Resistance Management Specialist Exam

ONTARIO PERFORMANCE OBJECTIVES

The American Society of Agronomy

Ontario Certified Crop Adviser Program

Effective October 2020

Resistance Management Specialist (RMS)
Performance Objectives

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FOREWORD

The International Certified Crop Adviser (ICCA) Program developed the Resistance Management (RM) Specialty Certification to meet the growing demand for qualified advisers with focused knowledge and skills in pest and resistance management. The Resistance Management Specialty is an additional specialty certification that builds upon the basic components of the International CCA Certification, to demonstrate the Crop Adviser's proficiency in working with the RM concept and building it into a holistic management model.

This specialty, like others within the CCA program falls under one of the five major pillars of a CCA's knowledge, which include Nutrient Management (*4R Nutrient Management Specialty*), Soil and Water Management, Integrated Pest Management (*Resistance Management Specialty*), Crop Management (*Sustainability Specialty*), and Professional Development. Not all CCAs work extensively on pest management but focus on other aspects of crop advising. The RM Specialty allows those CCAs who advise on pest management to become more visible and recognized for their integrated systems thinking and approach to avoid development of resistance or alleviate resistance problems in order to meet the need for improved environmental stewardship.

As indicated above, the RM Specialty falls under the pillar of IPM within the ICCA program because IPM is the overarching premise for resistance management systems. It should also be noted that resistance management applies to more than just pesticides. Plants, insects, and diseases can develop resistance to any practice that is repeated often enough to where it selects an individual or population with the genetic make up to tolerate or resist that practice. BMPs for both prevention and treatment of resistant species should include integrated techniques, which is the basis for this specialty.

The ASA and ICCA Program are based on fundamentals and include the latest discoveries and new approaches. We encourage comments and suggestions concerning possible modifications to this first edition of the POs for Resistance Management. Comments on this document should be sent via email to: certification@sciencesocieties.org.

The ASA, ICCA and Ontario CCA Program would like to thank the many volunteers who contributed to the writing of this document, which were comprised of a broad-based group of professionals from industry, private consulting, government, and academia. This type of program would not be possible without their dedication to the RM discipline within the profession of agronomy and the ICCA program.

Ontario CCA RMS Exam Committee

August 2020

Notes on Exam Format and Conversions

- The exam that will be written from this set of Performance Objectives (POs) is a specialty exam and thus will contain questions that are more in depth and complex than the exams that were taken to obtain the CCA. Potential examinees should look at the verbs associated with each PO to determine the type of information that may be asked about each topic area. For example, the verb “list” would be considered a much less complex idea than a verb such as “interpret”. The format of the exam will be multiple choice questions that address scenarios where the examinee will be provided with data tables, figures, etc. from which to work.

- Examinees should be able to convert between metric and English units and vice versa, as well as understand SI units. Conversion factors will be provided for questions within the exam.

I. EVOLUTION OF RESISTANCE

Competency Area 1. Development of Resistance

1. Discuss the biology of resistance evolution:
    a. selection pressure
    b. recessive versus dominant genes
    c. single step versus multistep mutation/single gene versus cumulative resistance
    d. mechanisms of resistance
    e. genetic diversity of the target species
2. Discuss how the following affect the development and evolution of resistance including:
    a. rotation and/or combinations of best management practices
    b. pest maturity, pest severity, frequency of control
    c. pest dispersal mechanisms
    d. reliance on a single mechanism of action
    e. reduced or off label application rates of pesticides
    f. off label application practices of pesticides

Competency Area 2: Identifying Resistance

1. Identify the possible reason(s) for pest control failures.
2. Identify the possible reason(s) for genetic plant and trait resistance failures.
3. Discuss the processes for identifying pest resistance.
4. Discuss the methodologies for testing and confirming suspected resistant pests.

II. BEST MANAGEMENT PRACTICES (BMPs) FOR RESISTANCE MANAGEMENT

Competency Area 1: Mechanism of Action's Role

1. Discuss an effective mechanism of action for pest control in:
    a. insects
    b. weeds
    c. diseases
2. Discuss mechanism of action's role(s) in:
    a. delaying or
    b. accelerating pest resistance

3. For pesticides, evaluate the importance of rotating effective Insecticide Resistance Action Committee (IRAC), Fungicide Resistance Action Committee (FRAC), and Herbicide Resistance Action Committee (HRAC) code or group designations for mechanisms of action.
4. Discuss an IPM framework that includes multiple effective mechanisms of action or tools to delay resistance development.

Competency Area 2: Resistance Management

1. Develop a resistance management plan:
    a. assessment/scouting pre- and post-treatment
    b. identification
    c. control methods:
        i. biological
        ii. chemical
        iii. cultural
        iv. mechanical
    d. sanitation
    e. reporting
    f. evaluation and follow-up
2. Discuss the roles that local situations and needs play in the development of resistance management plans.
3. Discuss the effects of resistance BMPs on production issues involving the following:
    a. soil conservation stewardship practices
    b. surface water and groundwater quality protection practices
    c. terrestrial habitat
    d. species at risk
    e. reduction/mitigation of off-target impacts to pollinators and beneficial organisms

III. PROFESSIONAL COMMUNICATION AND SHARING INFORMATION

Competency Area 1: Communication and Resistance Management

1. Discuss why it is critical and how to identify and report resistance issues.
2. Identify the benefits of active networks, up-to-date information systems and other available communications tools.

3. Discuss the role of public agencies, non-profit and private organizations in advocating for resistance management approaches that are sustainable within an IPM framework.
4. Discuss the importance of communicating integrated approaches that impact resistance with various stakeholders:
    a. the public
    b. landowners
    c. producers
    d. social media and news outlets

Resistance Management Terms Used in this Exam

Fungicides

Definitions of Resistance, Tolerance, Field Resistance

Fungicide Resistance – Fungicide resistance is an acquired, heritable reduction of sensitivity of a fungus to a specific anti-fungal agent (or fungicide).
[Source: *Fungicide Resistance Action Committee*]

Fungicide Tolerance – "Some scientists use the terms reduced sensitivity or tolerance when referring to smaller reductions in sensitivity which may have little to no impact on fungicide usage in the field, and save the term "resistance" for large reductions in sensitivity of individual isolates which are likely to affect efficacy of a specific fungicide under field conditions if the resistant isolates become widespread in the pathogen population."
[Source: *Fungicide Resistance Action Committee*]

Fungicide Field Resistance – Growers observed reduced efficacy of a product that has previously demonstrated efficacy against that particular pathogen.
[Source: *Fungicide Resistance Action Committee*]

Definitions of Cross Resistance, Multiple Resistance

Fungicide Cross Resistance – "Cross-resistance is a phenomenon that occurs when resistance arises to one fungicide that also results in resistance to another fungicide. Occasionally, cross-resistance can occur between compounds active at different target sites."
[Source: *Fungicide Resistance Action Committee*]

Fungicide Negative Cross Resistance – "Negative cross resistance is when a change results in a reduction in sensitivity to one fungicide and an increase in sensitivity to another fungicide."
[Source: *Fungicide Resistance Action Committee*]

Definitions of Mode of Action, Mechanism of Action, Site of Action

Fungicide Mode of Action – "Mode of action (MOA) refers to the specific cellular process inhibited by a particular fungicide."
[Source: *Fungicide Resistance Action Committee*]

Fungicide Mechanism of Action – "Some pathologists use the term mechanism of action interchangeably with mode of action."
[Source: *Fungicide Resistance Action Committee*]

Fungicide Site of Action – "These sites of action or target sites are the specific enzymes in a cellular process to which the fungicides are binding."
[Source: *Fungicide Resistance Action Committee*]

Fungicide Target Sites – "These sites of action or target sites are the specific enzymes in a cellular process to which the fungicides are binding."
[Source: *Fungicide Resistance Action Committee*]

Fungicides 101 Iowa State University Extension Presentation
http://www.extension.iastate.edu/sites/www.extension.iastate.edu/files/greene/Fungicide101.pdf

Herbicides

DEFINITIONS OF RESISTANCE, TOLERANCE, FIELD RESISTANCE

Herbicide Resistance – Herbicide resistance is the inherited ability of a plant to survive and reproduce following exposure to a dose of herbicide normally lethal to a wild type. In a plant, resistance may be naturally occurring or induced by such techniques as genetic engineering or selection of variants produced by tissue culture or mutagenesis.
[Source: *Weed Technology* Volume 12, Issue 4 (October-December) 1998. p. 789.]

Herbicide Tolerance – Herbicide tolerance is the inherent ability of a species to survive and reproduce after herbicide treatment. This implies that there was no selection or genetic manipulation to make the plant tolerant; it is naturally tolerant."
[Source: *Weed Technology* Volume 12, Issue 4 (October-December) 1998. p. 789.]

DEFINITIONS OF CROSS RESISTANCE, MULTIPLE RESISTANCE

Herbicide Cross Resistance – "Cross resistance is defined as the expression of a genetically-endowed mechanism conferring the ability to withstand herbicides from different chemical classes."
[Source: *Herbicide Resistance Action Committee*]

Herbicide Target Site Cross Resistance – "Target site cross resistance occurs when a change at the biochemical site of action of one herbicide also confers resistance to herbicides from a different chemical class that inhibit the same site of action in the plant. Target site cross resistance does not necessarily result in resistance to all herbicide classes with a similar mode of action or indeed all herbicides within a given herbicide class."
[Source: *Herbicide Resistance Action Committee*]

Herbicide Multiple Resistance – "(Herbicide) multiple resistance is defined as the expression (within individuals or populations) of more than one resistance mechanism. Multiple resistant plants may possess from two to many distinct resistance mechanisms and may exhibit resistance to a few or many herbicides."
[Source: *Herbicide Resistance Action Committee*]

DEFINITIONS OF MODE OF ACTION, MECHANISM OF ACTION, SITE OF ACTION

Herbicide Mode of Action – "Herbicide Mode of Action: The plant processes affected by the herbicide, or the entire sequence of events, that results in the death of susceptible plants. Includes absorption, translocation, metabolism, and interaction at the mechanism of action.
[Source: Weed Science Society of America – WSSA Herbicide Resistance Management Lesson 2]

"The Mode-of-Action is the overall manner in which a herbicide affects a plant at the tissue or cellular level. Herbicides with the same mode-of-action will have the same translocation (movement) pattern and produce similar injury symptoms."
[Source: Purdue University "Herbicide Mode-of-Action Summary" WS-23-W]

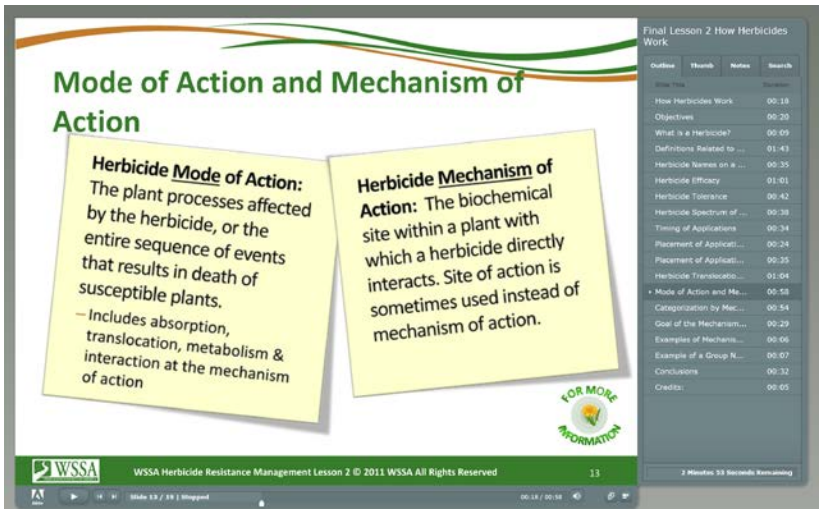
"Mode of Action is defined as how a particular herbicide acts on a plant."
[Source: Passel, University of Nebraska, Lincoln]

Herbicide Mechanism of Action – "The biological site within the plant with which a herbicide directly interacts. Site of action is sometimes used instead of mechanism of action."
[Source: Weed Science Society of America – WSSA Herbicide Resistance Management Lesson 2]

"The mechanism of action (MOA) is the way the herbicide controls susceptible plants. More specifically, it describes the biological processes that are disrupted by the herbicide."
[Source: Sosnoskie & Hanson, University of California]

Herbicide Site of Action – (The herbicide) target site of action or mechanism of action is the exact location of inhibition, such as interfering with the activity of an enzyme within a metabolic pathway.
[Source: Wayne Buhler, North Carolina State University – "Herbicide Resistance Terms to Know"]

"The (herbicide) Site of Action is the biochemical pathway a particular herbicide acts upon in a plant."
[Source: Passel, University of Nebraska, Lincoln]



WSSA Herbicide Resistance Management Lessons
http://wssa.net/wssa/weed/resistance/turf-modules-download/

Herbicide Mode of Action vs. Site of Action – The distinction between Mode of Action and Site of Action relates to "how" the herbicide works versus "where" it works. For example, one mode of action works to destroy chlorophyll in the presence of light. However, different herbicides can do that by blocking different enzymes, or sites, in the plant's physiology. Each represents a site of action that takes a different path to achieve the same result. Therefore, using multiple herbicide sites of action versus just multiple modes of action adds even more diversity to your weed management strategy. All of these classifications are important to consider when developing a weed management plan. - See more at: http://takeactiononweeds.com/understanding-herbicides/

[Source: Take ACTION – Herbicide Resistance Management]

Insecticides

DEFINITIONS OF RESISTANCE, TOLERANCE, FIELD RESISTANCE

Insecticide Resistance – Insecticide resistance is a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species.

[Source: *Insecticide Resistance Action Committee*]

DEFINITIONS OF CROSS RESISTANCE, MULTIPLE RESISTANCE

Insecticide Cross Resistance – "(Insecticide) cross-resistance occurs when resistance to one insecticide confers resistance to another insecticide, even where the insect has not been exposed to the latter product."

[Source: *Insecticide Resistance Action Committee*]

DEFINITIONS OF MODE OF ACTION, MECHANISM OF ACTION, SITE OF ACTION

Insecticide Mode of Action – "The mode of action of an insecticide is the way in which it causes physiological disruption at its target site."

[Source: Pest Control Technology website - http://www.pctonline.com/article/pct1011-insecticide-information/]

"MOA is the specific process by which an insecticide kills an insect, or inhibits its growth."

[Source: Wayne Buhler, North Carolina State University – "Introduction to Insecticide Resistance"]

Insecticide Mechanism of Action – Few specific references. Usually used synonymously with "site of action."

Insecticide Site of Action – "Target site is defined as the physical location within an organism where the insecticide acts."
[Source: Pest Control Technology website - http://www.pctonline.com/article/pct1011-insecticide-information/]

Target Site of action is the exact location of inhibition, such as interfering with the activity of an enzyme within a metabolic pathway. MOA (Mode of Action) and target site of action are often used interchangeably in practice…"
[Source: Wayne Buhler, North Carolina State University – "Introduction to Insecticide Resistance"]

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