Tri-State Certified Crop Adviser Performance Objectives

CONTENTS

PERFORMANCE OBJECTIVES
FOR THE
TRI-STATE CERTIFIED CROP ADVISER PROGRAM
ILLINOIS--INDIANA--OHIO

INTRODUCTION

The Certified Crop Adviser (CCA) Program is an educational program with two main goals: to certify individuals who have passed a minimum competency examination and to establish a mechanism of continuing education for those already certified.

At the core of this program are the Competency Areas and Performance Objectives (P.O.'s). These describe the knowledge and skills that crop advisers consider important in order to carry out their duties.

The Competency Areas and P.O.'s outlined in this publication are the result of a cooperative effort by the Ohio, Indiana, and Illinois CCA Boards. The purpose of this Tri-State CCA initiative is to eliminate unnecessary duplication of time, effort, and expense spent on managing the minimum competency exam, and to coordinate mutual continuing education efforts. This document contains the Competency Areas and Performance Objectives that are common to the tri-state region.

To become certified, an individual must be competent in areas addressed in both the International and Tri-State P.O. documents. The Tri-State P.O.'s are intended to complement, not duplicate, the International P.O.'s. The Tri-State P.O.'s address areas of crop advising that are specific to the tri-state region.

The P.O.'s are dynamic and will be upgraded, changed and modified as the needs of crop advisers in the tri-state region evolve. While this is a cooperative effort, the authority and management of each state's CCA program remains with the state CCA boards.

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Tri-State Certified Crop Adviser

NUTRIENT MANAGEMENT COMPETENCY AREAS

1. Nutrient Movement in Soil and Water
2. Nutrient Application, Availability, and Uptake
3. Crop Nutrient Deficiencies
4. Soil Test Interpretation
5. Lime Application and Soil pH
6. Manures and Biosolids
7. Nutrient Management Planning

NUTRIENT MANAGEMENT

COMPETENCY AREA 1. NUTRIENT MOVEMENT IN SOIL AND WATER

1. Recognize how the following affect nutrient movement in soil and water
   a. temperature and precipitation
   b. soil physical, chemical, and biological properties
   c. tillage
   d. nutrient form
   e. rate of application
   f. time of application
   g. method of application

COMPETENCY AREA 2. NUTRIENT APPLICATION, AVAILABILITY, AND UPTAKE

2. Recognize how the following affect nitrogen fertilization practices
   a. soil texture
   b. soil organic matter
   c. crop and cropping system
   d. soil moisture
   e. soil temperature
   f. time and method of application

3. Describe how soil pH and soil nitrogen levels affect nitrogen fixation

4. Describe how to use the following nitrogen fertilizers
   a. anhydrous ammonia
   b. urea
   c. Urea/Ammonium-Nitrate (UAN) solutions
   d. ammonium sulfate
   e. manure/biosolids

5. Explain factors affecting when to apply the fertilizers listed in #4

6. Describe characteristics of slow and controlled release fertilizers

7. Explain when to use urease and nitrification inhibitors in a nitrogen fertilization program

8. Recognize how the following affect phosphorus fertilization and uptake
    a. soil texture
    b. soil pH
    c. soil test results
    d. soil moisture
    e. soil temperature
    f. tillage system
    g. crop and cropping system
    h. source of P
    i. band vs. broadcast application

9. Recognize how the following factors affect potassium fertilization and availability to crops
    a. soil texture
    b. soil test results
    c. soil moisture
    d. tillage system
    e. crop and cropping system
    f. cation exchange capacity (CEC)
    g. fall, winter, or spring application

10. List advantages and limitations of banded and seed placed methods of applying N, P, and K fertilizers

11. Describe environmental and economic impacts of the following on applying N, P, and K
    a. time
    b. method
    c. form

COMPETENCY AREA 3. CROP NUTRIENT DEFICIENCIES

12. Recognize nitrogen deficiency symptoms in corn, soybeans, wheat, and alfalfa

13. Recognize phosphorus deficiency symptoms in corn, soybeans, wheat, and alfalfa

14. Recognize potassium deficiency symptoms in corn, soybeans, wheat, and alfalfa

15. Identify plant deficiency symptoms for the following
    a. magnesium in corn
    b. sulfur in corn and alfalfa
    c. zinc in corn
    d. boron in alfalfa
    e. iron or manganese in soybeans

16. Describe how to apply nutrients for correcting deficiencies listed in #12-15

17. List soil characteristics and cropping systems that contribute to causing nutrient deficiencies listed #12-15

18. Describe environmental conditions that cause deficiencies in #12-15

COMPETENCY AREA 4. SOIL TEST INTERPRETATION

19. Explain how the following items on a soil test report affect nutrient recommendations
    a. CEC
    b. soil pH
    c. buffer pH
    d. organic matter
    e. P level
    f. K level
    g. Ca/Mg level

20. Explain why phosphorus recommendations differ between Bray P1 and Mehlich-3 soil test procedures

21. Explain how to interpret soil nitrate and incubation tests for nitrogen availability

COMPETENCY AREA 5. LIME APPLICATION AND SOIL PH

22. Recognize how the following factors affect lime application
    a. tillage system
    b. crop and cropping system
    d. soil type
    e. soil pH and buffer pH
    e. timing of surface urea application

23. Describe how dolomitic differs from calcitic limestone

24. Describe how fineness and purity influence lime quality

25. Recognize how soil pH affects nutrient availability

26. Describe appropriate uses of liquid or pelletted lime

27. Explain how soil pH affects herbicide activity

COMPETENCY AREA 6. MANURES AND BIOSOLIDS

28. List nutrient availability rates from manure/biosolids

29. Describe advantages and limitations of using manure/biosolids as nutrient sources

30. Describe timing, methods, and rates of applying manures and biosolids

COMPETENCY AREA 7. NUTRIENT MANAGEMENT PLANNING

31. Name the agency responsible for overseeing Nutrient Management Plans

32. Use soil test reports to make economically and environmentally sound fertilizer recommendations

33. List the purposes of a nutrient management plan

34. Identify sources of information to meet legal requirements for nutrient management planning for your state

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SOIL AND WATER MANAGEMENT COMPETENCY AREAS

1. Natural Resource Conservation Issues
2. Soil Productivity and Environmental Management
3. Water Quality
4. Soil Erosion

SOIL AND WATER MANAGEMENT

COMPETENCY AREA 1. NATURAL RESOURCE CONSERVATION ISSUES

1. Describe how the following affect conservation of natural resources
   a. sedimentation
   b. soil erosion
   c. nutrient transport
   d. pesticide transport
   e. manure/biosolids management

2. Describe how the following practices affect soil and water conservation
   a. tillage/residue management
   b. nutrient management
   c. pest management
   d. buffer strips, riparian areas, field borders
   e. cropping systems

3. Describe how the following conservation practices impact wildlife habitat
   a. crop rotation
   b. tillage/residue management
   c. buffer strips, riparian areas, field borders

4. Identify costs/benefits associated with implementing conservation measures

5. Identify state and federal agencies involved with soil and water management

6. Define soil erosion tolerance level (T)

7. Define highly erodible land (HEL)

8. Describe land management practices recommended for HEL

9. List factors used by USDA to define a wetland (WL)

10. Describe how planned drainage and cropping systems affect the management of wetlands

COMPETENCY AREA 2. SOIL PRODUCTIVITY AND ENVIRONMENTAL MANAGEMENT

11. Explain how the following affect soil and crop productivity potential
    a. soil nutrient level
    b. tillage/residue management
    c. crop rotation
    d. soil organisms
    e. drainage
    f. cover crops
    g. soil texture
    h. soil organic matter

12. Describe how the following factors influence soil temperature and moisture
    a. plant cover
    b. surface residue
    c. tillage system
    d. soil organic matter
    e. soil texture
    f. drainage

13. Describe how the following influence soil compaction
    a. soil moisture
    b. soil texture
    c. organic matter
    d. tillage practices
    e. traffic patterns
    f. livestock
    g. machinery

14. Explain how the following factors influence water infiltration into soil
    a. plant cover
    b. surface residue
    c. tillage system
    d. soil slope

COMPETENCY AREA 3. WATER QUALITY

15. Define hypoxia

16. Define eutrophication

17. Describe how the following influence movement of pollutants in surface water quality
    a. soil permeability
    b. topography
    c. cropping practices
    d. surface and subsurface drainage
    e. controlled drainage
    f. pollutant characteristics
    g. conservation buffer strips and setbacks
    h. soil test nutrient levels
    i. tillage practices
    j. livestock operations
    k. nutrient application methods

18. Explain how the following influence movement of pollutants in groundwater quality
    a. pollutant characteristics
    b. slope
    c. nutrient type, form and time of application
    d. water table depth
    e. soil permeability
    f. restrictive layers
    g. soil nutrient levels
    h. Karst topography
    i. exposed sand and gravel
    j. abandoned wells
    k. livestock lots

19. Describe nutrient application practices that minimize nutrient loss from a field

20. Define total maximum daily load (TMDL)

21. Define water quality impairment

22. Describe how the following affect water quality
    a. sediments
    b. nutrients
    c. pathogens
    d. pesticides

23. Describe soil characteristics that affect rate of liquid manure/waste application

COMPETENCY AREA 4. SOIL EROSION

24. Describe how soil erosion affects the following
    a. water quality
    b. waterway, stream, and lake sedimentation
    c. soil productivity potential

25. Describe how to measure soil loss from the following
    a. sheet and rill erosion
    b. gully erosion
    c. wind erosion

26. Describe how the following management practices affect sheet and rill erosion
    a. tillage/residue management practices
    b. crop rotation
    c. cover crops
    d. row spacing and direction

27. Describe how the following management practices affect erosion by wind
    a. tillage/residue management
    b. surface roughness
    c. row direction
    d. crop strip width
    e. windbreak
    f. cover crops

28. Describe how water and sediment control basins, grassed waterways, and grade stabilization structures affect erosion

29. Describe how wind erosion damages growing crops

30. Describe how to use the line transect method to measure crop residue

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INTEGRATED PEST MANAGEMENT COMPETENCY AREAS

1. Integrated Pest Management (IPM) Principles and Concepts
2. Insect Management
3. Crop Disease Management
4. Weed Management
5. Health, Safety, and Environmental Stewardship of Pesticides
6. Pesticide Performance and Application
7. Pest Resistance Management

INTEGRATED PEST MANAGEMENT

COMPETENCY AREA 1. INTEGRATED PEST MANAGEMENT (IPM) PRINCIPLES AND CONCEPTS

1. Describe characteristics of diseases, insects, and weeds that make them crop pests

2. Explain how the following factors influence field scouting
   a. sampling pattern
   b. pest life cycle
   c. sampling time and frequency
   d. field history
   e. pest population level
   f. weather conditions

3. Describe how to use a weeds key

4. Describe how the following environmental factors affect pest management recommendations
   a. low temperature stress
   b. drought
   c. heat stress
   d. excessive moisture

5. Describe pest problems associated with the following tillage systems
   a. intensive
   b. reduced
   c. no-till
   d. strip-till

6. List factors to consider when using transgenic, chemical, cultural, mechanical, or biological pest control methods

COMPETENCY AREA 2. INSECT MANAGEMENT

7. Identify the following pests at the life stages indicated below

Adult	Adult and Larval or Nymph	Larval
aphids	brown marmorated stink bug	alfalfa weevil
bean leaf beetle	corn rootworms	armyworm
brown stink bug	corn borers	cutworms
flea beetle	Hessian fly	earworms
spider mites	Japanese beetle	grape colaspis
	Mexican bean beetle	seedcorn maggot
	potato leafhopper	stalk borer
	western bean cutworm	white grubs
		wireworm

8. Identify crop injury symptoms caused by each pest in objective #7

9. Describe management strategies for each pest in objective #7

10. Explain how the following insect characteristics influence pest management decisions
    a. developmental time and period of activity
    b. host plants for egg, larval, pupal, adult or nymph insect life stages
    c. site of insect feeding on plant
    d. insect mobility

11. Explain how an insect's overwintering and oversummering strategies affect pest management decisions

12. Describe how the following cropping practices affect management and potential crop damage from insects
    a. planting date
    b. harvest date
    c. tillage method
    d. presence of weeds
    e. pesticide interactions
    f. insecticide selection and application method
    g. hybrid, variety and trait selection
    h. crop rotation

COMPETENCY AREA 3. CROP DISEASE MANAGEMENT

13. Identify the symptoms of the following crop diseases

Corn
gray leaf spot
northern corn leaf blight
Goss's leaf blight
seedling blights
anthracnose stalk rot
gibberella stalk and ear rot
fusarium stalk and ear rot
diplodia stalk and ear rot
rusts
nematodes

Soybeans
brown stem rot
phytophthora root rot
fusarium seedling blight
pythium seedling blight
rhizoctonia seedling blight
soybean cyst nematode
sudden death syndrome
sclerotinia stem rot
bean pod mottle virus
Asian rust

Wheat
barley yellow dwarf virus
head scab
powdery mildews
rusts
Septoria leaf blotch
Stagonospora glume blotch
Stagonospora leaf blotch

Alfalfa
phytophthora
anthracnose
bacterial wilt
leaf spots

14. Describe how the diseases in objective #13 affect crop growth, quality, and productivity

15. Describe management strategies for each disease in objective #13

16. Explain how the following factors affect crop disease damage and management
    a. cultivar or hybrid selection
    b. fertility practices
    c. insect vectors
    d. date of planting
    e. time of infection/crop stage
    f. environmental stresses
    g. tillage system
    h. crop rotation
    i. soil compaction
    j. alternate host

17. Describe how disease race affects hybrid and variety selection

COMPETENCY AREA 4. WEED MANAGEMENT

Weed Identification and Biology

18. Identify the following vegetative structures of grass weeds
    a. ligule
    b. auricle
    c. blade
    d. sheath
    e. leaf and stem pubescence

19. Identify broadleaf weeds using the following characteristics
    a. cotyledon shape
    b. true leaf shape
    c. leaf arrangement
    d. leaf and stem pubescence
    e. seed

20. Identify the following grass and broadleaf reproductive structures
    a. seed heads
    b. seeds
    c. stolons
    d. rhizomes
    e. tubers and bulbs

21. Identify the following weeds at seedling, vegetative and reproductive growth stages

Sedges and Grasses	Broadleaves	Broadleaves
barnyardgrass	bindweeds	kochia
crabgrasses	burcucumber	lambsquarters
fall panicum	Canada thistle	morningglories
giant foxtail	common chickweed	Palmer amaranth
green foxtail	common cocklebur	pigweed species
yellow foxtail	common milkweed	poison hemlock
Johnsongrass	common ragweed	pokeweed
quackgrass	giant ragweed	purple deadnettle
shattercane	dandelion	smartweeds
woolly cupgrass	eastern black nightshade	velvetleaf
yellow nutsedge	hemp dogbane	waterhemp
	henbit	wild carrot
	horseweed (marestail)	wild garlic
	jimsonweed	wild mustard
		wild onion

22. Classify each weed in #21 as winter annual, summer annual, biennial, or perennial

23. Explain how tillage systems affect weed infestations, seed bank dynamics, and species composition

Weed Control

24. Describe plant damage symptoms for corn and soybeans caused by the following WSSA-Weed Science Society of America herbicide MOA-mode of action groups
    a. Group 1: ACCase grass growing point disintegrators
    b. Group 2: ALS amino acid synthesis inhibitors
    c. Group 3: seedling root inhibitors
    d. Group 4: synthetic auxins
    e. Groups 5, 6, 7: photosystem II inhibitors
    f. Group 9: EPSP aromatic amino acid inhibitors
    g. Group 10: nitrogen metabolism inhibitors
    h. Group 14: cell membrane disrupters
    i. Group 15: seedling shoot inhibitors
    j. Group 22: photosystem I inhibitors
    k. Groups 27, 28: pigment inhibitors

25. Describe how to use the following to manage weeds
    a. crop rotation
    b. plant population and row spacing
    c. tillage and cultivation
    d. planting date of crop
    e. proper soil fertility and pH
    f. herbicide tolerant crops
    g. herbicides

COMPETENCY AREA 5. HEALTH, SAFETY, AND ENVIRONMENTAL STEWARDSHIP OF PESTICIDES

26. Explain how the following chemical factors influence the persistence and carryover of pesticides within a field environment
    a. microbial degradation
    b. photodegradation
    c. chemical breakdown
    d. volatility
    e. sorption

27. Explain how the following environmental factors influence the persistence and carryover of pesticides within a field environment
    a. soil pH
    b. moisture
    c. temperature
    d. leaching
    e. soil erosion
    f. crop residue

28. Explain how the pesticide signal words Caution, Warning, and Danger relate to toxicity

29. List sources of information about your state's pesticide laws

30. List record keeping requirements related to pesticides

31. Using information on a label or Material Safety Data Sheet (MSDS), determine the following
    a. toxicity
    b. handling precautions
    c. first aid procedures
    d. environmental hazards
    e. dosage or use rate
    f. application restrictions
    g. Re-Entry Interval (REI)
    h. WSSA-MOA group number

COMPETENCY AREA 6. PESTICIDE PERFORMANCE AND APPLICATION

Pesticide Performance

32. Recognize how soil and environmental factors affect pesticide performance

33. Explain how timing of application affects pesticide performance

34. Distinguish control from suppression for weed control products

35. Describe how to use the following information to develop a pest management program
    a. field pest history
    b. severity of infestation
    c. crop growth stage
    d. application method
    e. economic threshold
    f. previous pesticide applications
    g. non-pesticide alternatives

36. Describe how the following factors affect liquid pesticide performance
    a. spray pattern
    b. spray pressure
    c. application rate
    d. application speed
    e. adjuvants
    f. pesticide compatibility
    g. carrier
    h. mixing order
    i. wind speed
    j. water characteristics
    k. micronutrients

Pesticide Application

37. Describe how the following pesticide formulations differ
    a. water soluble liquids
    b. water soluble powders
    c. water soluble concentrates
    d. wettable powders
    e. emulsifiable concentrates
    f. water dispersible granules
    g. pellets
    h. granules

38. Describe the pattern form, relative droplet size, proper pattern overlap, operating pressure, and primary uses of the following nozzle types
    a. standard flat fan
    b. even flat fan
    c. flood tip
    d. air induction
    e. twin jet

39. List consequences of inadequate spray equipment

40. Explain why frequency of cleaning spray equipment is important

41. Distinguish spray particle drift from volatilization

COMPETENCY AREA 7. PEST RESISTANCE MANAGEMENT

42. Explain why refuge design in insect resistant crops varies with insect species and traits

43. List factors that cause weeds to develop resistance to herbicides

44. List methods that can help prevent weeds from developing herbicide resistance

45. Describe how to identify and manage herbicide resistant weed populations

46. Describe how the following influence the evolution of resistance
    a. number and type of traits
    b. pest life cycle
    c. refuge requirements
    d. crop rotation
    e. diversity of pest control methods

Tri-State Certified Crop Adviser

CROP MANAGEMENT COMPETENCY AREAS:

1. Cropping Decisions
2. Hybrid and Variety Selection
3. Crop Growth, Development, and Diagnostics
4. Crop Harvesting, Handling, and Storage
5. Managing Agronomic Information

CROP MANAGEMENT

COMPETENCY AREA 1. CROPPING DECISIONS

1. Describe how the following affect management decisions within continuous and rotational systems
   a. pest resistance
   b. pest persistence
   c. crop traits
   d. residue management
   e. tillage
   f. nutrient management
   g. soil physical properties

2. Describe environmental and economic factors which influence selection of a tillage system

3. List agronomic advantages and limitations of intensive, reduced, strip-till, and no-till systems

4. Describe consequences of planting corn, soybeans, wheat, or forage crops earlier or later than optimum

5. Describe how row spacing affects the following
   a. weed control
   b. disease control
   c. insect control
   d. crop yield
   e. interplant competition
   f. lodging

6. Describe how the following factors influence selection of optimum population
   a. soil type
   b. planting date
   c. hybrid and variety
   d. row spacing
   e. irrigation

7. Describe the role of cover crops in the following
   a. nutrient management
   b. soil conservation
   c. soil physical properties
   d. herbicide selection
   e. pest cycles

COMPETENCY AREA 2. HYBRID AND VARIETY SELECTION

8. Describe how the following influence hybrid and variety selection:
    a. yield potential for corn, soybeans, and wheat
    b. maturity rating for corn, soybeans, and wheat
    c. lodging resistance in corn, soybeans, and wheat
    d. pest resistance in corn, soybeans, wheat, and alfalfa
    e. winter hardiness of wheat and alfalfa
    f. intended end use of corn, soybeans, wheat, and alfalfa

9. Describe how the following affect transgenic crop selection
    a. refuge requirements
    b. weed management programs
    c. insect management programs
    d. trait characteristics

10. Describe how planting date affects hybrid and variety selection

11. Describe how tillage systems affect hybrid and variety selection

12. Describe the advantages and limitations of growing the following:
    a. herbicide resistant crops
    b. insect resistant crops
    c. disease resistant crops
    d. non-transgenic crops
    e. drought tolerance crops

13. Describe the agronomic and economic advantages and limitations of growing value-added crops

COMPETENCY AREA 3. CROP GROWTH, DEVELOPMENT, AND DIAGNOSTICS

14. Use the Iowa State system to identify corn and soybean growth stages

15. Identify the location of growing points through vegetative stages of corn and soybeans

16. Differentiate soybean fixation nodules and soybean cysts

17. Use the Feeke's scale to identify each of the following growth stages in cereal grains
    a. emergence
    b. tillering
    c. jointing
    d. boot
    e. flag leaf emergence
    f. flowering
    g. physiological maturity

18. Describe how corn, soybeans, and wheat respond to row spacing, population, and in-row plant spacing variation

19. Use the node injury scale to quantify corn root injury

20. Describe physical damage to corn, soybeans, wheat, and alfalfa from
    a. hail
    b. frost
    c. flooding
    d. drought
    e. wind

21. Identify the most susceptible growth stage of corn, soybeans, wheat, and alfalfa for each type of damage in #20

22. Describe how the following inhibit stand development and plant growth
    a. planter operation
    b. pesticide application
    c. pests
    d. soil factors
    e. climatic factors
    f. nutrient placement
    g. residue management

23. Use the following factors to make a replant decision
    a. type and level of crop damage
    b. crop growth stage
    c. calendar date
    d. existing population and stand uniformity
    e. potential yield
    f. environmental factors

24. Describe how crop and pest growth stages affect the following management decisions
    a. pest management
    b. nutrient management
    c. water management
    d. tillage

25. Identify the following growth stages of alfalfa
    a. vegetative
    b. flowering
    c. one-tenth bloom
    d. full bloom

26. Identify wheat and alfalfa frost heaving damage

COMPETENCY AREA 4. CROP HARVESTING, HANDLING, AND STORAGE

27. Describe how the following factors affect harvest practices and timing
    a. crop moisture
    b. drying cost
    c. forage growth stage
    d. pest population and activity
    e. susceptibility to lodging

28. Identify causes of harvest loss in corn, soybeans, wheat, and forages due to the following
    a. machine operation
    b. environmental conditions
    c. nutrient deficiencies
    d. pest infestations
    e. crop moisture

29. Describe how storage moisture, temperature, and pests affect grain quality and marketability

30. Describe harvest, handling, and storage practices for identity-preserved (IP) crops

31. Describe how timing and frequency of perennial forage harvest affects
    a. legume/grass mix
    b. stand longevity
    c. forage quality
    d. annual yield

COMPETENCY AREA 5. MANAGING AGRONOMIC INFORMATION

32. Describe how the following affect reliability of agronomic trials:
    a. weather variability
    b. field variability
    c. number of locations
    d. number of treatments
    e. number of replications
    f. trial and sample size

33. Relate site specific information to yield map variability

34. Describe how to use crop management data to make crop management decisions

35. Describe how to use the following to determine crop variability
    a. yield monitor
    b. soil sampling
    c. tissue sampling
    d. remote sensing rating
    e. as-applied maps

36. Describe how to calibrate a yield monitor and equipment

RESOURCE MATERIALS

FOR THE

TRI-STATE

CERTIFIED CROP ADVISER

PROGRAM

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This document contains resource materials that address the competency areas and performance objectives of the Tri-State Certified Crop Adviser Program. It is intended to provide guidance, for those seeking certification, on where to obtain information about knowledge and skills used by CCA's.

Resources for the Tri-State Certified Crop Adviser Program

Nutrient Management and Soil and Water Management

1. *Soil Science & Management* by Edward J. Plaster, 3rd ed., ©1997, Delmar Publishers: Albany NY
2. *Fundamentals of Soil Science* by Henry D. Foth, 8th ed., ©1990, John Wiley & Sons Publishing: NYC NY
3. *The Nature and Properties of Soils* by Nyle C. Brady & Ray R. Weil, 12th ed., ©1999, Prentice Hall: Upper Saddle River NJ
4. *Soils in our Environment* by Roy L. Donahue & Raymond W. Miller, 7th ed., ©1995, Prentice Hall: Englewood Cliffs NJ
5. *Soil Fertility* by Boyd G. Ellis & Henry D. Foth, 2nd ed., ©1997, CRC Press: Boca Raton FL
6. *Soils in our Environment* by Duane T. Gardiner & Raymond W. Miller, 8th ed., ©1998, Prentice Hall: Upper Saddle River NJ
7. *Soils and Soil Fertility* by Louis M. Thompson & Frederick R. Troeh, 5th ed., ©1993, Oxford University Press: NYC NY
8. *Natural Resource Conservation* by D. D. Chiras & Oliver S. Owen, 6th ed., ©1995, Prentice Hall: Upper Saddle River NJ

Integrated Pest Management

1. *Applied Weed Science* by Carole A. Lembi & Merrill A. Ross, 2nd ed., ©1999, Prentice Hall: Upper Saddle River NJ

2. *Seed Corn Pest Management Manual for the Midwest* by multiple authors, Rev. 4/1995, Purdue University Pest Management Program, Purdue Cooperative Extension Service, and the Department of Botany & Plant Pathology
3. *Pest Management* by G. A. Matthews, ©1984, Longman Group Ltd: NYC NY
4. *The Science of Entomology* by William S. Romoser & John G. Stoffolano Jr., 4th ed., ©1998, WCB/McGraw-Hill: NYC NY
5. *The Standard Pesticide User's Guide* by Bert L. Bohmont, 5th ed., ©2000, Prentice Hall: Upper Saddle River NJ
6. *Entomology & Pest Management* by Larry P. Pedigo, 4th ed., ©2002, Prentice Hall: Upper Saddle River NJ
7. *The Biochemistry & Uses of Pesticides* by Kenneth A. Hassall, 2nd ed., ©1990, VCH Publishers Inc: NYC NY
8. *Application Technology for Crop Protection* by G. A. Matthews & E. C. Hislop, ©1993, CAB Int'l: UK
9. *Pesticide Application Methods* by G. A. Matthews, 2nd ed., ©1992, Longman Group UK Ltd: UK
10. *Chemical Exposures: Low Levels & High Stakes* by Nicholas A. Ashford & Claudia S. Miller, ©1991, Van Nostrand Reinhold: NYC NY
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3. Herbicide Safety Information: www.cdms.net/manuf/manuf.asp
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5. Field Crops Entomology IPM: http://www.entm.purdue.edu/fieldcropsipm
6. Weed Science: www.weedscience.com
7. Extensive Corn related Information: www.kingcorn.org
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