Integrated Pest Management and Invasive Weed Species

Strategic Management Framework: Options, Tools, and IPM For Invasive Plant Management

Strategic Management of Invasive Species in the Southwest Workshop

October 27, 2009
Integrated Pest Management and Invasive Weed Species

Session Outline:
- Defining Integrated Pest Management (IPM)
- Species of Interest – ID and Ed
- Management Options Available:
  - Biological Control
  - Use of Herbicides
  - Mechanical Equipment
- Application/Management Equipment
  - Applying Herbicides
  - Vegetation Management
- Species Specific IPM Examples
- Group Exercise
  - Individual Projects – address situation and provide a summary report
- Group Summarization Discussion
What Would You Do Here?

- Take a look at these two situations and let's talk about what you would do for each of them.

- What are some of the pieces of information you are collecting in your mind?
What Would You Do Here?

- As you look at this situation, what is it that drives the type of responses you are formulating regarding what you are seeing and the question of what needs to be done?
  - Educational background?
  - Years of experience?
  - Funding issues?
  - Federal regulations - NEPA?
  - Fear of litigation?
Norris, Caswell-Chen, and Kogan defined Integrated Pest Management as:

- “A decision support system for the selection and use of pest control tactics singly or harmoniously coordinated into a management strategy, based upon cost-benefit analysis that take into account the interests of and impacts on producers, society, and the environment.”
Walker & Buchanan defined IWM:

“The application of many kinds of technologies in a mutually supportive manner. It involves the deliberate selection, integration, and implementation of effective weed control measures (pest control measures) with due consideration to economic, ecological, and sociological consequences.”
Decision Making

- Information on the identified pest(s):
  - Understand the biology of the pest and the characteristics associated with the spread and impact associated with the particular pest.

- Information regarding the site of infestation:
  - To provide a descriptive analysis of the site occupied by the pest(s) in question.
Management Tools in IPM

- Just what are my options with a piece of land and, what should I take into consideration?

- Management Options:
  - Herbicides?
  - Tillage/Plowing?
  - Grazing?
  - Biological Control?

- Action Considerations:
  - Return on investment
    - Immediate
    - Long term
Weed Management - Options

What are the options available to us for weed management?

- **Pest Manipulation**
  - Legislation
  - Herbicidal Applications
  - Biological Control
    - Classical
    - Non-classical
  - Physical/Mechanical
- **Plant/Site Manipulation**
  - Cultural Activities
  - Host-Plant Resistance
Weed Management Options - Legislative

- Legislative mandate (laws and regulations) can limit the spread of weeds into areas not currently infested.
  - State laws
  - Federal laws
- Legislation establishes level playing fields.
Weed Management Options - Legislative

- Federal Noxious Weed Act of 1974, as amended by Sec. 15 – Management of Undesirable Plants on Federal Lands, 1990:
  - Authorizes federal agencies “to cooperate with other federal and state agencies, and others in carrying out operations or measures to eradicate, suppress, control, prevent, or retard the spread of any noxious weed.”
Federally Listed Noxious Weed – Which of these is one?
Herbicides are chemicals designed to alter the target plants ability to complete it’s life cycle.

Herbicides can be classified several ways.
- Vegetation controlled – grass vs broadleaf.
- Application method – soil vs foliar.
- Application timing – pre vs post-emergence.
- Plant/Soil environmental behavior – selective vs non-selective, systemic vs non-systemic, residual vs non-residual.
- Mechanism of activity in the plant.
Weed Management Options - Biological Control

- "Biological control is the intentional use of living organisms to reduce the population of a pest."

- Classical and Non-classical:
  - Includes the use of:
    - Insects
    - Nematodes
    - Mites
    - Plant Pathogens
    - Livestock
Yellow Starthistle Hairy Weevil

*Eustenopus villosus*
Weed Management Options - Classical Biological Control
Weed Management Options - Non-classical Biological Control

Cattle
- Grass-eaters
- Large/strong mouths

Sheep
- Grass/forbs eaters
- Small selective mouths

Goats
- Forbs/woody plant eaters
- Small selective mouths
Weed Management Options - Physical/Mechanical

- Management through the direct physical action.
  - Hand pulling & hoeing
  - Mowing
  - Cultivation
  - Chaining
  - Root plowing
It is always better, and cheaper, to prevent a weed problem than to try and “cure” one.

Prevention as a cultural activity:
- Certification programs
  - Seed, mulch, forage
- Educational activities

Management strategies.
Integrated Weed Management

- The only way we will be able to successfully address our weed problems is in an integrated approach – identifying objectives/goals for site, understanding the weeds to be treated, site to be treated, tactics available and keeping good records.

- Anything less – will be a waste of time.
Integrated Pest Management and Invasive Weed Species

Session Outline:
- Defining Integrated Pest Management (IPM)
- Species of Interest – ID and Ed
IPM and Invasive Weed Species – Species Identification/Education

- Yesterday, Dan Robinett spoke to you regarding several plant species of interest within the Southwest.

- Take what you know, regarding identification, and build a mindset of management.
IPM and Invasive Weed Species – Species Identification/Education

- Provide the following information:
  - Name
IPM and Invasive Weed Species – Species Identification/Education

- Provide the following information:
  - Name
  - Life cycle:
    - How does it spread and reproduce.
    - When is it observed growing.
IPM and Invasive Weed Species – Species Identification/Education

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    - How does it spread and reproduce.
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  - Typical sites of habitat, invasion, infestation, etc. – where is it found.
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  - Life cycle:
    - How does it spread and reproduce.
    - When is it observed growing.
  - Important characteristics associated with the plant.
  - Typical sites of habitat, invasion, infestation, etc. – where is it found.
  - Invasive transportation – large scale movement.
IPM and Invasive Weed Species – Species Identification/Education

- Information I need:
  - Name
  - Life cycle:
    - Spread & Reproduction
    - Growth observance
  - Important characteristics
  - Typical sites of inhabitation
  - Invasive transportation
IPM and Invasive Weed Species – Species Identification/Education

Information:
- Name
- Life cycle:
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**Hoary Cress**
- *Cardaria draba*
- Creeping perennial
- Mustard Family – petals in shape of a cross.
- Reproduction – Seed and Creeping Roots
- Other points?
IPM and Invasive Weed Species – Species Identification/Education

- **Information:**
  - **Name**
  - **Life cycle:**
    - Spread & Reproduction
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  - **Important characteristics**
  - **Typical sites of inhabitation**
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Sahara Mustard
- Brassica tournefortii
- Winter annual – fall germination.
- Mustard Family – petals in shape of a cross.
- Reproduction - Seed
- Breaks off from root system and tumbles.
- Wind, vehicles aid in the movement.
- Other points?
IPM and Invasive Weed Species – Species Identification/Education

- Information:
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IPM and Invasive Weed Species –
Species Identification/Education

- **Information:**
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**Salt Cedar**
- *Tamarix ramosissima*
- Woody
- Tamarisk Family
- Smallflowered tamarisk – *T. parviflora* (flowers have four petals, not five).
- Serious impact in the Southwest
- Other points?
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**Spotted Knapweed**
- *Centaurea biebersteinii*
- Simple Perennial
- Sunflower Family
- Similar in appearance to diffuse knapweed (*C. diffusa*), but different life cycle.
- Other points?
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**Yellow Starthistle**
- *Centaurea solstitialis*
- Winter annual – fall germination
- Sunflower family – composite flower
- Reproduction - Seed
- Toxic to horses
- Looks similar to Malta Starthistle.
- Other points?
IPM and Invasive Weed Species – Species Identification/Education

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Scotch Thistle

- *Ornopordum acanthium*
- Biennial – rosette followed by bolting and flowering and seed set.
- Sunflower family – composite flower
- Reproduction - Seed
- Other points?
IPM and Invasive Weed Species – Species Identification/Education

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IPM and Invasive Weed Species – Species Identification/Education

Information:
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Downy Brome
- *Bromus tectorum*
- Grass Family
- Also known as “Cheatgrass”
- Winter annual
- Fall germination
- Reproduction – Seed
- Grazing – limited
- Ecosystem transformer
- Other points?
IPM and Invasive Weed Species – Species Identification/Education

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IPM and Invasive Weed Species – Species Identification/Education

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- Important characteristics
- Typical sites of inhabitation
- Invasive transportation

Kochia

- Kochia scoparia
- Goosefoot Family
- Summer Annual
- Spring Germination
- Reproduction – Seed
- Introduced as a forage plant
- Other points?

Kochia scoparia – Goosefoot Family

Summer Annual

Spring Germination

Reproduction – Seed

Introduced as a forage plant

Other points?
Integrated Pest Management and Invasive Weed Species

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- Management Options Available:
  - Biological Control
  - Use of Herbicides
  - Mechanical Equipment
“Biological control is the intentional use of living organisms to reduce the population of a pest.”

Classical and Non-classical:
- Includes the use of:
  - Insects
  - Nematodes
  - Mites
  - Plant Pathogens
  - Livestock
IPM and Invasive Weed Species – Biological Control

Queensland, Australia, May, 1928
IPM and Invasive Weed Species – Biological Control

Queensland, Australia, October, 1929
IPM and Invasive Weed Species – Biological Control

*Cactoblastis cactorum*
IPM and Invasive Weed Species – Biological Control

*Aphthona lacertosa*

*Aphthona nigriscutis*
IPM and Invasive Weed Species – Biological Control

- Why consider Biological Control:
  - Environmentally friendly
  - Selective and host specific
  - Self perpetuating
  - Only option available
IPM and Invasive Weed Species – Biological Control

- Points to remember:
  - Understand the individual requirements of the biological control agent.
  - Make sure the proper documents are in place prior to introducing the agent.
  - Make sure the agents coming in are clean and free of diseases and/or parasitoids.
IPM and Invasive Weed Species – Biological Control

Points to remember:
- Identify the proper release site.
- Following release – monitor the population.
- Document survival and spread of the biological control agent.

Leaf beetle: *Diorhabda elongata*

*Cyphocleonus achates*
IPM and Invasive Weed Species – Biological Control

Factors limiting success

Aside from those listed above:
- Competition from other biological control agents.
- Impacts associated with the density of the existing vegetation.
IPM and Invasive Weed Species – Biological Control

- Classical Biological Control involves using insects, pathogens, mites, and nematodes.
- Non-classical Biological Control utilizes livestock as a means of managing the undesirable vegetation.
IPM and Invasive Weed Species – Biological Control

- “Grazing Animals” versus “Non-classical Biological Control”
  - It depends upon the focus of the action.
    - “Grazing Animals” implies that the animals graze for the purpose of weight gain and if the weeds are managed – additional benefit.
      - Also referred to as “Targeted Grazing”
    - “Non-classical Biological Control Activity” implies that the focus of the activity is to manage a particular species, the additional benefit is the weight gain.
IPM and Invasive Weed Species – Biological Control

- Positive aspects:
  - Stress vegetation.
  - Reduce vegetative growth.
  - Reduce seed production.
  - Improve pasture quality.
  - Feasible on rough terrain.
  - Direct control of species being managed.
  - Utilization of the targeted species for a marketable product.
Negative effects:
- Create disturbed sites.
  - Invite weed introduction.
- Spread seed.
- Initial cost can be high.
- Management expenses:
  - Equipment
  - Personnel
IPM and Invasive Weed Species – Biological Control

- Negative effects:
  - Potential damage to non-target species.
  - Requires a greater understanding of the target species and the animal selected:
    - Timing and frequency of grazing.
    - Type of livestock best suited for the area – targeted species and environmental conditions.
IPM and Invasive Weed Species – Biological Control

- Cattle:
  - Grass-eaters.
  - Large/strong mouths.
  - Large rumens for fermentation.
  - Well designed for fiber digestion.
  - Can used to trample the vegetation.
  - Easy to contain and sell.
IPM and Invasive Weed Species – Biological Control

- **Sheep:**
  - Grass/forbs eaters.
  - Small selective mouths.
  - Large rumen for fermentation.
  - Large liver for detoxification.
  - Require fencing or herder to manage.
  - Market for final product?
IPM and Invasive Weed Species – Biological Control

- **Goats:**
  - Forbs/woody plants eaters.
  - Small selective mouths.
  - Large liver for detoxification.
  - Also requires fencing or herder to manage.
  - Market for finished product?
IPM and Invasive Weed Species – Biological Control

- Success depends upon the livestock selected for the particular targeted weed and the conditions of the grazing site.
IPM and Invasive Weed Species – Biological Control

- Leafy Spurge:
  - Sheep and goats successfully used for spurge control.
  - Goats more effective than sheep.
  - Considered a “good forage” for sheep.
  - Some cattle producers waive leases to sheep producers.
IPM and Invasive Weed Species – Biological Control

- Yellow Starthistle
  - Sheep and cattle grazing can reduce seed production and biomass.
  - Toxic to horses.
  - Most palatable when young.
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  - Use of Herbicides
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IPM and Invasive Weed Species – Use of Herbicides

- By Definition – herbicides are chemicals designed to alter the target plants ability to complete its life cycle.

- Herbicides can be classified several ways.
IPM and Invasive Weed Species – Use of Herbicides

- **Application Method**
  - **Foliar Applied**
    - Application made directly to the plant.
  - **Soil Applied**
    - Application can to the soil, usually requires some form of incorporation for activation.

- **Both of these applications can be applied as:**
  - Broadcast applications
  - Spot treatment applications
IPM and Invasive Weed Species – Use of Herbicides

- **Application Timing**
  - **Preemergence**
    - Application is made prior to seed germination.
    - Requires incorporation for activation.
  - **Postemergence**
    - Application is made following seed germination/bud sprouting and emergence from the soil to the emerged plants.
IPM and Invasive Weed Species – Use of Herbicides

- **Strengths of Preemergence:**
  - Broad window of application
  - Minimal competition between weeds and desirable plants

- **Weaknesses of Preemergence:**
  - Herbicide must move into soil through moisture or tillage
  - Rates must be adjusted for soil texture (sand, silt, clay) and organic matter
  - May make unnecessary treatments
IPM and Invasive Weed Species – Use of Herbicides

- **Strengths of Postemergence:**
  - Not strongly influenced by the soil environment
  - Applications made after the weed problem appears
    - Eliminate unneeded applications
    - Treat only infested areas

- **Weaknesses of Postemergence:**
  - Narrow time window for effective and safe application
    - Proper environmental conditions
    - Amount of area to be treated
    - Any delay in treatment increases potential for yield loss

- Eliminate unneeded applications
- Treat only infested areas
IPM and Invasive Weed Species – Use of Herbicides

- Herbicide & Plant Interaction:
  - Selectivity – is effective on one type/group of plants and not another:
    - Selective vs nonselective
  - When would you want to use a selective herbicide?
  - When would you want to use a nonselective herbicide?
IPM and Invasive Weed Species – Use of Herbicides

- Herbicide & Plant Interaction:
  - Selectivity
  - **Systemic** – herbicide does, or does not, move within the plant system:
    - Systemic vs nonsystemic
  - What is the advantage of a systemic herbicide?
  - When would you want to use a nonsystemic herbicide?
IPM and Invasive Weed Species – Use of Herbicides

- With systemic herbicides, timing is critical:
  - Growth stage influences herbicide movement
  - General recommendations
    - Biennials and simple perennials:
      - Time of first killing frost
    - Creeping perennials:
      - Bud to flower stage
IPM and Invasive Weed Species – Use of Herbicides

- Herbicide & Plant Interaction:
  - Selectivity
  - Systemic
  - Residual Activity – extended herbicidal activity in the soil:
    - Residual vs nonresidual
  - What are the advantages associated with a residual herbicide?
  - Are there any disadvantages?

[Image of DuPont Oustar® herbicide]
**Soil residual activity:**

- Length of time a herbicide persists in the soil and impacts plant growth
- Determined by 3 factors:
  - Water solubility
    - How well does it dissolve in water?
  - Adsorptive potential
    - Attraction between herbicide and soil
  - Half-life
    - How rapidly does the herbicide break-down?
IPM and Invasive Weed Species – Use of Herbicides

- Herbicide Formulations:
  - Liquid Formulations:
    - Solution (S):
      - Polar molecule/hydrophilic added to water.
    - Emulsifiable Concentrate (EC):
      - Emulsifying agent, which has a water-loving end and an oil-loving end, surrounds the oil-based molecule.
      - When added to formulation one end of the molecule orients into the oil phase of the mixture, surrounding the molecule so that the water loving end is exposed fooling the rest of the water loving ingredients, i.e. – water.
IPM and Invasive Weed Species – Use of Herbicides

- Herbicide Formulations:
  - Liquid Formulations:
    - Solution (S):
    - Emulsifiable Concentrate (EC):
    - Flowable (F,L):
      - Active ingredient is a finely ground insoluble compound which is suspended in a liquid phase.
      - Requires constant agitation once added to spray tank.
    - Unlike the solution, which needs very little agitation following initial mixing, and the emulsifiable concentrate which needs little agitation.
IPM and Invasive Weed Species – Use of Herbicides

- Herbicide Formulations:
  - Dry Formulations:
    - Soluble Powder (SP):
      - Finely ground water soluble powder.
      - Requires very little agitation once added.
    - Dry Flowable (DF, DG, WDG):
      - Water insoluble compound formulated into a small granule-like structure.
      - Requires constant agitation once added.
    - Granular (G):
      - Active ingredient impregnated onto a clay particle or some other carrier particle.
      - Never added to a spray tank.
IPM and Invasive Weed Species – Use of Herbicides

- Consider these numbers:
  - **Downy Brome (Cheatgrass):**
    - 56,000,000 acres in the West
    - Annual rate of spread = 14%
  - **Yellow Starthistle:**
    - 14,775,000 acres in the West
    - Annual rate of spread = 15%
  - **Spotted Knapweed:**
    - 5,233,000 acres in the West
    - Annual rate of spread = 10 - 24%
IPM and Invasive Weed Species – Use of Herbicides

- Rangeland Herbicides:
  - Aminopyralid
  - Chlorsulfuron
  - Clopyralid
  - 2,4-D
  - Dicamba
  - Glyphosate
  - Imazapic
  - Imazapyr
  - Picloram
  - Tebuthiuron
  - Triclopyr

- Non-cropland Herbicides:
  - Bromacil
  - Diuron
  - Sulfometuron methyl
IPM and Invasive Weed Species – Use of Herbicides

- Rangeland Herbicides:
  - Aminopyralid
  - Chlorsulfuron
  - Clopyralid
  - 2,4-D
  - Dicamba
  - Glyphosate
  - Imazapic
  - Imazapyr
  - Picloram
  - Tebuthiuron
  - Triclopyr

- Non-cropland Herbicides:
  - Bromacil
  - Diuron
  - Sulfometuron methyl
IPM and Invasive Weed Species – Use of Herbicides - Aminopyralid

- Plant Growth Regulator
- Herbicide Characteristics:
  - Postemergence
  - Systemic
  - Selective
  - Medium residual – microbial
- Herbicide Activity:
  - Broadleaves
- Comments:
  - Pre-mixed with 2,4-D & triclopyr
IPM and Invasive Weed Species – Use of Herbicides - Clopyralid

- Plant Growth Regulator
- Herbicide Characteristics:
  - Postemergence
  - Systemic
  - Selective
  - Low to medium residual
- Herbicide Activity:
  - Broadleaves
- Comments:
  - Good activity on *Centaurea* species
IPM and Invasive Weed Species – Use of Herbicides - Clopyralid
IPM and Invasive Weed Species – Use of Herbicides – 2,4-D

- Plant Growth Regulator
- Several formulations
  - Acid, salt, and esters
- Herbicide Characteristics:
  - Systemic
  - Selective
  - Low residual
- Herbicide Activity:
  - Broadleaves, but weak on kochia
- Comments:
  - Used alone or as a tank mix
IPM and Invasive Weed Species – Use of Herbicides - Glyphosate

- Amino Acid Biosynthesis Inhibitor
- Herbicide Characteristics:
  - Postemergence
  - Systemic
  - Non-selective
  - No soil activity
- Herbicidal Activity:
  - Grasses, broadleaves, and woody
  - Activity based upon rates of application
IPM and Invasive Weed Species – Use of Herbicides - Glyphosate

**Roundup ORIGINAL**

Complete Directions for Use

Avoid contact of herbicide with foliage, green stems, exposed non-woody roots or fruit of crops, desirable plants and trees, because severe injury or destruction is likely to result.

Read the entire label before using this product.

Use only according to label instructions.

A violation of Federal law to use this product in any manner inconsistent with its labeling.

Not all products recommended on this label are registered for use in California. Check the registration status of each product in California before using.

Read the “LIMIT OF WARRANTY AND LIABILITY” statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

This is an End-Use Product. Monsanto does not intend and has not registered it for reformulation. See individual container label for repackaging, limitations.

**1.0 INGREDIENTS**

**ACTIVE INGREDIENT:**

Glyphosate, N-glycine (20% v/v) 41.5% 100.0%

**OTHER INGREDIENTS:**

*Contains 600 grams per liter or 4 pounds per U.S. gallon of the active ingredient glyphosate, as the form of its isopropylamine salt. The product is registered by U.S. Patent Nos. 4,692,400; 4,702,396; 4,692,372; 5,171,399; and 5,171,260. No license granted under any non-U.S. patents.*

**Roundup PRO Concentrate**

The Complete Broad Spectrum Postemergence Professional Herbicide for Industrial, turf and ornamental weed control.

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Not all products recommended on this label are registered for use in California. Check the registration status of each product in California before using.

Read the “LIMIT OF WARRANTY AND LIABILITY” statement at the end of the label before buying or using. If terms are not acceptable, return at once unopened.

This is an End-Use Product. Monsanto does not intend and has not registered it for reformulation. See individual container label for repackaging, limitations.

**1.0 INGREDIENTS**

**ACTIVE INGREDIENT:**

Glyphosate, N-glycine (20% v/v) 71.6% 100.0%

**OTHER INGREDIENTS:**

*Equivalent to 64.9% of the acid, glyphosate contains 0.7% of non-woodland, and is equivalent to 1 quart of Roundup ProDry herbicide. This product is protected by U.S. Patent Nos. 5,104,180; 6,040,705; and 6,651,841. Other patents pending. No license granted under any non-U.S. patents.*
IPM and Invasive Weed Species – Use of Herbicides - Imazapic

- Amino Acid Biosynthesis Inhibitor
- Herbicide Characteristics:
  - Postemergence & Preemergence
  - Systemic
  - Selective
  - Residual – medium
- Herbicidal Activity:
  - Grasses and broadleaves
- Comments:
  - Activity on downy brome
IPM and Invasive Weed Species – Use of Herbicides - Imazapyr

- Amino Acid Biosynthesis Inhibitor
- Herbicide Characteristics:
  - Systemic
  - Selective and nonselective – rate dependent
  - Residual – moderate to high
- Herbicide Activity:
  - Broadleaves and woody species
- Comments:
  - Does have an aquatic formulation
IPM and Invasive Weed Species – Use of Herbicides - Imazapyr
IPM and Invasive Weed Species – Use of Herbicides - Metsulfuron

- Amino Acid Biosynthesis Inhibitor
- Herbicide Characteristics:
  - Postemergence
  - Systemic
  - Selective
  - Residual – low
- Herbicide Activity:
  - Broadleaves
- Comments:
IPM and Invasive Weed Species – Use of Herbicides - Picloram

- Plant Growth Regulator
- Herbicide Characteristics:
  - Postemergence
  - Systemic
  - Selective
  - Residual – high
- Herbicide Activity:
  - Broadleaves and woody
    - Weak on kochia and mustard species
- Comments:
  - “Restricted Use Pesticide”
IPM and Invasive Weed Species – Use of Herbicides – Sulfometuron

- Amino Acid Biosynthesis Inhibitor
- Herbicide Characteristics:
  - Preemergence and postemergence
  - Systemic
  - Non-selective
  - Residual – medium to high
- Herbicide Activity:
  - Annual grasses and broadleaves
- Comments:
  - Will provide preemergence activity when incorporated into the soil.
IPM and Invasive Weed Species – Use of Herbicides - Tebuthiuron

- Photosynthetic Inhibitor
- Herbicide Characteristics:
  - Preemergence and postemergence
  - Systemic
  - Selective & Non-selective
    - Rate dependent
    - Residual – medium to high
- Herbicide Activity:
  - Rate dependent activity – grasses, broadleaves and woody species.
  - Used to thin sagebrush – opening the canopy.
IPM and Invasive Weed Species – Use of Herbicides - Tebuthiuron

**Specimen Label**

Dow AgroSciences

*Trademark of Dow AgroSciences LLC*

**Spike® 20P**

**Specialty Herbicide**

A surface applied herbicide for woody plant control in such areas as:
- Acreage highways
- Fence rows
- Firebreaks
- Industrial sites
- Clearings for wildlife habitat
- Other non-cropland areas for control of woody plant species

Carefully read the entire label, including all use precautions, before applying to avoid inappropriate use of this product.

Spike® 20P will kill trees and shrubs. Carefully read the precautions before using.

**Active Ingredient:**
- Tebuthiuron (2.2%)

**Inert Ingredients:**
- Methyl paraben, citric acid, sodium benzoate, sodium metabisulfite, sodium chloride, and colorant.

**Recommended Precautions:**
- Read the label affixed to the container for Spike 20P before applying. Carefully follow all precautionary statements and applicable use directions.
- Use Spike 20P according to this supplemental labeling is subject to all use precautions and limitations imposed by the label affixed to the container for Spike 20P.

**Product Bulletin**

**Dow AgroSciences LLC**

9330 Zionsville Road
Indiana, IN 46268-1054 USA

**Spike® 20P**

EPA Reg. No. 62719-121

Special 2(ee) Recommendation

For Distribution and Use Only in the States of Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, South Dakota, Utah, Washington, and Wyoming

**Reduced Rate Application for Big Sagebrush Canopy Cover Reduction**

**ATTENTION**

This recommendation as made is permitted under FIFRA Section 2(ee) and has not been submitted to or approved by EPA.

- It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
- This labeling must be in the possession of the user at the time of application.
- Read the label affixed to the container for Spike 20P before applying. Carefully follow all precautionary statements and applicable use directions.
- Except as described below, use of Spike 20P according to this supplemental labeling is subject to all use precautions and limitations imposed by the label affixed to the container for Spike 20P.

**Directions for Use**

Spike® 20P herbicide may be applied at reduced rates of 1.0 to 2.5 lb per acre of product (0.2 to 0.5 lb ai./acre tebuthiuron) where reduction in big sagebrush (*Artemisia tridentata*) canopy cover is desired for wildlife habitat development and enhanced forage production. Application of reduced rates will thin (not eliminate) the live cover of big sagebrush resulting in a more open mosaic of woody and herbaceous vegetation and greater biodiversity on many sites.

The effectiveness of Spike 20P is dependent upon soil texture, soil organic matter, sagebrush density and plant growth conditions following application. The active ingredient (tebuthiuron) is more available for root uptake in coarse textured soils with low organic matter content. Conversely, in soils with high organic matter or clay content, a greater portion of the tebuthiuron will be bound (adsorbed) to the soil material and less available for uptake.
IPM and Invasive Weed Species – Use of Herbicides - Triclopyr

- Plant Growth Regulator
- Herbicide Characteristics:
  - Postemergence
  - Systemic
  - Selective
  - Residual – medium
- Herbicide Activity:
  - Broadleaves and woody
- Comments:
  - Does have an aquatic formulation
IPM and Invasive Weed Species – Use of Herbicides - Triclopyr
IPM and Invasive Weed Species – Use of Herbicides - Triclopyr
Integrated Pest Management and Invasive Weed Species

● Session Outline:
  - Defining Integrated Pest Management (IPM)
  - Species of Interest – ID and Ed
  - Management Options Available:
    ● Biological Control
    ● Use of Herbicides
    ● Mechanical Equipment