Pest Management and Pollination on Small Acreage

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Pesticide:

A pesticide is any substance or mixture of substances intended for: preventing, destroying, repelling, or mitigating any pest.

Though often misunderstood to refer only to insecticides, the term pesticide also applies to herbicides, fungicides, and various other substances used to control pests. Under United States law, a pesticide is also any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant.

Agricultural Pests

- InsectsArachnids
- Weeds
- Nematodes
 - Disease pathogens
 - Vertebrates



Pest Management

- Sound diagnostic practices
- Knowledge of both the pest and the crop being grown
- Knowledge of control options

The diagnostic challenge

- Pest problems can result from many factors: biotic, abiotic or both
- Crops have tremendous variability
 - Many problems look the same Chronic problems may be expressed subtly

Traits of a good diagnostician

Must combine many traits including strong educational background, field experience, and problem solving ability

- Knowledge of plant biology and horticulture
- Understanding of production cultural practices
- Access to diagnostic resources
- Working knowledge of current diagnostic techniques
- An inquiring mind
- An open mind
 - Ability to think logically
- Patience

Step by step diagnostic strategy Identify the plants Identify the symptoms Inspect the whole plant Inspect the site Look for patterns Investigate the crop management history Synthesis the information Test likely causes

Cropping systems are dynamic

- Plant environments change from day to day
- Changes may be positive or negative
- Growth brings changes in anatomy, morphology, and physiology
 These changes in the environment and in plant development make diagnosis even more challenging

Plant disorders, multiple factors may be involved

- Soil moisture imbalances
- Soil pH and nutrient availability
- Competition with other plants
- Air temperatures
- Wind
- Disease pathogens
- Chemical treatments
 - Low to moderate exposures may result in chronic problems that are difficult to diagnose

Biotic factors

Pathogens (fungi, bacteria, viruses, mycoplsmalike organisms, mollicutes)

- Nematodes,
- Insects
- Mites
- Mollusks
 - Vertebrates (rodents, birds) Parasitic plants (dodder)

Abiotic Factors

Physical or environmental problems (moisture, temperature extremes) Mechanical damage (root cutting, weed control) Chemical damage (salts, pesticides)

Primary and secondary causes

- Abiotic problems often weaken plants and make them more susceptible to biotic problems
- Evaluating all injury symptoms and sorting out the primary and secondary problems is key to accurate diagnosis and treatment strategies

Agricultural Pests

Blemish, damage, or destroy more than 30% of crops annually worldwide.

These losses have remained constant since the 1940's even after the widespread use of agrichemicals became commonplace. National Academy of Science Proceedings paper "A Total System Approach to Sustainable Pest Management" 1997

 Calls for "a fundamental shift to a total system approach for crop protection [which] is urgently needed to resolve escalatory economic and environmental consequences of combating agricultural pests."

Ecologically based pest management or ecological pest management

- Treats whole farm as a complex system
- Mimics nature's complex relationships among different species of plants and animals
- Keeps pests at acceptable populations using many complementary strategies
 - Relies on a preventative approach
- Existed in natural ecosystems for thousands of years

1996 National Academy of Science Report on Ecologically Based Pest Management states

Ecologically based pest management "should be based on a broad knowledge of the agro-ecosystem and will seek to manage rather than eliminate pests" in ways that are "profitable, safe, and durable"

Helpful partners in the natural ecosystem

- Beneficial insects that attack crop insects and mites by chewing them up or sucking out their juices
- Beneficial parasites that commandeer pests for habitat and food
- Disease-causing organisms including fungi, bacteria, viruses, protozoa, and nematodes that fatally sicken insects and weeds or keeps them from feeding or reproducing
 - Ground beetles that feed on weed seeds
- Beneficial fungi and bacteria that inhabit root surfaces, blocking attack by disease organisms

Ecological Approach to Pest Control

• Design cropping system to: Optimize crop growing conditions Encourage natural enemies of pests Restrict or impose stresses on pests **O**Increase biodiversity to reduce pest outbreaks •Know, understand, and monitor pests and their natural enemies

Ecological Approach to P Pest Control

• Disrupt pest life cycles with crop rotation

- Destroy or exclude pests through sanitation
- Provide and maintain beneficial habitat
- When direct suppression is needed, use leastdisruptive measures:

Purchase and release biocontrols

- Use physical barriers (row cover, etc.)
- Selective, NOP-allowed pest control sprays

The First Line of Defense: a Healthy, Vigorous Crop

• Healthy, fertile soil

- Locally adapted varieties
- Pest-resistant varieties
- Optimum planting dates
- Optimum plant spacing
- Optimum plant nutrition and irrigation



This vigorous eggplant crop has withstood the annual onslaught of flea beetles.



The Father of fertilizer, recognized toward the end of his life that synthetic fertilizers had robbed the soil of important recycling functions needed to keep soil healthy. He then championed the beings of the principles of organic farming.

Managing Insect Pests

Know each major pest:

- Mode of dispersal
- Life cycle
- Alternative hosts
- Habitat requirements
- Type of damage
- Economic threshold



Squash bug nymphs suck plant juices, inject toxin, and cause foliage to die and dry up.

Managing Insect Pests

Know the natural enemies of each pest:

- Predators and parasites already present
- Beneficial's available for purchase and release
- Life cycles
- Habitat requirements Preferred nectar or pollen plants



Pennsylvania leatherwing feeding on buckwheat nectar. Its larvae prey on cucumber beetles and other pests.

Managing Insect Pests: Monitoring

- Field scouting weekly or more often
 - Pheromone traps
 - Trap crops
 - Monitor pests and beneficials



Extension and NRCS personnel evaluate pest and beneficial populations in organic broccoli during practical training at Virginia Tech's Kentland Farm.

Biological Control of Insect Pests

Conservation biological control:

- Provide nectar and pollen for existing allies.
- Provide overwinter habitat sites.
 - Protect habitat from pesticides and tillage.



Mixed flowering plants provide season-long nectar for beneficials.

Year-round beneficial habitat

Mixed field border plantings to provide year-round food for beneficials:

- Carrot family (umbels)
- Sunflower family (composites)
- Legume, mint, buckwheat families



Yarrow (left) and wild carrot (right) provide nectar and pollen for adult phases of parasites and predators of many insect pests.

Year-round beneficial habitat

Ground cover for spiders, ground beetles and other generalist predators:

Organic mulches
 Cover crops
 Perennial vegetation



This low-growing clover, interplanted into tomato in mid-summer, provides cover for ground beetles and other predators.

Purchased Biological Controls

• Use when cultural and indigenous biological controls fail.

• Provide suitable habitat.

• Time release for maximum efficacy.

• Examples:

• Pedio wasp for bean beetle

• Lady beetles or lacewings for aphids, whiteflies

• Trichogramma wasps for caterpillar pests

NOP-allowed pest controls

Biological materials (Bt, beneficial nematodes, milky spore, Beauvaria)
Clay coating (Surround[™])
Dormant and summer oils
Garlic, hot pepper and other repellents
Insecticidal soap
Botanical pesticides (pyrethrin, neem, spinosad)

Listed from lower to higher environmental impact.

Getting the most pest control with the least ecological damage

• Choose least toxic, most selective material that will do the job.

• Be timely.

• Spray trap crops.

• Spot-spray local infestations.

• Avoid spraying habitat plantings.

• Spray when bees and other beneficials are inactive.

Pest Nematodes (root feeders)

- Common in sandy, low-organic soils
- Most troublesome when soil biological activity is low.
- Examples: cyst, sting, and root-knot nematodes
- Control:
 - Rotate to non-host crops (e.g. cereal grains).
 - Control host weeds.
 - Build soil quality, soil biodiversity.

Conservation Benefits of Organic Approach to Pest Management

- Less impact on wildlife and other nontarget species.
- Reduced pesticide risk to water and air quality.

• Soil conservation and soil quality benefits of ecological pest management practices – crop rotation, cover crop, field border planting, etc.

• Less risks to human health (farmer, workers, consumers)

Managing Crop Diseases • Prevention is key • Maintain healthy soil • Crop rotation O Disease-resistant varieties Sanitation • Avoid handling wet foliage • Promote air circulation • Protectant sprays as preventive measure

Most plant diseases cannot be cured once symptoms have appeared.

Managing Weeds in Organic Crops

- Weeds are the most costly pest category.
- No synthetic herbicides – protects water resources
- Rely more on tillage and cultivation :
 Burns up soil OM
 Each pass brings new flush of weeds



Purple nutsedge, here in sweet pepper, is a tough challenge for organic and conventional growers.

The Organic Farmer's Dilemma:





How can I manage weeds adequately without tilling my soil to death?

Organic Weed Management Does not Simply Substitute Herbicides with Steel

OKnow the Weeds.

 Minimize open niches for weeds – avoid bare soil (also good for conservation).

•Grow vigorous, weedcompetitive cash crops.

•Grow cover crops. •Use strategic and timely

control tactics.

Palmer amaranth and crabgrass in potato field.

Know the 5 or 10 Worst Weeds on the Farm

- Correct identification
- Life cycle, reproduction
- Triggers for emergence and growth
- How the weed affects the crop
 - Weak points in weed life cycle = management opportunities.

Jonhsongrass, showing root system and vegetative reproduction through rhizomes.

Minimize Niches for Weed Growth

- Minimize bare soil in time and space.
- Plan tight crop rotations.
- Cover crop during fallow period longer than 30 days.
- Mulch to cover bare soil.
- Choose row spacings that promote canopy closure.



Buckwheat, an excellent cover for short fallow periods, can cover the ground within 2-3 weeks after planting.

Keep the Weeds Guessing with Crop Rotation

• Vary crop species and crop architecture.

• Vary planting and harvest dates.

• Vary tillage and cultivation methods.



An eight-year vegetable rotation varies planting and harvest dates, year to year, and thus an unpredictable habitat for weeds

Grow vigorous, competitive crops

• Choose vigorous, locally adapted varieties. • Use high quality seed. • Transplant. • Maintain high soil quality. • Optimize crop nutrition and growing conditions. • Feed and water the crop, not the weeds.



In-row drip irrigation waters the tomatoes, not between-row weeds

The best weed management is good crop management

Close rows (mesclun)

Mulching in wide rows (tomato)

Wide range of planting and harvest dates

In-row Drip Irrigation

Crop vigor

Put the weeds out of work – grow cover crops!

Cover crops suppress weeds by:

Direct competition
Occupying the niche
Allelopathy
Modifying light environment for seeds



Daikon radish, a weedsuppressive cover crop

Manage the Soil Weed Seed Bank



Clipping and removing the pigweed now can prevent a large seed bank "deposit."

- Prevent weeds from setting seed.
- Prevent vegetative propagation by invasive perennials.
- Draw down the weed seed bank with stale () seedbed.
- Promote weed seed predation and decay.

Knock Weeds Out at Critical Times

• Ensure a clean seedbed.

- Get weeds while they are small.
- Keep crops clean through the minimum weed-free period (first 1/3 to 1/2 of season.

• Prevent weed seed set .



Cultivate now while the weeds are easy to kill.

Tools for Organic Weed Control

Additional tools include:Mulches (organic and plastic)

- Flame weeders
- **O** Mowers
- Roller-crimpers to terminate cover crop and create mulch



Tomato starts are set into black plastic to give them a head start on the weeds. Alleys are cultivated, then mulched with straw.

Organic Mulches Suppress Weeds, Contribute to Soil Quality



An organic mulch such as grain straw (above) applied after an initial cultivation can suppress weeds for several weeks while contributing organic matter.

No-till Cover Crop Management Without Herbicides



Rolling can be done with a specially designed roller-crimper (left), or with a flail mower with the PTO off (right).

No-till Vegetable Transplanting Into Mechanically Killed Cover Crop





Vegetable starts are transplanted with a no-till transplanter (left), or manually after preparing slots with a no-till planting aid consisting of a coulter and shank assembly (right).

Organic No-till Successes





Potato (left) and summer squash (above) planted no-till into mowed (left) or rolled (above) rye + hairy vetch

Observe Changes in Weed Flora and Adapt Management Accordingly

- Annual weeds increase in intensively tilled field
 - Invasive perennial weeds increase
 - Summer weeds
 - Cool weather weeds
 - Large seeded annuals

→ Reduce tillage; mulch

- → Tillage targeted at the problem weeds
- \rightarrow Cool season vegetables
- \rightarrow Summer vegetables
- → Non-inversion tillage or notill (stop plowing)

Pollinators are required for

70% of the world's flowering plants
Two-thirds of the world's crop species
Fruits and seeds from these crops are necessary for 30% of the foods and beverages we consume

Value to US growers in 2000

- \$20 billion dollars paid for insectpollinated crops
- Managed and wild native bee species as well as nonnative leafcutter and mason bees are responsible for one quarter of this value

• Honey bees are responsible for the rest

Native bees

•Contribute at least 3 billion dollars annually to US agriculture

•Pollination for home gardens and natural landscapes is largely done for "free" by native species of bees and managed honey bees

Managed pollination

• Information gathered by the USDA National Agricultural Statistics Service (NASS) in 2000 concluded that " the value of the increased yield and quality achieved through pollination by honey bees alone was \$14.6 billion, a 57% increase from a previous estimate published in 1989."

• A 20 -25% increase was due to inflation, the rest was from demand created by more people needing pollinated foods

Sustainable ecosystems

Require a knowledge and appropriate actions to protect and enhance pollinators

Photo © Jim Petrank

URL'S of interest

<u>http://organics.tennessee.edu</u>
 <u>http://vegetables.tennessee.edu</u>
 <u>http://bees.tennessee.edu</u>

Questions?