

**CALIFORNIA  
CERTIFIED CROP ADVISER  
PERFORMANCE OBJECTIVES**

**California Certified Crop Advisers**

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## TABLE OF CONTENTS

<b>Table of Contents</b>	2
<b>Introduction</b>	3
<b>Nutrient Management Competency Areas</b>	
I. Basic concepts of nutrient management	4
II. Nutrient movement in soil and water	4
III. Soil reaction, soil amendments and pH modification	4
IV. N, P, K plant requirements and stewardship	5
V. Secondary nutrient and micronutrient plant requirements	6
VI. Soil & plant diagnostic tools and nutrient management	6
VII. Fertilizer use and regulation	7
VIII. Certified organic nutrient management	7
<b>Soil and Water Management Competency Areas</b>	
I. Basic physical properties of soils and water	8
II. Drainage and water movement in soils	8
III. Soil conservation	9
IV. Tillage operation and soil characteristics	9
V. Saline and sodic soils and waters	9
VI. Water quality for irrigation	10
VII. Environmental impacts of soil and water management	11
VIII. Irrigation and plant water use	11
<b>Crop Management Competency Area</b>	
I. Basic Crop Science	12
II. General Crop Adaptation	12
III. Tillage systems used for seedbed preparation of row, small grain and forage crops	12
IV. Crop damage, mortality, and factors influencing replanting decisions	13
V. Cropping systems	13

# INTRODUCTION

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

The CA CCA Performance Objectives are reviewed at least once every four years, updates are added, and outdated information removed.

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# **NUTRIENT MANAGEMENT COMPETENCY AREA**

## **I. BASIC CONCEPTS OF NUTRIENT MANAGEMENT**

### **A. The soil as a source of nutrients**

1. List the 18 nutrients essential for plant growth.
2. Define macro and micro nutrients and which essential nutrients belong in each category.
3. List the ionic forms in which each mineral nutrient is available to plants.
4. Describe the role of cation exchange in plant nutrition.
5. Define soil solution and describe its relationship to nutrient mobility.
6. Explain how cation exchange capacity affects nutrient leaching.

### **B. Assessment of soil productivity based on soil physical properties**

7. Describe how texture, structure, organic matter, and bulk density affect the productivity of soil.
8. Describe how banding and broadcasting affects nutrient availability.
9. Explain how soil layering affects crop productivity.

## **II. NUTRIENT MOVEMENT IN PLANT, SOIL, AIR, AND WATER**

10. Describe the relative mobility of essential nutrients within plants.
11. Explain how soil, climatic, and nutrient properties affect movement of a nutrient in soil, air, or water.
12. Explain how farming practices (irrigation, cropping, tillage, fertilizer rates and timing, etc.) affect nutrient movement in soil, air, and/or water.
13. Distinguish between point and non-point sources of pollutant entry into groundwater and surface water.

## **III. SOIL REACTION, SOIL AMENDMENTS AND pH MODIFICATION**

14. Define soil pH and the pH scale.
15. List materials, processes and/or practices that change soil pH.
16. Explain how soil pH and physical properties affect soil processes that determine nutrient availability.
17. Describe the reactions of pH increasing (lime, etc.) and pH decreasing (sulfur, etc.) inputs in the soil and their effect on soil pH as it affects nutrient availability.

18. Describe pH modification associated with addition of various nitrogen sources.

#### **IV. N, P, K PLANT REQUIREMENTS and STEWARDSHIP**

##### **A. Nitrogen**

19. Describe the role of nitrogen for plant growth.
20. Describe general nitrogen deficiency symptoms.
21. Describe the ways nitrogen may be lost from the soil , and potential environmental consequences.
22. Describe the components of the nitrogen cycle and explain their chemical, microbial, and enzymatic transformations. .
23. Describe how soil physical properties affect the effectiveness of nitrogen containing materials to supply crop demands for nitrogen.
24. Explain how cropping systems affect the need for nitrogen fertilization.
25. Explain how soil drainage, irrigation, precipitation levels, and potential for water contamination affect nitrogen fertilization management.
26. Describe the safety precautions that should be taken in handling various nitrogen fertilizers.
27. Explain the role of nitrogen input form and application timing on plant nitrogen availability and potential for loss.
28. 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.
29. Describe chemical composition of different nitrogen fertilizers.
30. Explain how organic nitrogen forms differ from mineral forms in their nitrogen availability to plants.

##### **B. Phosphorus**

31. Describe the role of phosphorus in plant growth.
32. Describe general phosphorus deficiency symptoms.
33. Explain how soil properties affect phosphorus fertilization requirements.
34. Explain how cropping systems affect phosphorus fertilization requirements.
35. Describe how the soil retains phosphorus.
36. Describe the analysis and chemical composition of different phosphorus fertilizers.

37. 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.
38. Describe how tissue and soil analysis can be used for phosphorus fertility management.
39. Compare crop availability of various organic and inorganic phosphorus sources.

### **C. Potassium**

40. Describe the role of potassium in plant growth.
41. Describe general potassium deficiency symptoms in plants.
42. Describe how the soil retains potassium.
43. Explain how soil properties affect potassium fertilization requirements.
44. Explain how cropping systems affect potassium fertilization requirements.
45. Describe the analysis and chemical composition of different potassium fertilizers.
46. Describe how tissue and soil analysis can be used for potassium fertility management.
47. Compare crop availability of various organic and inorganic potassium sources.

## **V. SECONDARY AND MICRO-NUTRIENT PLANT REQUIREMENTS**

48. Describe the general deficiency symptoms of the secondary nutrients.
49. Describe the general deficiency and toxicity symptoms of the micronutrients.
50. List methods of correcting secondary and micro-nutrient deficiencies.
51. Explain the effect of soil pH on micronutrient availability.
52. Explain how secondary and micro-nutrients move/are retained in soil.

## **VI. SOIL AND PLANT DIAGNOSTIC TOOLS AND NUTRIENT MANAGEMENT**

53. Use a map to locate a tract of land and give a legal description.
54. Use a soil survey report to identify soils in a field and describe characteristics of each soil profile.
55. Describe soil sampling and handling procedures.

56. Describe the purpose of soil testing and the agronomic importance of items on a soil test in the formulation of a fertilizer recommendation.
57. Explain how to use information from soil test reports and calibration data to determine economically and environmentally sound recommendations for fertilizer rate and form.
58. Explain how to use fertilizer analysis information to calculate amounts of different fertilizers required to meet a specific recommendation.
59. Explain how to calculate residual soil nitrogen content from soil analysis results.
60. Describe tissue sampling and handling procedures.
61. List purposes of tissue testing, and describe how it can be used to diagnose crop nutrient status.
62. Describe the relationship between tissue nutrient critical concentration and plant part (old vs. new growth) and plant age.

## **VII. FERTILIZER USE AND REGULATION**

63. Describe potential advantages and disadvantages of different fertilizer placements and timing of application on productivity and crop quality.
64. Explain how fertilizer placement and time of application affect nutrient losses to the environment.
65. Describe special environmental concerns associated with fertigation.
66. Describe and interpret the contents of a fertilizer label.
67. Identify who enforces fertilizer laws and regulations in California.
68. Explain the steps to take when reporting a fertilizer spill or leak.

## **VIII. CERTIFIED ORGANIC NUTRIENT MANAGEMENT**

69. 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.
70. Describe the relative roles of soil amendments and cover cropping in organic fertility management.
71. Explain the effects of composting on nutrient availability of composted products.

## **SOIL AND WATER MANAGEMENT COMPETENCY AREA**

### **I. BASIC PHYSICAL PROPERTIES OF SOILS AND WATER**

#### **A. Soil texture**

1. List the characteristics of sand, silt, and clay.
2. Use a textural triangle to determine textural classification of a soil when given the percents of two of the three soil separates (sand, silt or clay).
3. Explain how texture influences other soil physical and chemical properties.

#### **B. Soil structure**

4. List the benefits of well-developed soil aggregation.
5. List the problems associated with poor soil aggregation.
6. Explain how soil organisms and organic matter affect soil structure.
7. Explain how soil management (tillage, cropping systems, etc.) affects soil structure.
8. Describe how exchangeable sodium and soil salinity affect soil aggregation and water penetration and movement in soils.

#### **C. Soil organic matter**

9. Explain how soil organic matter affects soil aggregation, water holding capacity and water infiltration.
10. Explain how soil organic matter is related to CEC, color, structure, and soil warming.
11. Describe the role of soil organic matter in pesticide movement in soil.
12. List ways to maintain the organic matter content of an agricultural soil.
13. Describe the importance of soil organic matter in nutrient management.
14. Describe how the carbon: nitrogen ratio of organic materials in the soil may affect the availability of soil nitrogen to plants.
15. List the advantages and disadvantages of using cover crops to modify soil fertility and tilth.

### **II. DRAINAGE AND WATER MOVEMENT IN SOIL**

16. Describe how pore size distribution affects the drainage characteristics and water holding capacities of soils.
17. Explain how soil texture, structure, and organic matter content affect pore size, soil drainage and plant available water.



18. Explain how plant residues and tillage affect infiltration rate.
19. Explain the nature and development of clay, silica, and other cementable materials and how they can strongly influence drainage and root development.
20. Describe the influence of stratified soil layers on soil drainage and how to manage them.

### **III. SOIL CONSERVATION**

21. Describe wind erosion and the types of water erosion.
22. List management practices that reduce water and wind erosion.
23. Describe how soil loss through erosion can result in nutrient and pesticide losses and impact the environment.
24. Describe how soil erosion affects field productivity.
25. Explain how cover crops can improve soil fertility by introducing and retaining nutrients, control erosion, and improve soil physical properties.

### **IV. TILLAGE OPERATIONS AND SOIL CHARACTERISTICS**

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

### **V. SALINE AND SODIC SOILS AND WATERS**

29. Define a salt.
30. Define saline, saline-sodic, and sodic soils.
31. Explain how the growth stage of a crop can affect its salt tolerance.
32. Explain how rootstocks can affect the tolerance of tree and vine crops to salinity and specific ion toxicity.
33. Explain the relationship between sodium absorption ratio (SAR) and exchangeable sodium percentage (ESP).
34. Describe how soil salinity and exchangeable sodium interact to affect soil structure, and water penetration and movement in soils.
35. Explain why good drainage is the key to soil reclamation and to the

long-term sustainability of irrigation.

36. List techniques used to improve saline, saline-sodic, and sodic soils for crop growth.
37. Describe how to calculate the leaching requirement.
38. Explain how to manage seedbeds to minimize salt accumulation in the seedling zone.
39. Describe how various amendments function to improve saline, saline-sodic, and sodic soils.
40. Describe the relationships of pH in saline soils, saline-sodic soils, or sodic soils
41. Describe how the presence of free lime affects the amendment selection decision.
42. Explain the difference between an amendment which supplies calcium directly and one that supplies calcium by the dissolution of soil lime (calcium carbonate).
43. Explain the complications associated with irrigation water management and control of saline conditions.
44. Explain why drainage waters generated by irrigated agriculture can pose an environmental hazard to both surface and groundwater.

## **VI. WATER QUALITY FOR IRRIGATION**

45. Describe the major constituents of irrigation water.
46. 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.
47. Explain the effect of bicarbonate on water quality.
48. 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.
49. Describe how to convert ion concentrations expressed in ppm (mg/l) to concentrations expressed in meq/l.
50. Explain how the precipitation of irrigation water calcium and bicarbonate as soil lime (calcium carbonate) can affect its sodicity hazard.
51. Explain the influence of irrigation water quality on the potential for clogging problems with drip irrigation systems.
52. Identify materials and practices commonly used to improve irrigation water infiltration.

## **VII. ENVIRONMENTAL IMPACTS OF SOIL AND WATER MANAGEMENT**

53. Describe how soil and water management practices can affect movement of nutrients and pesticides to surface and groundwater.
54. Describe how to evaluate the risk of sediment, pesticide, and nutrient loss from a specific field.
55. Describe the purpose of a Phosphorus Index or a Nitrogen Index.
56. Explain how infiltration and percolation rates affect potential ground water contamination.
57. Describe how sprinkler, furrow, flood, and drip irrigation methods can impact surface and ground water quality.

## **VIII. IRRIGATION AND PLANT WATER USE**

58. Define plant available water and available water capacity (AWC).
59. Describe the differences between soil moisture saturation percentage, field capacity, available water capacity, and permanent wilting point.
60. Compare the relative amounts of available water held by soils of differing textures.
61. Describe the types of instruments used to measure soil water.
62. Describe the effect of saline water on water use by plants.
63. Explain the hazards associated with sprinkler irrigation.
64. Describe how to calculate the water requirement of a crop from the amount of water needed to meet evapo-transpiration (ET).
65. Explain the calculation of the leaching fraction necessary to maintain the appropriate salt balance for a particular crop.
66. Describe how to use soil and crop characteristics, and climatic data to develop an irrigation schedule for a given field.
67. Explain the value of water meters in irrigation management.
68. Explain the role of backflow protection in irrigation systems.
69. Explain the importance of tailwater management to improve irrigation efficiency and protect environmental water quality.

# **CROP MANAGEMENT COMPETENCY AREA**

## **I. BASIC CROP SCIENCE**

1. Define xylem and phloem and describe their functions in plants.
2. Define meristematic tissue.
3. Describe the location of meristematic tissues in annual and perennial plants.
4. Define photosynthesis and respiration.
5. Explain how temperature extremes affect plant growth.
6. Define physiological maturity, vegetative growth, and reproductive growth.
7. Explain the process of transpiration.
8. Explain the interaction of internal (genetic) and external (environmental) factors on crop production.
9. Describe the categories of growth regulators (auxins, cytokinins, ethylene, etc.) and their physiological effects.
10. Define dormancy, photoperiodism and vernalization.
11. Describe the general growth pattern of annual crops

## **II. GENERAL CROP ADAPTATION**

12. Describe how crops respond to salinity, soil fertility, soil pH extremes, and soil drainage.
13. Describe the soil pH ranges where agronomically important crops will best perform.
14. Explain how the water requirements of a crop typically change during growth and development.
15. Explain how the nutrient requirements of a crop typically change during growth and development.
16. Describe the relative differences of nutrient contents in different plant organs (leaves, fruit, etc.).

## **III. TILLAGE SYSTEMS USED FOR SEEDBED PREPARATION OF ROW, SMALL GRAIN AND FORAGE CROPS**

16. Describe the environmental and management factors that influence the selection and use of a tillage system.

17. Explain how cropping systems, environment, and tillage affect soil residue cover.
18. List the advantages and limitations of a no-till system.

#### **IV. CROP DAMAGE, MORTALITY, AND FACTORS INFLUENCING REPLANTING DECISIONS**

19. Describe the types of damage hail, frost, flooding, drought, and wind can cause to agronomic crops
20. List climatic and plant factors which influence plant mortality or a plant's ability to resume growth after injury

#### **V. CROPPING SYSTEMS**

21. Describe the function(s) of fallow in crop production
22. Explain the advantages and limitations of growing cover crops
23. Explain the advantages and limitations of a monoculture system versus a crop rotation
24. List the advantages and limitations of precision farming techniques including global positioning systems (GPS), yield monitoring, variable rate application, and directed soil sampling.