast single crop systems and crop rotations.
3. Define the objective of using transgenic crops in a particular cropping system.

Competency Area 9. Site Specific Technology

1. List the advantages and limitations of soil sampling:
 - a. grid
 - b. soil type
 - c. topographical (LIDAR)
 - d. diagnostic
 - e. other
2. List the advantages and limitations of site-specific application of the following:
 - a. fertilizer
 - i. soil
 - ii. foliar
 - b. manure
 - c. lime/soil amendments
 - d. pesticides
 - e. seed
3. List the advantages and limitation of scouting.
4. List the advantages and limitation of harvest monitors.
5. List the advantage and limitations of remote sensing.
6. List the advantages and limitations of GPS/GIS.