







NDSU | EXTENSION


# 2026 Field to Fork

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EXTENDING KNOWLEDGE » CHANGING LIVES

# Upcoming Webinars

- **April 15 - Does soil health make a difference in producing healthy food?**

  Carlos Pires, NDSU Extension soil health specialist and assistant professor

Zoom Webinar

You are viewing Scott Swanson's screen

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- **Please complete the short online survey** that will be emailed to you after today's webinar. It will take just a couple minutes!
- Be sure to sign up for an opportunity to win a prize in the drawing.  After submitting the survey, a form to fill out with your name/address will appear.

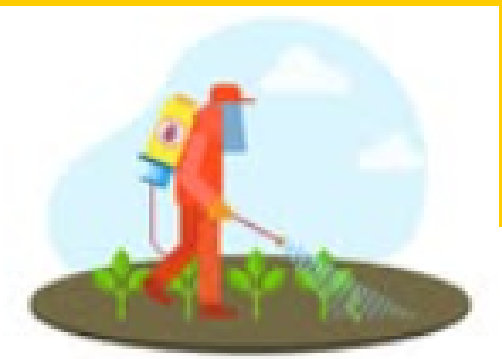

***Acknowledgement: This project was made possible with funding from the North Dakota Department of Agriculture through the U.S. Department of Agriculture's Specialty Crop Block Grant program. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the USDA.***

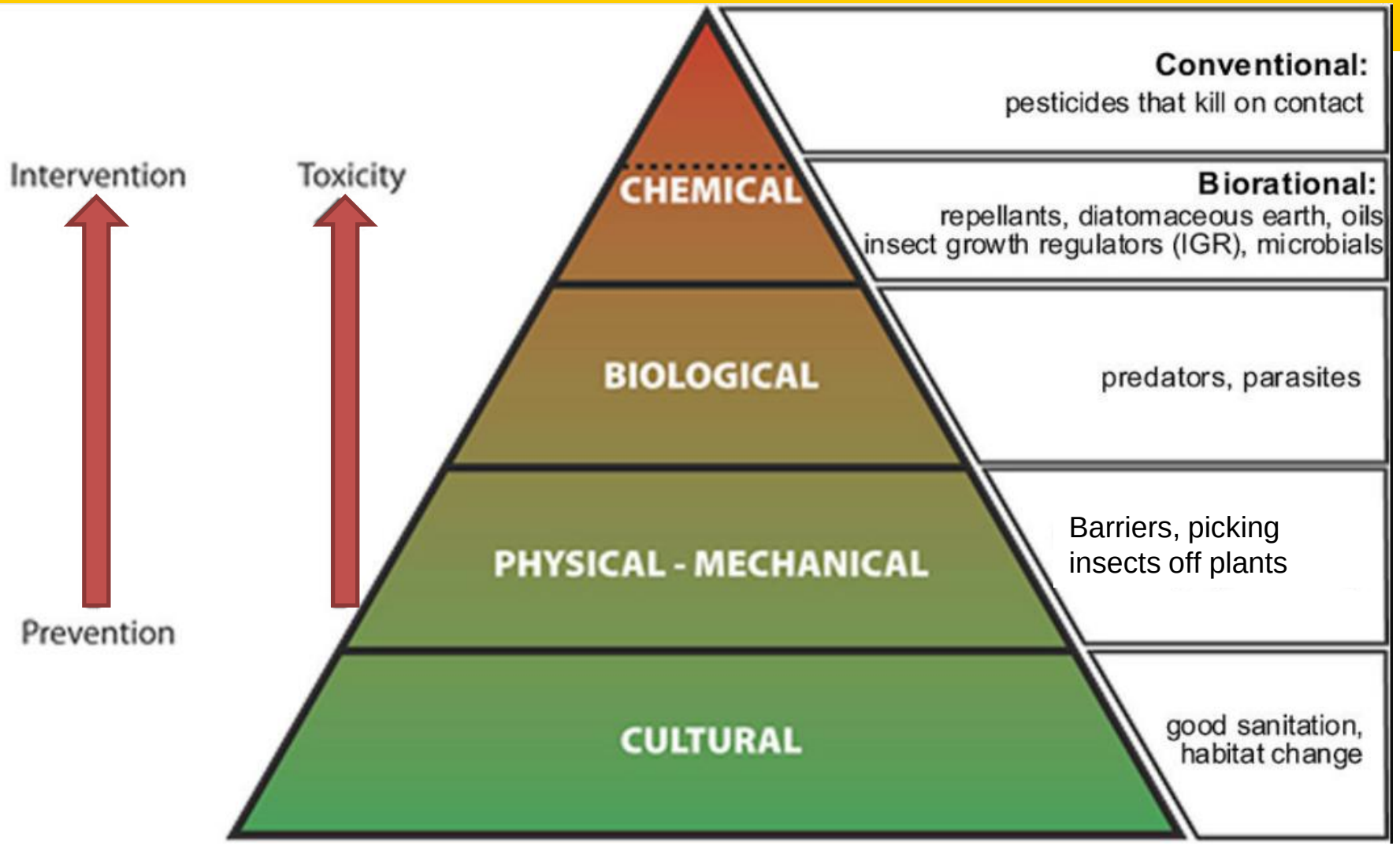
April 8

# Safer solutions: Natural insecticides to manage garden insects

Janet Knodel, NDSU Professor and Entomologist

# IPM Triangle for InsectPests





# Pest Prevention - #1

- Select plants that do well in your garden/growing area
- Keep plants healthy (water, fertilizer, sun or shade, etc.)
- Diversity of vegetables and flowers

# Beautify the Ecosystem

# Principles of Integrated Pest Management

1. **Identify:** Know your foe and know your friend

2. **Scout:** Have to know what is out there before making management decisions

3. **Integrate:** Employ different strategies to manage pests instead of relying on one approach

Lady Beetle (Predator)

Spotted cucumber beetle (Pest)

# What is it?

**KEY**

**HERBIVORE INSECT PEST**

**BENEFICIAL INSECT**


XERCES SOCIETY
for Invertebrate Conservation

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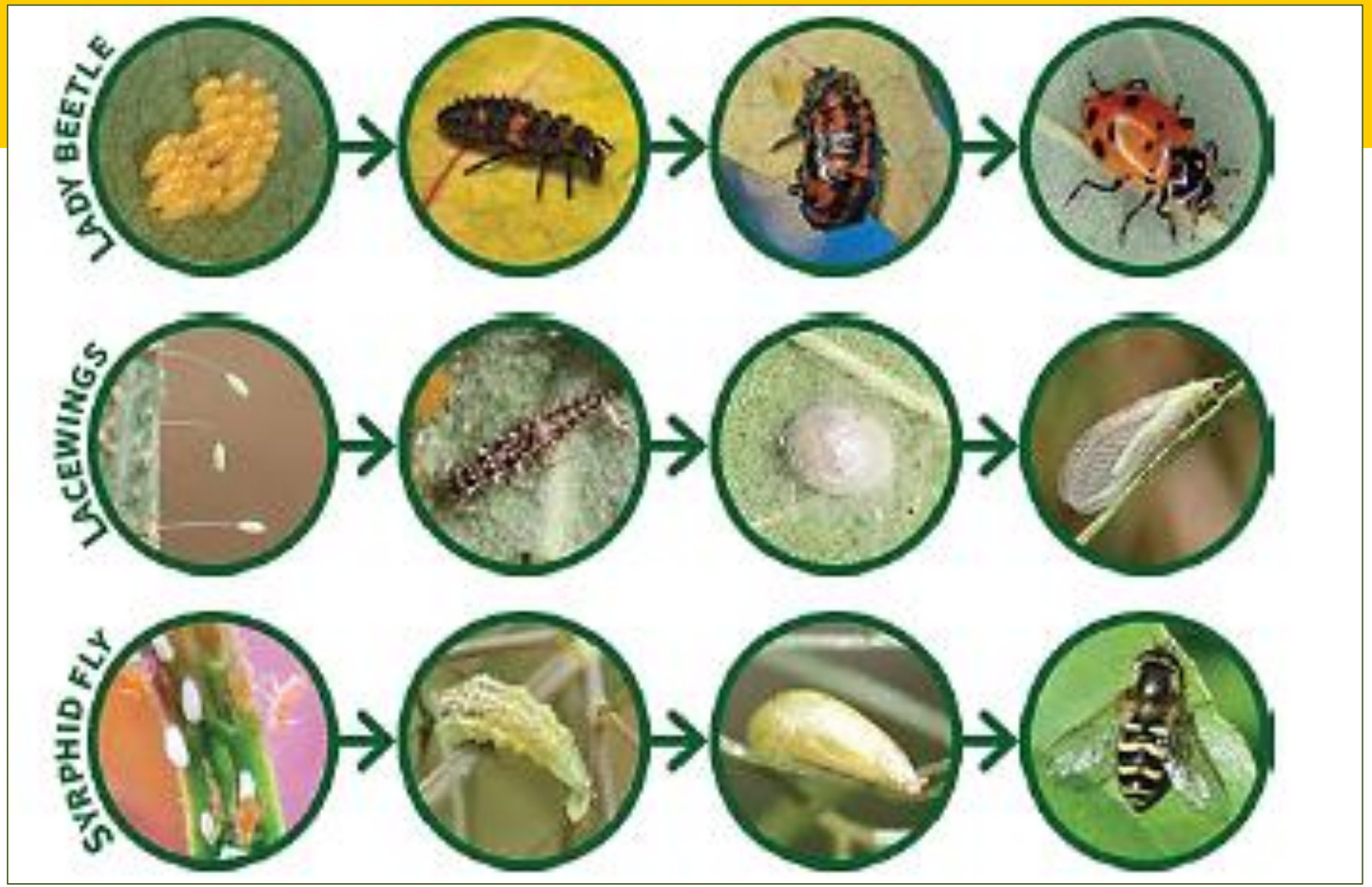


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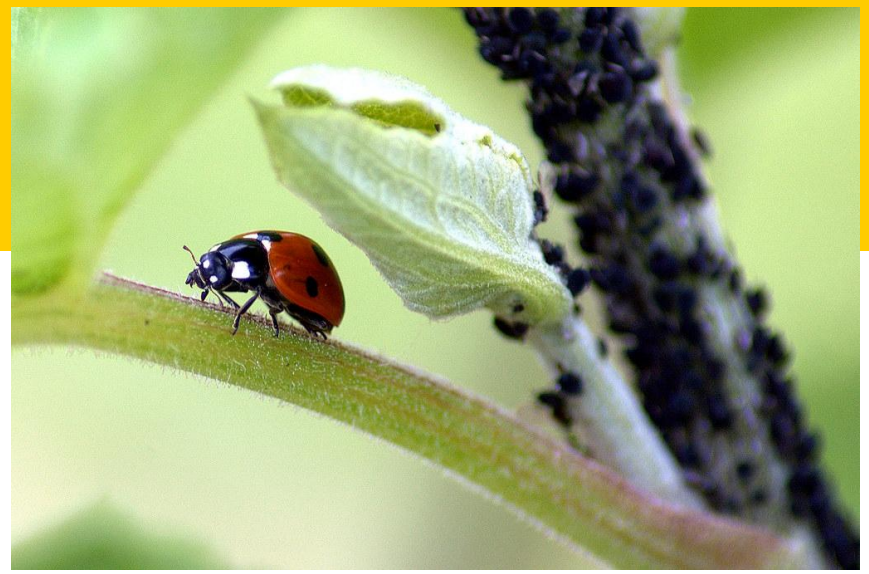
# Monitor for Insect Pests



- Find infestation EARLY!
- Scouting
  - Look for both insect pests and good bugs
- Insect trapping

GREAT LAKES IPM

ARBICO organics


- Action thresholds

# Try Other IPM Strategies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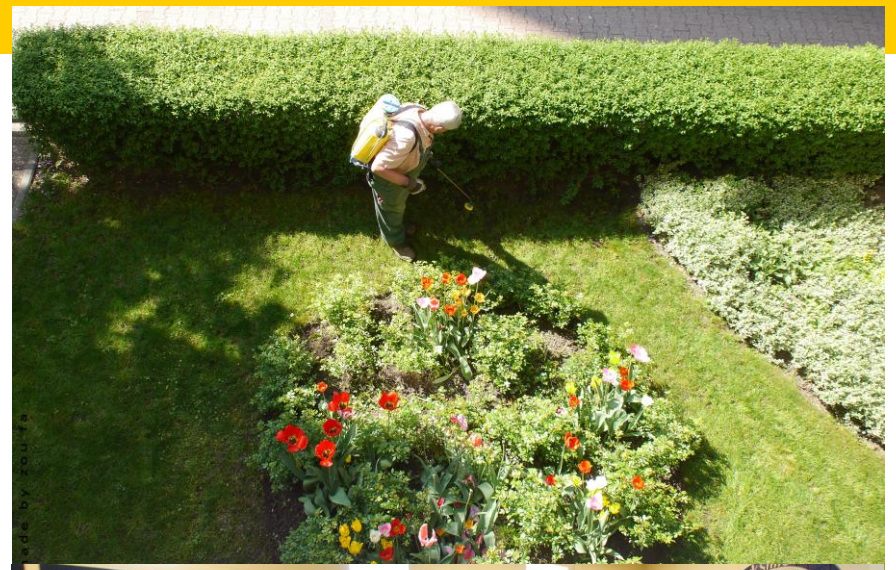
for Invertebrate Conservation

# Use Insecticides as the Last Resort

- Select insecticides with the lowest risk to humans, animals, beneficial insects and the environment
- Plants can ‘tolerate’ some insect pests
  - Know the biology of key insect pests
  - Pest phenology
- More ecological approach to gardening
- People have a lower tolerance for eating food with synthetic pesticides on their food



# Insecticides:  Low Toxicity Options

- **Horticultural Oils**
  - Suffocates soft-bodied insects and mites and can be used on many ornamentals, vegetables, fruits and edibles
  - Soft-bodied insects: Aphids, adelgids, mites, mealybugs, scale insects, whiteflies, and leafhoppers
  - Pests unlikely to develop resistance to oils or soaps
  - Not toxic to humans or pollinators once dried

# Insecticides: Low Toxicity Options

- **Horticultural Oils**
  - **Application Timing**
  - ✓ **Dormant Oils (Winter/Early Spring):** Heavier oils used to kill overwintering eggs/insects on dormant plants
  - ✓ **Summer Oils/Supreme Oils (Growing Season):** Lighter oils used to manage active infestations
- **Coverage is Crucial:** Because it is a contact killer, the spray must directly cover the pests and their eggs
- **Timing:** Apply when temperatures are between 40°F and 80°F, and not on moisture-stressed plants

# Insecticides:  Low Toxicity Options

- **Insecticidal Soaps**
  - Wash away the protective oil coating of exoskeletons, which causes dehydration
  - Safe on most plants
  - Highly effective against **soft-bodied insect pests** like aphids, mealybugs, and spider mites
  - When using insecticidal soaps, make sure to really saturate the entire plant and be sure to apply it multiple times a week for the best results
  - Pests unlikely to develop resistance to soaps

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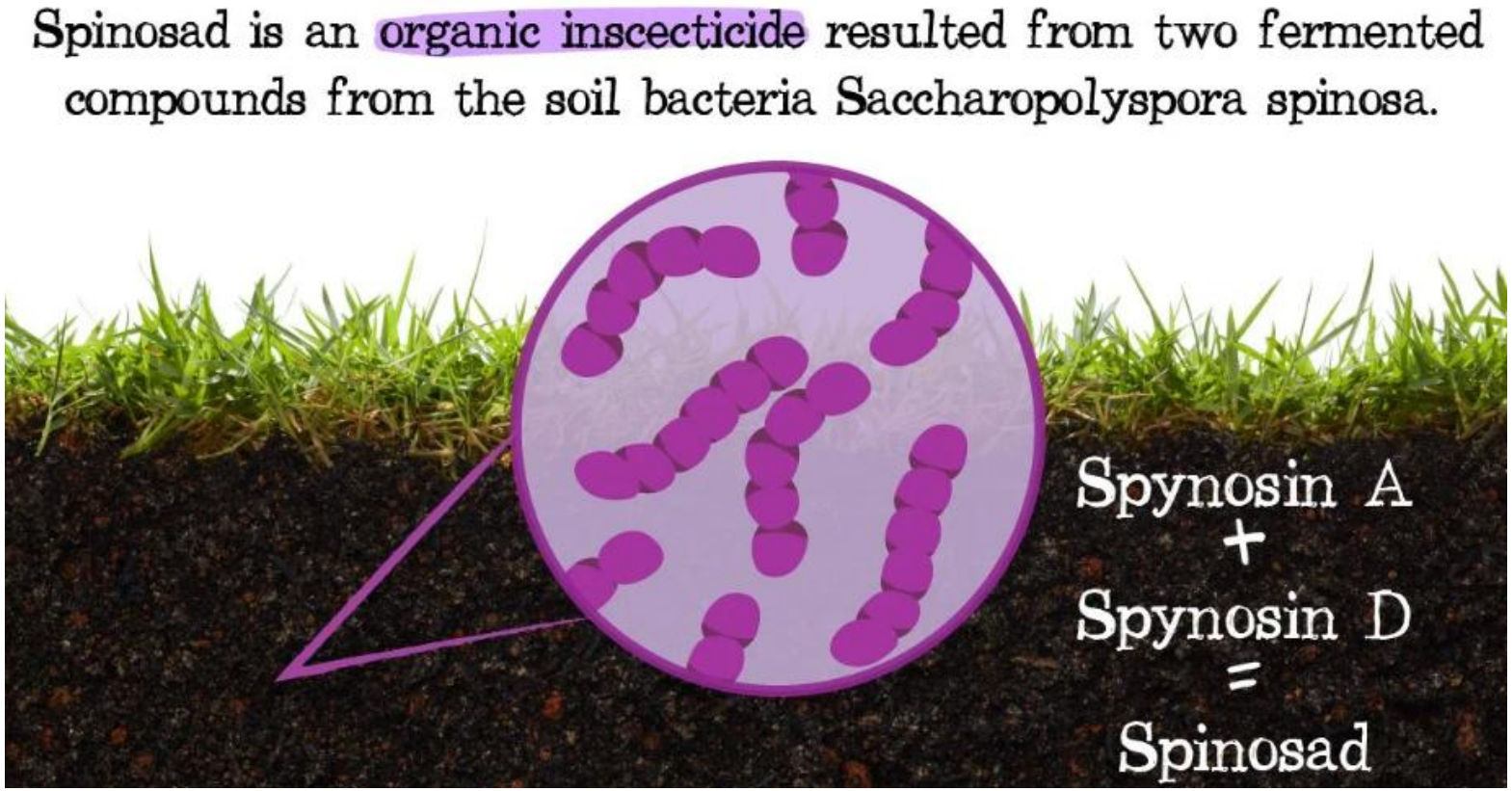
# Insecticides:  Low Toxicity Options

- **Spinosad:**
  - Natural, soil-based bacterium insecticide
  - Used in organic gardening

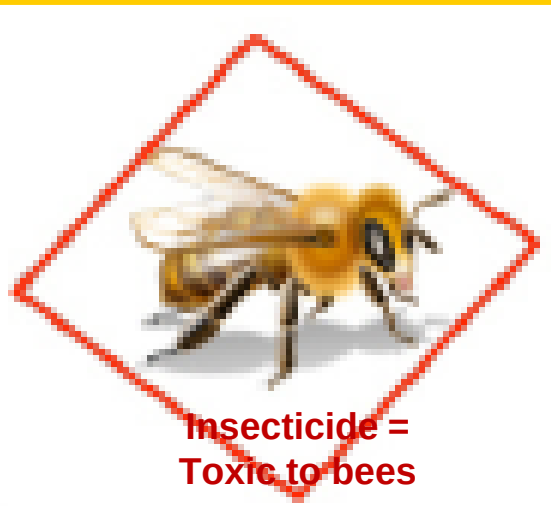


# Insecticides:  Low Toxicity Options

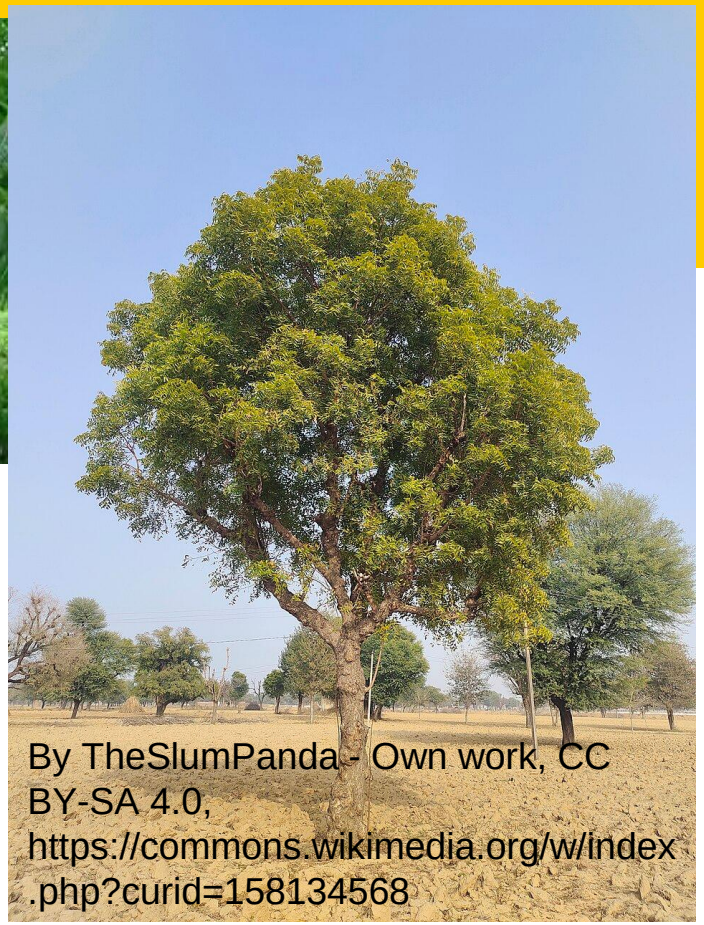
- **Spinosad:**
  - Acts on the insect's nicotinic acetylcholine receptors in the insect's nervous system, causing rapid excitability, paralysis, and death
  - Contact & ingestion toxicity
  - Chewing insects, caterpillars (corn earworms, corn borers, tomato hornworms), Colorado potato beetles, leafminers, thrips, spider mites, mosquitoes, ants, fruit flies and many others

# Insecticides:  Low Toxicity Options

- **Spinosad:**
  - Low toxicity to fish, birds and mammals
  - Not toxic to most beneficial insects
  - Toxic to bees
  - Broken down by sunlight and water, with a relatively short half-life in the environment

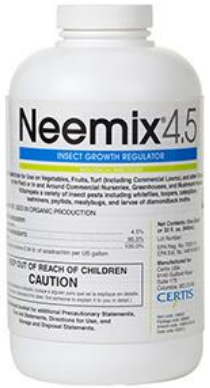



# Insecticides:  Botanical



By TheSlumPanda - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=158134568

- **Neem Oil (Azadirachtin)**
  - Works as an anti-feedant, insect growth/molting, repellent and deters egg laying
  - Broad-spectrum – aphids, mealybugs, caterpillars, sawfly larvae, beetles, leafminers, scale, whiteflies, spider mites, root aphids
  - Anti-fungal against powdery mildew
  - Compatible beneficial fungus *Beauveria  bassiana*




# Insecticides: Botanical

- **Neem Oil (Azadirachtin)**
  - Residual - 1-2.5 days
  - Low toxicity to humans and anim
  - Slightly toxic to fish and aquatic animals
  - Low toxicity to pollinators
  - India used to fight bacteria in the mouth via toothpicks and neem toothpaste

Drying fruits for oil extraction

By Sathishindexagro - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=58108408

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# Insecticides: Botanical

- **Pyrethrin**
  - Derived from the flower *Chrysanthemum cinerariifolium*
    - From Kenya, East Africa
  - Contact insecticide that rapidly paralyzes the nervous system of both target and nontarget insects
  - Broad-spectrum – aphids, beetles, caterpillars, crickets, fruit flies, mites, thrips and many more

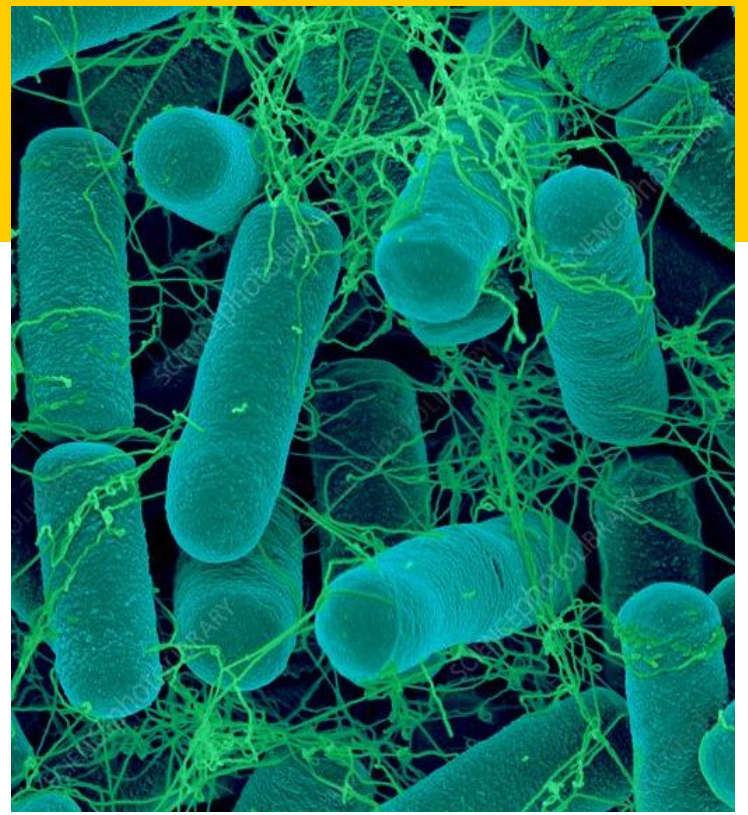
*Tanacetum cinerariifolium* also called the Dalmatian chrysanthemum

# Insecticides:  Botanical

- **Pyrethrin**
  - Breaks down within a few hours to 1-2 days
    - Respray for insect pests
    - Sprayed on food crops close to harvest
  - Mammalian toxicity = very low
  - Fish and invertebrates: Highly Toxic to fish and invertebrates of the aquatic food chain
    - Lack the enzymes to break down pyrethrin
  - Bees: Extremely sensitive; should be used carefully to avoid harming pollinators.


# Insecticides: Microbials

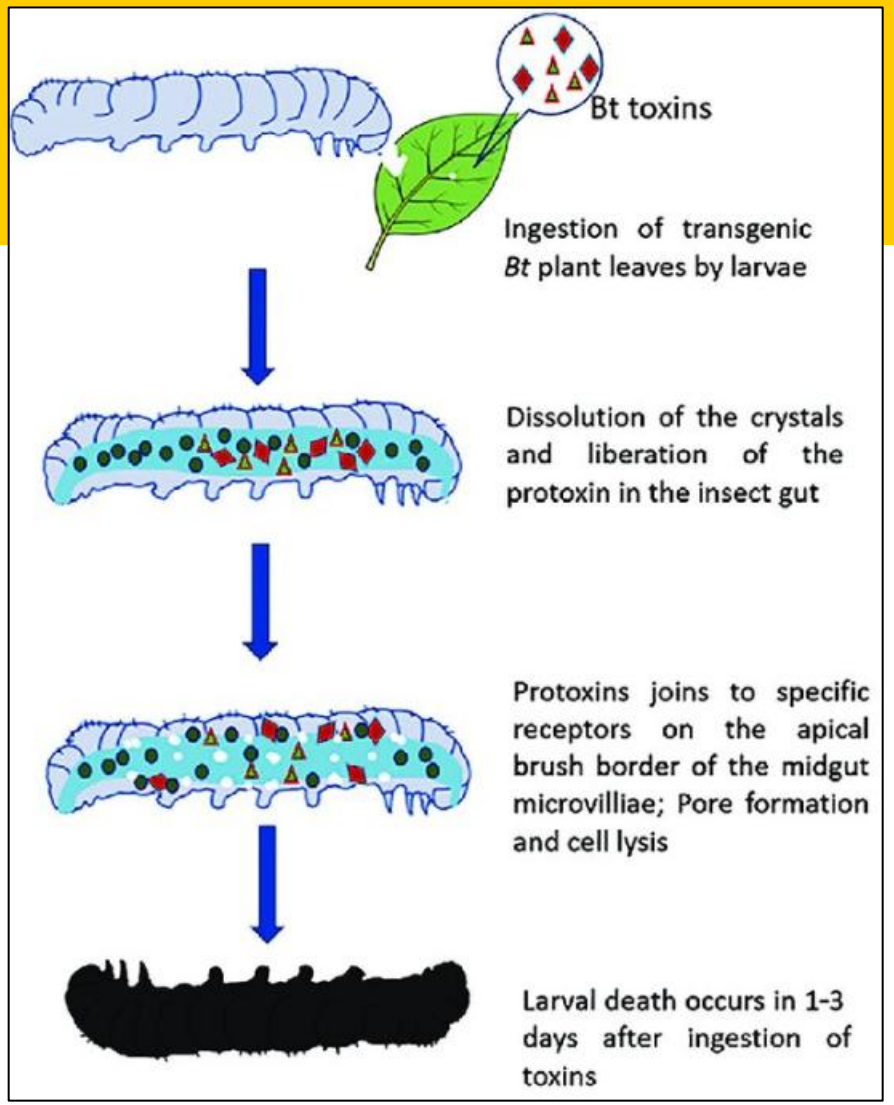
- **Bacillus thuringiensis (Bt)**
  - A naturally occurring bacterium in soil, found worldwide
  - Bt was first used in Germany in 1911 as a bacterial pathogen for flour moths
  - Spraying or dusting plants with spores of this bacterium
  - Caterpillars (gypsy moth, tent caterpillars, tomato hornworm), mosquitoes or specific grubs




BONIDE® Thuricide

# Insecticides: Microbials

- **Bacillus thuringiensis (Bt)**
  - Acts as a stomach poison
    - Ingested crystalline (Cry) protoxins are solubilized
    - Activated by proteases in the high-pH insect midgut
    - Binding to specific receptors to form pores in the cell membrane
    - Resulting in severe membrane damage, sepsis, gut paralysis, and larval death




https://www.researchgate.net/publication/371408108_Bacillus_thuringiensis_in_Pest_Management/figures?lo=1

# Insecticides: Microbials


Forest Service spraying for the forest tent caterpillar

- **Bacillus thuringiensis (Bt)**
  - Target the immature stage (caterpillar, larvae)
  - Bt must be ingested
  - Breakdown rapidly in sunlight (spray on cloudy days or evenings)
  - Not harmful to humans, animals, birds, or pollinators
  - Harmful to butterfly caterpillars (Monarch, etc.)
  - Particular strains of Bt proteins are host-specific to insect groups

DiPel® DF

| Strain | Order Affected | Targeted Insects |
|---|---|---|
| *Bt aizawai* | Lepidoptera (moths, butterflies) | Wax moth larvae in honeycombs, grape berry moth |
| *Bt galleriae (Btg)* | Coleoptera (beetles) | Adult and larval stages of Asian, Japanese and Oriental beetles |
| *Bt israelensis* | Diptera (flies, mosquitoes, gnats) | Mosquito larvae, fungus gnat larvae, blackfly larvae |
| *Bt japonensis and kumamotonsis* | Coleoptera (beetles) | Northern masked chafer and oriental beetle larvae |
| ***Bt kurstaki (BtK)*** | **Lepidoptera (moths, butterflies)** | **Cabbage loopers, codling moth larvae, diamondback moth larvae, imported cabbageworm, spruce budworms, tomato hornworms, cutworms, Gypsy moth caterpillars** |
| *Bt var. san diego (BtSD) and tenebrionis* | Coleoptera (beetles) | Leaf-feeding beetle larvae, black vine weevil larvae, Colorado potato beetle larvae, Elm leaf beetle larvae |

# Insecticides: Microbials

- **Baculovirus (Baculoviridae)**
  - Entomopathogens - viruses that infect insects and arthropods
  - Ingested by an insect to produce a fatal infection and epizootics
  - Nuclear polyhedrosis virus (NPV)
  - Highly specific to its host
  - Not harmful to humans, animals, birds, or most pollinators except Lepidoptera

# Insecticides: Microbials

- **Baculovirus (Baculoviridae)**
  - Naturally infects Monarch caterpillars and other butterfly larvae
  - ***Black death***, your caterpillars will deflate, turn black, then liquify like something out of a horror movie!

# Natural Biological Control

- **Diseases**
  - Fungal (*Nomuraea rileyi*)
  - Viral
    - Nuclear polyhedrosis virus
  - Favored by high humidity and warm temperatures
- **Parasitic wasps**


# Insecticides: Microbials

- ***Beauveria bassiana***
  - Natural, soil-borne parasitic fungus that attacks and kills insects, white muscadine fungus
  - Larvae—beetles, caterpillars
  - Adults—aphids, thrips, whiteflies, chinch bugs, plant bugs, stink bugs, beetles
  - Do not use with fungicides (controls diseases)

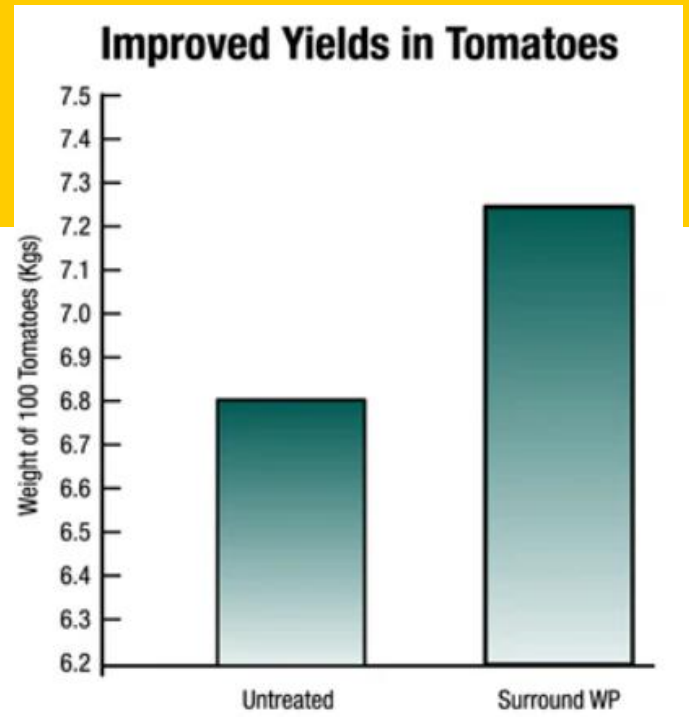
# Insecticides: Microbials

- ***Beauveria bassiana***
  - Application: high humidity, low UV light (late afternoon or cloudy/rainy days) and warm temperatures 64° – 85°F
  - Not harmful to humans, animals or birds
  - Do not use when pollinators are actively foraging
  - May be toxic to fish – do not discharge rinsate into bodies of water or public waterways or apply this product over standing water or near aquatic habitats

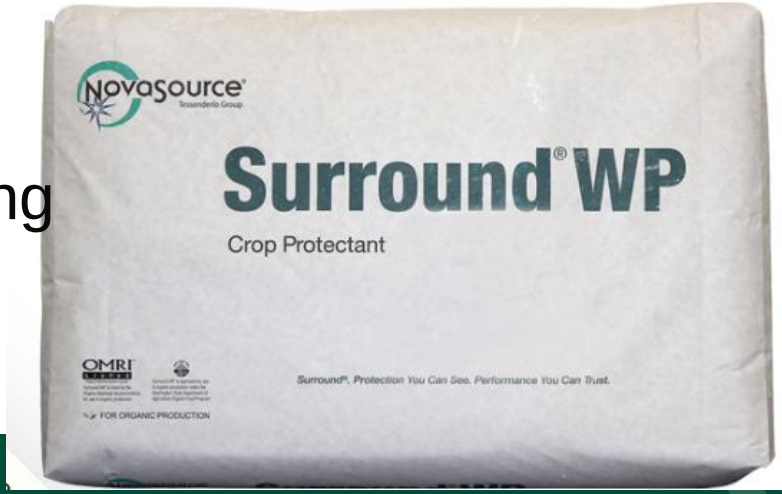
# Insecticides: Minerals

- **Kaolin Clay**
  - A soft, naturally occurring mineral primarily composed of kaolinite
  - White, powdery "particle film"
  - Acts as a physical and behavioral barrier to prevent insect feeding
  - Non-toxic to humans, animals and pollinators
  - Broad-spectrum insect pests: Beetles (Japanese beetles, cucumber beetles, flea beetles, and Colorado potato beetles); Flies & Maggots (Apple maggot, cherry fruit fly); Moths & Caterpillars (Codling moth, leafrollers) Sucking Insects(Pear psylla, aphids, thrips, stink bugs); Others (grasshoppers, crickets)

# Insecticides: Minerals




- **Kaolin Clay – How it works?**
  - ✓ **Physical Barrier:** coats leaves and fruit, making them unrecognizable or unpalatable to insects
  - ✓ **Irritation:** Tiny clay particles adhere to insects' bodies, causing intense irritation and discomfort
  - ✓ **Oviposition Deterrent:** The film creates an unsuitable surface for insects to land and lay eggs
  - ✓ **Environmental Protection:** Reflects infrared and UV light, reducing sunburn on fruit by up to 50% and cooling the plant canopy by 10–15°F
- Surround WP - OMRI listed for organic use



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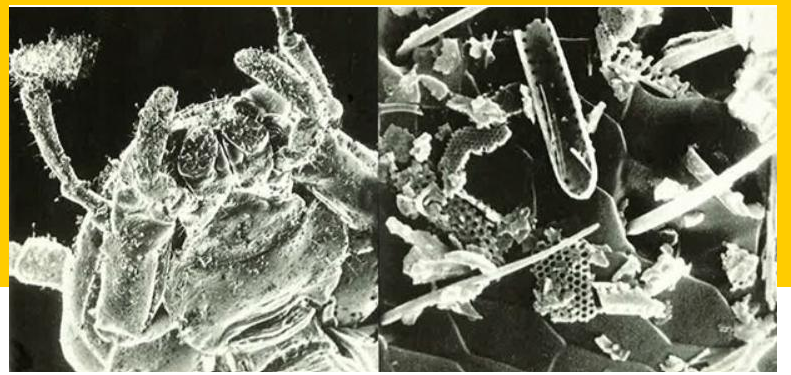

- **Diatomaceous earth (not an insecticide)**
  - Finely ground fossilized remains of tiny, aquatic organisms called diatoms
  - Effective preventive treatment against any and all insects that have a hard exoskeleton
  - Fine powder is abrasive on the microscopic level and kills the insects by piercing the hard outer layer and quickly causing dehydration
  - Acts as a physical barrier to prevent insect feeding
  - Applied as a foliar spray or sprinkle powder on the soil

# Insecticides: Protect our Pollinators!


- **Low-toxicity ≠ Non-toxic**
  - Harm pollinators if applied directly onto insects or in excess
- **Timing**
  - Avoid spraying flowers or during flowering
  - Apply spray in early morning / late evening, and temperatures below 55F when pollinators are less active
  - Use short residual insecticides
  - Always READ & FOLLOW the pesticide label


**Thanks to collaborators:**

- **Patrick Beauzay**
- **Dr. Esther McGinnis**
- **April Johnson**

***Janet J. Knodel***

***Professor & Extension Entomologist***

***janet.knodel@ndsu.edu***

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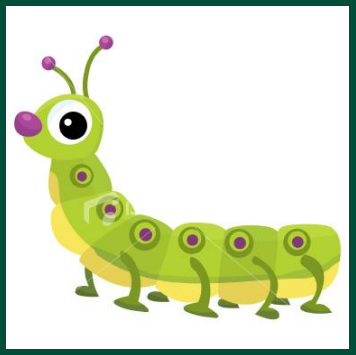

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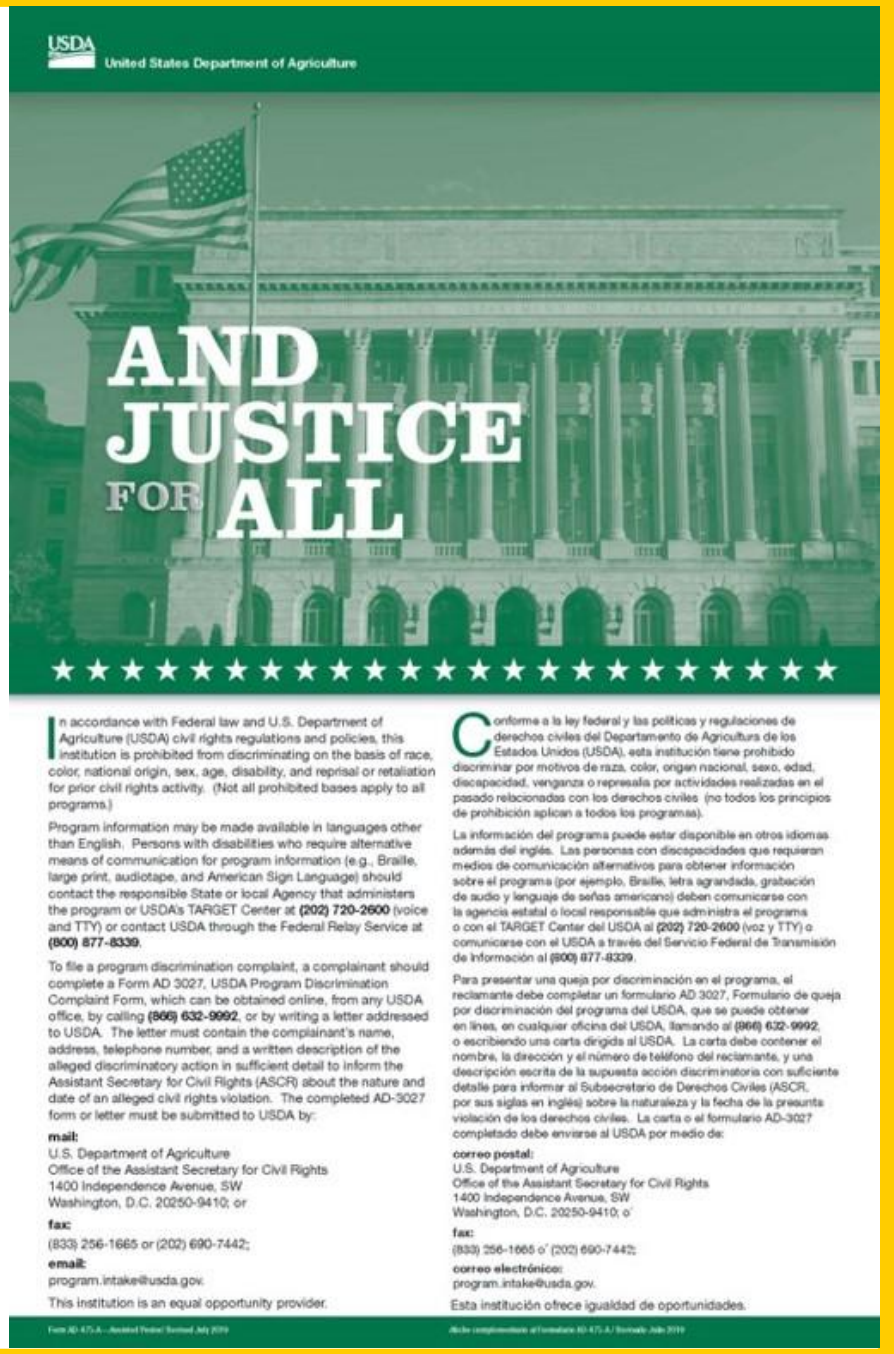


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