WESTERN REGION CERTIFIED CROP ADVISER PERFORMANCE OBJECTIVES

California Certified Crop Advisers

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INTRODUCTION

The contents of this document outline the knowledge areas covered in the Western Region Certified Crop Advisor (CA CCA) Exam. They constitute what a person needs to know to qualify as a Certified Crop Advisor in the Western Region.

The WR CCA Performance Objectives are reviewed at least once every four years, updates are added, and outdated information removed.

Updated: 2021

NUTRIENT MANAGEMENT PROFICIENCY AREA

Competency Area 1. Basic Concepts of Nutrient Management

1. Identify the 16 agriculturally important macro, secondary, and micronutrients essential for plant growth:
    a. Macronutrients: C, H, O, N, P, K,
    b. Secondary Macronutrients: Ca, Mg, S,
    c. Micronutrients: Cl, Zn, Fe, Mn, Cu, B, Mo
2. List the ionic forms in which each mineral nutrient is available to plants.
3. Describe the role of soil cation exchange capacity (CEC) in plant nutrition.
4. Explain how cation exchange capacity affects nutrient leaching or nutrient loss.

Competency Area 2. Nutrient Movement in Plant, Soil, Air, and Water

1. Define soil solution and describe its relationship to nutrient mobility.
2. Describe how texture, structure, organic matter, and bulk density affect the productivity of soil.
3. Explain how abrupt texture changes or nutrient stratification affects crop productivity.
4. Describe the relative mobility of essential elements within plants.
5. Explain how soil and climate affect movement of a nutrient in:
    a. soil
    b. air
    c. water
6. Explain how farming practices in perennial and annual crops (irrigation, tillage, fertilizer rates, and timing, etc.) affect nutrient movement and retention in soil, air, and/or water.

Competency Area 3. Soil Reaction, Soil Amendments and pH Modification

1. Define soil pH and explain the pH scale.
2. List materials, processes, and/or practices that change soil pH.
3. Explain how soil pH and physical properties such as texture and water holding capacity interact to determine nutrient availability.
4. Describe the reactions of pH increasing (lime, etc.) and pH decreasing (sulfur, etc.) amendments in the soil.
5. Describe pH modification associated with addition of various nitrogen sources such as anhydrous ammonia, urea, ammonium nitrate, and calcium nitrate.

Competency Area 4. Plant Requirements and Stewardship

Nitrogen

1. Describe the role of nitrogen in plant growth.
2. Describe general nitrogen deficiency symptoms in plants.
3. Describe the components of the nitrogen cycle and explain their chemical, microbial, and enzymatic transformations.
4. Describe forms of nitrogen that may be lost from an agricultural system, the pathways of loss, and potential environmental consequences.
5. Describe the conditions that promote the maximum amount of loss risk for each loss pathway.
6. Describe how soil physical properties affect the efficacy of nitrogen fertilizer or soil amendments in supplying nitrogen crop demands.
7. Explain how elements of a cropping system such as cover cropping and conservation tillage affect nitrogen fertilizer requirements.
8. Describe the safety precautions that should be taken in handling various nitrogen fertilizers.
9. Explain the role of nitrogen fertilizer form and application timing on plant nitrogen availability and potential for loss.
10. Describe how to estimate non-fertilizer nitrogen contributions (including biological fixation, nitrogen mineralization, and irrigation water nitrate concentration) and how to integrate soil/tissue test nitrogen levels into a nutrient management program.
11. Construct an N budget for a field that allows you to estimate the N lb/ac that need to be met by a fertilizer program after adjusting for expected crop removal rates and properly documenting any N credits received from manure/compost and irrigation water inputs.
12. Describe the chemical composition of common nitrogen fertilizers and calculate the amount of N in a given amount of fertilizer.
13. Explain how organic nitrogen forms differ from mineral forms in their nitrogen availability to plants.

Phosphorus

1. Describe the role of phosphorus in plant growth.
2. Describe general phosphorus deficiency symptoms.
3. Explain how soil properties affect phosphorus fertilization requirements:
    a. pH
    b. nutrient antagonism with Ca

    c. soil temperature
    d. soil moisture
4. Explain how cropping systems affect phosphorus fertilization requirements.
5. Describe how the soil retains phosphorus.
6. Describe the analysis and chemical composition of different phosphorus fertilizers commonly used in the Western Region.
7. Explain the environmental water quality aspects of phosphorus management, the means by which it enters surface waters, and key practices used to limit loss of P.
8. Describe how tissue and soil analysis can be used for phosphorus fertility management.
9. Compare crop availability of phosphorus contained in inorganic fertilizers and organic amendments.

Potassium

1. Describe the role of potassium in plant growth.
2. Describe general potassium deficiency symptoms in plants.
3. Describe how the soil retains potassium.
4. Explain how soil properties affect potassium fertilization requirements:
    a. clay mineralogy
    b. soil temperature
    c. soil moisture
5. Explain how cropping systems affect potassium fertilization requirements.
6. Describe the analysis and chemical composition of different potassium fertilizers commonly used in the Western Region.
7. Describe how tissue and soil analysis can be used for potassium fertility management.
8. Compare crop availability of potassium contained in inorganic fertilizers and organic amendments.

Competency Area 5. Secondary and Micronutrient Plant Requirements

1. Describe the general deficiency symptoms of the secondary nutrients.
2. Describe the general deficiency and toxicity symptoms of the micronutrients.
3. Describe methods of correcting secondary and micronutrient deficiencies.
4. Explain the effect of soil pH on micronutrient availability.
5. Explain how secondary and micronutrients move/are retained in soil.

Competency Area 6. Soil and Plant Diagnostic Tools and Nutrient Management

1. Use a map to locate a tract of land and give a legal description and vice versa.
2. Be able to use GPS and understand how to use degrees, minutes, seconds and convert to decimal and vice versa.
3. Use a soil survey to identify soils in a field and describe characteristics of each soil profile.
4. Describe soil sampling and handling procedures.
5. Describe the purpose of soil testing and the agronomic importance of items on a soil test in the formulation of a fertilizer recommendation.
6. Describe the common laboratory tests for soil availability of macro, secondary, and micronutrients.
7. Explain how to use information from soil test reports and calibration data to determine economically and environmentally sound recommendations for fertilizer rate and form.
8. Explain how to use fertilizer analysis information to calculate amounts of different fertilizers required to meet a specific recommendation.
9. Explain how to calculate residual soil nitrogen content from soil analysis results.
10. Explain how to relate the soil nitrogen contents from different depths to get a ‘whole profile N measurement.
11. Describe tissue sampling and handling procedures.
12. List purposes of tissue testing and describe how it can be used to diagnose crop nutrient status.
13. Describe the relationship between tissue nutrient critical concentration and plant part (old vs. new growth) and plant age.

Competency Area 7. Fertilizer Use and Regulation

1. Describe potential advantages and disadvantages of different fertilizer placements and timing of application on productivity and crop quality.
2. Explain how fertilizer placement and time of application affect nutrient losses to the environment.
3. Describe special environmental concerns associated with fertigation.
4. Describe and interpret the information found on a fertilizer label.
5. Identify who enforces fertilizer laws and regulations in the Western Region.
6. Explain the steps to take when reporting a fertilizer spill or leak.

7. Explain the difference between a nutrient recommendation and a fertilizer recommendation.
8. Explain how to calculate the lb/ac (dry) or gal/ac (liquid) needed by a certain fertilizer analysis to meet a nutrient recommendation.

Competency Area 8. Certified Organic Nutrient Management

1. Explain how the ratio of nutrients present in organic materials can differ from a plant's nutrient requirements and the management significance of these differences.
2. Describe the relative roles of soil amendments and cover cropping in organic fertility management.
3. Explain the effects of composting on nutrient availability of composted products.
4. Understand the organic certification process and information sources for products that conform with organic standards.
5. Describe how you would incorporate release of nutrients from organic fertilizer sources and/or amendments into a nutrient budget and understand the release rate characteristics of the macronutrients.

SOIL AND WATER MANAGEMENT COMPETENCY AREA

Competency Area 1. Basic Physical Properties of Soils

<u>Soil texture</u>

1. List the characteristics of sand, silt, and clay.
2. Explain how soil texture influences the soil physical and chemical properties listed below:
    a. water and nutrient movement
    b. aeration
    c. soil structure
    d. water holding capacity
    e. CEC
    f. nutrient leaching potential
3. Understand how bulk density may differ with soil texture.
4. Understand how bulk density affects the interpretation of soil nitrate tests.
5. Use soil survey data to determine sampling strategy based on soil texture.

<u>Soil structure</u>

1. List the benefits of well-developed soil aggregation.

2. List the problems associated with poor soil aggregation.
3. Explain how soil organisms and organic matter affect soil structure.
4. Explain how soil management (tillage, cropping systems, amendments, etc.) affects soil structure.
5. Describe how exchangeable sodium and soil salinity affect soil aggregation and water penetration and movement in soils.
6. Describe how structure can affect root growth and structure.

Soil organic matter

1. Explain how soil organic matter affects soil aggregation, water holding capacity and water infiltration.
2. Explain how soil organic matter is related to CEC, color, structure, and soil temperature.
3. Describe the role of soil organic matter in pesticide movement in soil.
4. List ways to maintain the organic matter content of an agricultural soil.
5. Describe the importance of soil organic matter in nutrient management.
6. Describe how the carbon:nitrogen ratio of organic amendments in the soil may affect the availability of soil nitrogen to plants.
7. List the advantages and disadvantages of using cover crops to modify soil fertility and tilth.
8. Contrast the agricultural soil organic matter levels that are found in different areas of the Western Region.
9. Understand how lab values and lab methods for Soil Organic Matter (SOM) and Soil Organic Carbon (SOC) differ and how those values can be used for management.

Competency Area 2. Drainage and Water Movement in Soil

1. Describe how pore size distribution affects the drainage characteristics and water holding capacities of soils.
2. Explain how soil texture, structure, and organic matter content affect pore size, soil drainage, and plant available water.
3. Explain how plant residues and tillage affect infiltration rate.
4. Explain the nature and development of clay, silica, and other cementable materials and how they can strongly influence drainage and root development.
5. Describe the influence of stratified soil and preferential flow patterns on soil drainage and how to manage them.

6. Discuss how tile drainage is used to manage water levels.

Competency Area 3. Soil Conservation

1. Describe types of erosion by wind and water.
2. List best management practices that reduce erosion by wind and water.
3. Describe how soil loss through erosion can result in nutrient and pesticide losses and impact the environment.
4. Describe how soil erosion affects field productivity.
5. Explain how vegetative cover can improve soil fertility by introducing and retaining nutrients, control erosion, and improve soil physical properties.

Competency Area 4. Tillage Operations and Soil Characteristics

1. Explain how tillage operations influence erosion, soil structure, organic matter content, and compaction.
2. Identify plant symptoms and soil characteristics associated with compaction and impermeable layers.
3. Describe the causes of soil compaction and methods which alleviate it.

Competency Area 5. Saline and Sodic Soils and Waters

1. Define a salt.
2. Define saline, saline-sodic, and sodic soils.
3. Explain how the growth stage of a crop can affect its salt tolerance.
4. Explain how rootstocks can impact the tolerance of tree and vine crops to salinity and specific ion toxicity.
5. Explain the relationship between sodium absorption ratio (SAR) and exchangeable sodium percentage (ESP).
6. Describe how soil salinity and exchangeable sodium interact to affect soil structure, and water infiltration and movement in soils.
7. Explain why good drainage is the key to soil reclamation and to the long-term sustainability of irrigation.
8. List techniques used to improve saline, saline-sodic, and sodic soils for crop growth.
9. Describe how to calculate the leaching requirement.
10. Explain how to manage seedbeds to minimize salt accumulation in the seedling zone.

11. Describe how various amendments function to improve saline, saline- sodic, and sodic soils.
12. Describe the relationships of pH in saline soils, saline-sodic soils, or sodic soils.
13. Explain the difference and uses between an amendment which supplies calcium directly and one that supplies calcium by the dissolution of soil lime (calcium carbonate).
14. Explain the complications associated with irrigation water management and control of saline conditions.
15. Explain the challenge of salinity management and groundwater quality.

Competency Area 6. Water Quality for Irrigation

1. Describe the major constituents (cations and anions) of irrigation water.
2. List the chemical constituents that are commonly measured in the evaluation of irrigation water quality and identify which of these can cause specific ion toxicities.
3. Explain the effect of bicarbonate on water quality.
4. Explain the effects of irrigation water salinity (both high and low) and SAR on soil degradation due to aggregate dispersion, soil crusting, and reduced infiltration rates.
5. Describe how to convert ion concentrations expressed in ppm (mg/l) to concentrations expressed in meq/l.
6. Given an irrigation suitability analysis explain how to convert ppm (mg/L) or meq/L to lb/acre foot.
7. Explain how the precipitation of irrigation water calcium and bicarbonate as soil lime (calcium carbonate) can affect its sodicity hazard.
8. Explain the influence of irrigation water quality on the potential for clogging problems with drip irrigation systems and how to alleviate clogging.
9. Identify materials and practices commonly used to improve irrigation water infiltration.
10. Describe how to use an irrigation water sample to derive an estimate of salinity inputs to a field (sodium, chloride, boron).

Competency Area 7. Environmental Impacts of Soil and Water Management

1. Describe how soil and water management practices can affect movement of nutrients and pesticides to surface and groundwater.
2. Describe how, and list specific tools, to evaluate the risk of sediment, pesticide, and nutrient loss from a specific field.
3. Explain how infiltration and percolation rates affect potential ground water contamination.

4. Describe how sprinkler, furrow, flood, and drip irrigation methods can impact surface and ground water quality.
5. Distinguish between point and non-point sources of pollutant entry into groundwater and surface water.
6. Be aware of water quality regulations that would apply to producers such as Total Maximum Daily Load (TMDLs).

Competency Area 8. Irrigation and Plant Water Use

1. Be able to build an irrigation water budget.
    a. Understand plant available water and available water capacity (AWC). soil moisture saturation percentage, field capacity, and permanent wilting point.
    b. Compare the relative amounts of available water held by soils of differing textures.
    c. Describe how to calculate the water requirement of a crop from the amount of water needed to meet evapotranspiration (ET) and explain how the result from the ET equation can be used to estimate the irrigation interval (days) when soil water storage is known (e.g., 3 inches of water stored in the soil that is available for depletion).
    d. Explain the calculation of the leaching fraction necessary to maintain the appropriate salt balance for a particular crop.
    e. Understand how irrigation efficiency and uniformity affect the amount of water to meet crop needs.
    f. Understand differences in crop growth water needs across the Western Region.
2. Describe typical types of instruments used to measure soil water such as
    a. Tensiometers
    b. Neutron probes
    c. Capacitance
3. Explain how to measure plant water status:
    a. Stem water potential
    b. Dendrometer
    c. Infrared/remote sensing
    d. Sap flow sensors.
4. Describe the effect of saline water on water use by plants.
5. Explain the hazards to plants associated with sprinkler irrigation using saline water.
6. Explain the value of water meters in irrigation management.
7. Explain the role of backflow protection in irrigation systems.

8. Explain the importance of tailwater management to improve irrigation efficiency and protect environmental water quality.

CROP MANAGEMENT COMPETENCY AREA

Competency Area 1. Basic Crop Science

1. Describe the function of the xylem and phloem in plants.
2. Describe the location of meristematic tissues in annual and perennial plants.
3. Contrast the properties of photosynthesis and respiration.
4. Explain how temperature extremes affect plant growth.
5. Describe factors that affect physiological maturity, vegetative growth, and reproductive growth.
    a. degree days
    b. genetics
    c. climate
    d. management factors
6. Explain the process of transpiration.
7. Describe the categories of growth regulators (auxins, cytokinins, ethylene, etc.) and their physiological effects.
8. Explain dormancy, photoperiodism and vernalization as they relate to Western Region crops.
9. Describe the general growth pattern of annual crops.

Competency Area 2. General Crop Adaptation

1. Describe how crops respond to salinity, soil fertility, and soil drainage.
2. Describe the soil pH ranges where agronomically important crops will best perform and how pH extremes affect nutrient availability, toxicity, and plant health.
3. Explain how the water requirements of a crop change during growth and development of annual and perennial crops.
4. Explain how the nutrient requirements of a crop change during growth and development of annual and perennial crops.
5. Describe the relative differences of nutrient contents in different plant organs (leaves, fruit, etc.).
6. Understand the importance of selecting seed, rootstock, and scion genetic characteristics to adapt to environmental conditions.

Competency Area 3. Tillage Management for Annual and Perennial Direct Seeded and Transplanted Crops

1. Describe the environmental and management factors that influence the selection and use of a tillage system for direct seeded and transplanted crops.
2. Explain how cropping systems, environment, and tillage affect soil residue cover.
3. List the advantages and limitations of a minimum till or no-till system for direct seeded and transplanted crops.
4. Understand the reason for doing primary tillage to establish drainage for perennial crops.
5. Explain the need, timing, and types of tools used for primary and secondary tillage in both annual and perennial systems.

Competency Area 4. Crop Damage, Mortality, and Factors Influencing Replanting Decisions

1. Describe the types of damage hail, frost, flooding, drought, wind, or other abiotic stress that can cause crop damage.
2. List climatic and plant factors which influence plant mortality or a plant's ability to resume growth after injury.
3. Explain factors in the decision-making process for replanting perennial systems.
    a. Newly established perennial systems
    b. Termination of older perennial.

Competency Area 5. Cropping Systems and Concepts

1. Describe the function(s) of fallow in crop production.
2. Explain the advantages and limitations of growing cover crops.
3. Explain the advantages and limitations of a monoculture system versus a crop rotation.
4. Describe the application of precision farming techniques in annual and perennial crops including global positioning systems (GPS), yield monitoring, variable rate application, and directed soil sampling.
5. Describe how banding and broadcasting affects nutrient availability.
6. List nutrient management strategies that incorporate each of the 4R concepts for different cropping systems in the Western Region.
7. List farming techniques that would build soil health or sequester soil carbon.
8. Know what a carbon market is and generally how a carbon market works.
9. Understand what is meant by regenerative agriculture.