Organic Agronomy Training

Dr. Martin Entz – University of Manitoba

Lesson 3

Pest Management with a Focus on Disease, Insects (and Weeds)

Organic Agronomy Training

This training was developed and delivered by Martin Entz, PhD, Department of Plant Science, University of Manitoba. It is intended for private and public sector agronomists who want to respond to the growing demand from producers for more information about organic grain production. Grain farmers considering a transition to organic or current organic practitioners who want to learn the theory and latest science will also find the course valuable. The course was designed with the Prairies in mind, however agronomists in other ecoregions will learn universal principles of organic production.

The training consisted of five 75 minute live online sessions over two weeks in January 2023:

- January 5: Designing Cropping Systems with a Focus on Nutrient Management
- January 6: Crop Establishment and Seeding Systems, Tillage and Weed Control
- January 10: Pest Management with a Focus on Disease, Insects (and Weeds)
- January 12: Soil Management for Organic Production: Putting Theory into Practice
- January 13: Question & Answers

All course content (lesson recordings, presentations and notes) can be accessed on pivotandgrow.com.

The Organic Agronomy Training was developed as part of the Prairie Organic Development Fund's Canadian Organic Ingredient Strategy.

The Canadian Organic Ingredient Strategy was funded by:

CANADIAN AGRICULTURAL PARTNERSHIP

PODF PRAIRIE ORGANIC DEVELOPMENT FUND

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In conventional farming systems, continuous external inputs, such as fertilizers, herbicides and insecticides, are usually required to provide nutrients and to keep pests and diseases under control. Organic farmers strive for a healthy ecosystem with high biological diversity, minimal nutrient losses and a natural buffering capacity against insect pests and diseases.

According to the Canadian organic standard (5.6.1), "Practices to control pests, including insects, diseases and weeds, shall focus on organic management practices that enhance crop health and reduce losses due to weeds, disease, insects and other pests."

Permitted practices include:

- "cultural practices (for example, crop rotations, establishment of a balanced ecosystem, and use of resistant varieties),
- mechanical techniques (for example, sanitation measures, cultivation, trapping, mulching and grazing), and
- physical techniques (for example, flaming against weeds and the use of heat against diseases)."[1]

If such practices alone can't control pests, certain substances can be used to control pests. The substance must be listed in Table 4.2 of the Permitted Substances Lists. Growers must record what measures they took to control the pests before using the substance and all details related to the use of the substance (timing, rate of application, brand name, etc.). Use of a prohibited substance can lead to a loss of certification for three years. See details about organic pesticides below.

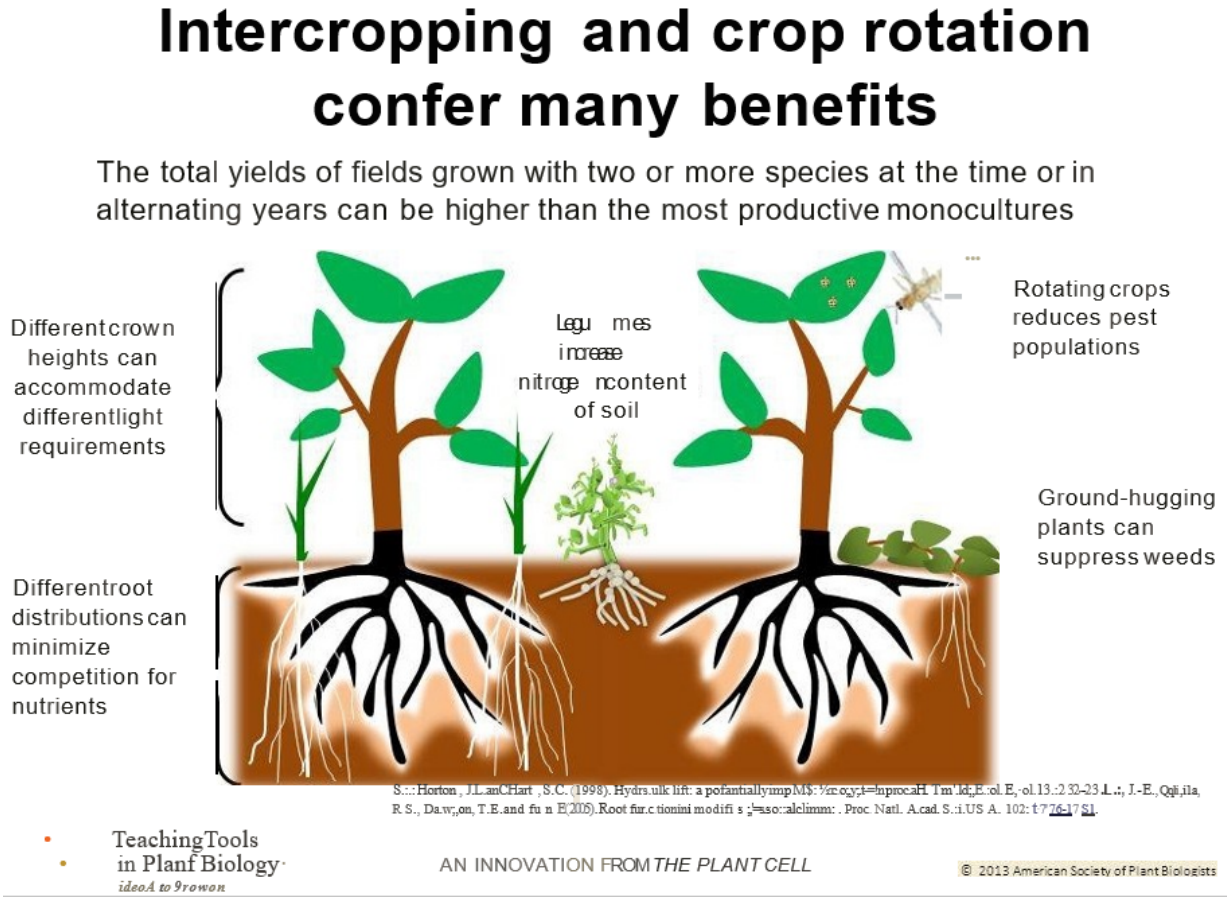
For a comprehensive review on insect management on organic farms, see Pest Control in Organic Systems | IntechOpen.

[1] The Canadian Organic Standards can be found at Organic production systems : general principles and management standards.

Key points about organic insect pest management

- Large-scale pest problems, such as grasshoppers, are difficult to control. (See https://www.producer.com/opinion/organic-methods-for-tackling-grasshoppers-organic-matters).
- The vast majority of insects cause no problems.
- Pest problems are less likely to occur in complex (diversified) farm ecosystems.
- Intercropping and cover cropping can help reduce insect problems.
- Organic growers focus on cultivating beneficial insects in fields and on farms.

To see images of beneficial insects: PHOTOS: A guide to beneficial insects and Field Crop and Forage Pests and their Natural Enemies in Western Canada (152 pages).



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Cultural practices

Cultural pest control practices include choosing resistant varieties, adjusting seeding dates, practicing crop rotation, intercropping, mulching and more. To learn more about organic pest control, check out the free online book, Manage Insects on Your Farm - SARE and other resources listed above.

Choosing resistant varieties

Organic farmers can select crop cultivars that are resistant to the most serious pests in the area. For example, the orange wheat blossom midge (*Sitodiplosis mosellana*) is an important pest of wheat and can cause severe yield loss in some years. Entomologists and plant breeders at Agriculture and AgriFood Canada developed wheat varieties that are resistant to this pest (Midge Tolerant Wheat).

Case Study: The wheat stem sawfly

The wheat stem sawfly is a pest in much of the Canadian Prairies. The sawfly larvae feed within the wheat stem and this can lead to a reduction in yield and/or grade. The pests can cause a 5-15% decrease in total seed weight. More significantly, they can cut stems, which lets the tops of the plants fall to the ground, making pick-up for harvest extremely difficult.

Ways to avoid sawfly damage

1. Grow resistant varieties of wheat.
   - Solid-stemmed wheat varieties are resistant to larval damage. Currently, three registered varieties have the solid-stem trait: AC Lillian, AC Abbey and AC Eatonia. Research from Agriculture and Agri-Food Canada in Lethbridge has shown that solid-stemmed wheat outyields even the best hollow-stemmed wheat when grown in sawfly-affected areas.
   - Durum wheat varieties are semi-solid and are rarely attacked by the sawfly.
2. Plant an alternate crop that is not susceptible to sawfly infestation. If you grow susceptible crops, be sure to include non-susceptible crops in the rotation. (Note once again, the importance of crop rotation.)
3. Use shallow fall tillage. This can result in 90% sawfly mortality, which is good news for most organic producers. Spring tillage only provides about 25% sawfly mortality. (To counteract the negative effects of fall tillage, growers can plant a fall cover crop after tilling.)
4. Delay planting susceptible varieties.

Although some growers burn infested stubble to reduce sawfly numbers, this practice also harms the parasites and other beneficial organisms that attack sawflies and eliminates the many benefits of returning stubble to the soil.

Voices From the Field: Penny Lane Organic Farms

Experiments and observations are essential to tackling pests. For example, back in the 90s, Stewart Wells noticed bare patches in flax. At first, he thought it was operator error – a poor seeding job. But he dug around and found cutworms.

Stewart couldn't find an organic solution and conducted cutworm feeding trials in pails in the basement of the house. Following up on information Stewart's partner, Terry Toews, had read in gardening books, Stewart gave cutworms bran, cornmeal and flax seedlings. They preferred the bran and cornmeal, which swell inside their bodies and kill them. More significantly, he discovered the cutworms responded to his crop rotation.

The ideal egg laying conditions for cutworm moths is soft soil with small seedlings in August. Now they ensure that fields in August are either completely bare or, if covered with a crop, the soil is hard and dry. Since then, they haven't had any trouble with cutworms.

Biological Control

Biological control using predators, parasites and parasitoids

Biological control (biocontrol) occurs when growers introduce beneficial organisms to control pest insects. Farmers can buy beneficial organisms and release them into their fields or focus on creating habitat to attract and support the pest's natural enemies that are already present on the farm. These beneficial organisms are the predators, parasites and parasitoids that attack pest insects.

For more about biological control, see here.

Parasitoids Important in Managing Potential Crop Pests in Manitoba

PARASITOIDS	MAJOR CROP FEEDING INSECT HOST OR PREY
Macroglenes penetrans (Pteromalidae)	Wheat midge
Glypta prognatha (Ichneumonidae)	Banded sunflower moth
Diadegma insulare (Ichneumonidae)	Diamondback moth
Microplitis plutellae (Braconidae)	Diamondback moth
Banchus flavescens (Ichneumonidae)	Bertha armyworm
Pediobius eubius (Eulophidae)	Hessian fly
Platygaster hiemalis (Platygasteridae)	Hessian fly
Aphidius ervi (Aphidiidae)	Aphids
Aphidius smithi (Aphidiidae)	Aphids

Fly Parasitoids Important in Managing Potential Crop Pests in Manitoba

PARASITOID	MAJOR CROP FEEDING INSECT HOST OR PREY
Athrycia cinerea (Tachinidae – Tachinid flies)	Bertha armyworm, etc.
Villa spp. (Bombyliidae – Bee flies)	Cutworms
Blaesoxipha atlanis (Sarcopgagidae – Flesh flies)	Grasshoppers

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Pollinator Strips

The image below shows such a strip in an organic grain field. The purpose is to provide the needed habitat for beneficial insects to live and reproduce, and to have ready access to the crop fields where the pests (their prey) live. Jason Gibbs from the University of Manitoba is measuring how strips of flowers can influence the abundance and diversity of beneficial insects. He will evaluate how the change in beneficial organisms can enhance pollination and biological pest control in organic and non-organic farms in Manitoba. Find out more in the podcast (also available as a transcript): Flower Power: Attracting Pollinators and Beneficials in Field Crops - Organic Federation of Canada.

Other strategies to enhance the ability of beneficial insects include intercropping and leaving natural areas intact around production fields. Learn more about intercropping on the Canadian prairies in the podcast Intercropping - Manitoba Organic Alliance and SaskOrganics webinar Mixing it Up Covercropping & Intercropping.

Drones can be used to deploy pest predators in large fields as described in Research: Drones as delivery vehicle for biological control agents | PotatoPro.

Biological control using pathogens

Producers can control insect pests by infecting them with disease-causing organisms such as bacteria, fungi, viruses or nematodes.

"Microbial biopesticides may contain viruses, bacteria, fungi or nematodes. Canadian Organic Science Cluster (OSC) researchers are investigating the control of wireworms by the soil fungus, *Metarhizium brunneum* LRC112, sold as Attracap. Other species of Metarhizium can be used against other pests. To control caterpillars in brassicas, many organic growers use Dipel or other commercial products containing soil bacteria (*Bacillus thuringiensis* var. kurstaki). Unfortunately, many pests have developed resistance to Bt. Alternatives are being studied by OSC scientists, who found that applications of the fungi *Beauveria bassiana* (BotaniGard), as well as certain viruses, can control diamondback moths, cabbage loopers and imported cabbageworms."[2]

Trap crops

"Trap crops are plants that attract pests, thereby diverting pests from commercial crops. By concentrating pests – like rounding up the enemy – farmers can destroy them by mowing or tilling the trap crop or applying a botanical pesticide. Another approach is to let the predators and parasitoids in the trap crop attack the pests….

"Trap crops can be managed to manipulate the movement of pest predators and parasitoids by mowing trap crops when these organisms are needed in the crop. For example, both hops and faba beans will attract aphids. Organic hop growers have planted fabas among hops to attract the natural enemies of the hop aphid, which will arrive after the aphids become established[21]. Once aphids were detected in the hops, the growers cut the neighbouring faba plants. The organisms that had been attacking aphids in the favas lost their habitat and quickly moved into the hops. The result: greater aphid control in the hops plus the benefits of a green manure."[3]

[2] Biological Pest Control
[3] Biological Pest Control

Examples of trap crops:

- Marigold (*Tagetes* spp.), *Crotolaria* spp., and *Mucuna* spp. can be used in a crop rotation to control nematodes. Marigolds are effective in controlling nematodes such as *Pratylenchus* or *Meloidogyne* spp., however not all marigold species are equally effective for all nematodes in all soils. In general, *Tagetes* spp. are more effective than *Calendula* spp.
- Brassica cover crops can be used as trap or allelopathic crops for nematodes, including the sugar beet cyst nematode.
- Sawflies lay eggs in bromegrass rather than wheat, so bromegrass makes an effective trap crop.
- Lygus bugs prefer cut alfalfa – growers can cut strips around the seed field to attract them from the seed.
- Grasshoppers do not like certain pea varieties, so plant these varieties of peas around flax crops to protect the flax.
- To protect a crop, seed a strip of perennial forage strip around a field, then till the forage after grasshoppers lay eggs in that strip.

Organic Insecticides

Certain insecticides, particularly bioinsecticides, are available for organic crops. Note for certified and transitional organic growers: check the standards and with your certifying body before using any new substance or practice. The Canadian Organic Standards can be found at Organic production systems : general principles and management standards and the Permitted Substances List is at Organic production systems : permitted substances lists. **Using a substance that is not permitted can lead to a loss of certification for three years.**

To help understand the standards, refer to *COG's Guide to the Canadian Organic Standards*.

Many organic insecticides are made from living or dead microorganisms such as *Bacillus thuringiensis* (Bt), *Saccharopolyspora spinosa* or *Beauveria bassiana* (as described above). Even though many bioinsecticides are permitted in organic production, it's critical to ensure a specific product is permitted before using it because it may contain prohibited substances or have been created using a prohibited process (e.g., genetic engineering).

In terms of microorganisms, the Permitted Substances Lists (PSL) of the Canadian Organic Standards states "Microorganisms, such as viruses, bacteria, protozoa, phages, and fungi, are permitted living, dead or as extracts. Microbial products may contain substances in Table 4.2 (Column 1 or 2). Examples include the following: rhizobium bacteria; mycorrhizal fungi; azolla; yeast; *Bacillus thuringiensis*; virus and virus sprays

(e.g., granulosis); and spinosad. … Ionizing radiation is permitted for use on a peat moss carrier before the addition of microbial inoculants. Radiation is otherwise prohibited. Pharmaceuticals derived from biological sources, such as natamycin, penicillin and streptomycin, are prohibited even if registered as pesticides."[4]

Bacillus thuringiensis (Bt)

Microbial insecticides that contain Bt are allowed in organic production as long as the product is not the product of genetic engineering nor contains any substance that is not on the PSL. However, in recent years, many varieties of field crops have been genetically modified to express Bt toxins. In conventional agriculture, these products (which are not permitted in organic production) have been relied upon to control pest species that are resistant to conventional insecticides. As a result of the widespread use of genetically engineered crops containing Bt, some pests have now developed resistance to Bt. The diamondback moth, for example, has developed Bt resistance.

Spinosad

Spinosad is a biopesticide derived from the soil-dwelling actinomycete *Saccharopolyspora spinosa*. Certain commercially available formulations of spinosad are allowed for use in organic systems. Permitted formulations of spinosad provide excellent control of many types of caterpillars, but they are less effective against piercing/sucking insects (such as stink bugs and plant bugs). Spinosad also controls Colorado potato beetle larvae. Formulations of spinosad are labeled for a wide array of vegetables—for example, potatoes, eggplant, tomatoes, cucurbits (melons, cucumbers, pumpkins, squash), cole crops, and sweet corn, as well as some field crops (such as peanuts).

Disease management in organic agriculture

Crop protection in organic farming is not focussed on controlling possible pathogens directly, but rather managing the environment to minimize disease presence and improve the ability of plants to withstand potential attacks.

Organic disease management

- Focus on prevention - take measures to prevent introducing the pathogen to the farm. If a disease is on the farm, take steps to prevent its spread.
- Organic farmers can control diseases through sanitation, rotation, diversity and monitoring (e.g., field scouting).
- Maintaining a healthy, biologically active soil is critical to keeping disease levels low.
- Intercropping and cover cropping can help reduce disease.

[4] Permitted Substances List

- Certain biological substances can suppress disease (e.g., using compost tea as a seed treatment or foliar spray).

Crop rotation for disease control

Crop rotation prevents inoculum build-up over the years and allows the natural decline of various pathogens. After a transition period of about five years, soil-borne diseases are commonly suppressed in organic farming provided the crop rotation is sufficiently long – this includes viral diseases transmitted by fungi and nematodes. In Europe, crop rotations average seven years for organic farms and three years for conventional farms.

Crop rotation is less effective for disease prevention if the pathogen is carried over long distances by wind. In addition, pathogens with a wide range of hosts and persistent overwintering structures, such as *Sclerotinia sclerotiorum*, are difficult to control by crop rotation unless cereals and grasses have a prominent place in the rotation. Diseases such as white mould can be very problematic on organic farms that specialize in vegetable production or have a rotation that is too short. Certain species of *Fusarium* can affect such a wide range of host plants that only comprehensive soil health management will help to avoid problems. Overall, organic farms tend to have less of a problem with root diseases - this can be attributed largely to the longer crop rotations in organic farming than in conventional farming.

An example of using the crop rotation to reduce disease:

Seed a brassica-oat fall cover crop before seeding peas the following year. This can decrease the incidence of common root rot. The brassica can be a mustard, radish, kale or any other member of the brassica family but mustards appear to be most effective in disease control. As the brassica decomposes, sulphur-containing compounds are released. These, along with compounds released from the breakdown of the oat residue, can inhibit the development of root rot. It is important that brassica plants are shredded and then immediately incorporated into the soil.

Mustard Biofumigation Project is a good video from Manitoba Agriculture that explains use of mustard as a biofumigant.

Voices from the Field, G + G Farm

The Johnsons pay close attention to the health of their crops. Fortunately, their disease rate has been "very minimal," says Garry. "I guess it might be a testament to our rotation." They also seed disease-sensitive crops, like lentils, into fields that are isolated from neighbouring farms.

"With our practices, and I think organic practices in general," explains Garry, "plant diseases are really a minimal threat."

He gives credit to the knowledge "developed from the early days of organic farming by farmers who knew that they couldn't use [pesticides]. The tools in their toolbox were limited compared to their commercial neighbours. So they developed and devised these rotations and green manures."

"We're standing on the shoulders of those that came before us. There's no doubt about it. And we have to do the same," he adds. "We have to provide examples of improved agronomy for the next generation of farmers as we move along."

Garry feels that the low disease rates on organic farms is because of healthier soil, which produces healthier plants that are less attractive to pests.

"The long and the short of it is: the lower disease rate on organic farms is a very strong signal that we're doing something right by concentrating on soil health and rotation."

Focus on soilborne diseases

For soilborne diseases, for example, the following methods can limit their introduction.

- Use of healthy seeds and planting materials. This is particularly important to avoid seed borne-diseases in cereals.
- Crop rotation.
- Biofumigation - using natural gases released from cover crops to inhibit pests and diseases. The most common biofumigation method is the cultivation, maceration and incorporation of green manure crops that contain precursors of toxic compounds. Examples of such precursors are glucosinolates, which are commonly produced in members of the Brassicaceae family, including rapeseed and mustard.
- Soil solarization.
- Sanitation (e.g., removing cull piles of potatoes).

Ways to limit pathogen growth

- Use crop rotation as discussed above.
- Adjust planting times to avoid periods when diseases are known to surge and to avoid heavy aphid flights (note: aphids spread plant viruses). For example, organic growers in temperate regions avoid severe damage from late blight by planting pre-sprouted, early-maturing potato varieties early in the growing season. This allows for an early harvest because by the time late blight becomes pervasive and the tubers need to be harvested, they have already grown to a reasonable size.
- Spatial isolation. Separate fields by natural vegetation or wind breaks.
- Plow deeply on occasion to reduce weed or sclerotinia problems.
- Control disease vectors – vectors are the organisms that carry disease, such as aphids. For example, straw mulch around potato plants is effective in reducing potato virus Y infections because the texture of the straw seems to confuse the aphids.

Limiting pathogen establishment

Once a pathogen has entered a field, various conditions can either enhance or suppress its infection rate, multiplication speed, degree spread and thus establishment in the field.

Farmers can enhance natural disease control by:

- increasing the diversity in the terrestrial and soil food webs in the agroecosystem, for example by increasing diversity of plants including crops, cover crops and flowering strips
- adding organic matter, for example, by applying compost, incorporating crop residue or growing cover crops
- improving soil health (as described below)
- making the above-ground environment less hospitable to pathogens (as described below).

Voices from the Field: Mill Creek Organics

On both Mill Creek Organics, the Boersches treat all the seed (in addition to inoculating legume seed with Rhizobia). They treat seed with commercial compost tea product along with 'catalysts,' including humic acid, kelp extract, alfalfa meal and other substances that can stimulate the plant and the soil life.

The effect of the seed treatment seems to vary. On the conventional side, they found that the treatment had a greater impact when fertilizer applications were lower, and the impact was greater in dry years.

The impact on yield can be as high as a three- or four-bushel response on wheat (per acre). In other years and fields, there might not be a dramatic impact on yield but they find the plants from treated seed have greater root development. Inoculated legumes have "way more nodulation, especially on the lateral roots, the finer roots," Alex explains.

"Our philosophy is that if the plant is healthier, it should be able to fend off diseases better. It's hard to say what's going to affect the plant on a year to year basis. It's not as exact as when you spray a fungicide," Alex laughs. "But we think that [using permitted seed treatments] is obviously way more beneficial in the long term."

Improve soil health

- Increase aggregate stability. Aggregate stability refers to the ability of soil aggregates (clumps of soil particles) to resist disruption, for example, from a heavy rainfall. To increase aggregate stability, farmers can increase levels of soil organic matter and protect soil life. As microorganisms break down organic matter, they release compounds and produce mycelia which help hold soil particles together. Better aggregate stability increases aeration which allows more diverse soil biology. Also increased aeration helps root health, making roots more able to resist or tolerate soil pathogens.
- Reduce the incidence of waterlogging to reduce the levels of root infection. Improving water infiltration rates can reduce waterlogging.
- Maintain lower rates of available N.* (see box above)
- Maintain lower rates of soluble phosphorus - this will increase mycorrhizal colonization, which in turn protects roots from pathogens.
- Add organic material that is slow to decompose. This will enhance the activity of primary decomposers, mainly bacteria and fungi, and the associated food web. The actual mechanism involved in disease suppression may vary according to the type of organic matter applied, the pathogen and environmental conditions. Diseases are generally suppressed by regular additions of hard-to-decompose organic amendments, such as plant residues high in lignin and cellulose, compost made from mature plant waste or composted animal manure.
- Add soil amendments like compost to induce disease resistance in plants.

Make the above-ground environment less hospitable to pathogens

- Organic growers sometimes attempt to suppress weeds and increase yields by creating a dense, quickly closing canopy by narrow row spacing and high seeding rates. Unfortunately, this results in a microclimate that is highly suitable for the development of various foliar diseases. Low-growing living mulches between crop plants may be a better option if diseases are a problem.
- Select resistant varieties – this is very, very important!
- Mix crop species (intercropping) or crop varieties.
    - Resistant plants in a mixture create obstacles and traps to pathogens and their vectors.
- Spray biological control agents.
    - Compost tea. Spraying compost tea on the foliage or the soil or coating seeds with compost tea can inhibit disease. The effects of compost tea are variable, depending on the compost ingredients (feedstocks); the composting method; the compost-to-water ratio; the inclusion of other ingredients, such as molasses; and tea pH.
    - Microbial inoculants are sometimes used as seed treatments. However, these may be less effective in organic systems compared to non-organic farms, because organic farms generally have greater biodiversity in their soil. So, adding more biodiversity may have less of an effect.

Voices from the Field: Sundog Organic Farm

At Sundog Organic Farm, Jenny Berkenbosch and James Vriend use vermicompost (worm castings) and a vermicompost liquid extract from Annelida Organics in Alberta. They mix biochar with vermicompost and apply it to beds when they plant. This may stimulate soil life and make nutrients more accessible.

"We bathe seed potatoes with the worm casting extract," explains Jenny, "because when you inoculate the seed potato, as soon as the plant starts growing, the root system will become like a nursery for those beneficial microorganisms to grow and multiply."

Also, when transplanting, they give the starts [transplants] "a shot of worm casting juice." Jenny describes this practice, like inoculating seed potatoes, as a quick and low-cost way to accelerate the production of microorganisms in your soil.

Complex relationships between pest, beneficials, weeds and crops
"On-farm research in Nova Scotia demonstrated how the interactions between soil, weeds and insects on an organic farm provided natural pest control.[5] Weeds in faba beans provided habitat for ladybeetles (ladybugs) and other natural enemies of aphids. The weeds also used up some of the nitrogen in the soil. The resulting low levels of soil nitrate minimized excessive uptake of nitrogen by the faba beans and limited the reproductive rates of the aphids.

Consequently, infestations were effectively controlled before the pod-fill stage (when pests are most damaging to the crop). When levels of soil nitrogen were high, weeds reduced yields. However, at low nitrogen levels, the crops thrived and the weeds were kept in check. Surprisingly, crop yields were higher in plots **with** weeds, compared to yields from the weed-free plots (because the weed-free plots had more aphid damage)."[6]

Treating disease

What can be done once the pathogen is established in the crop? There are limited organic options for treating disease. he use of synthetic pesticides is prohibited in organic farming. Note that organic producers should check the standards and with their certifying body before using any new substance or practice. The Canadian Organic Standards can be found at Organic production systems : general principles and management standards.: P29-32-310-2020E-PDF - Government of Canada Publications and the Permitted Substances List is at Organic production systems : permitted substances lists.: P29-32-311-2020E-PDF - Government of Canada Publications. Using a substance that is not permitted can lead to loss of certification for three years.
To help understand the standards, refer to *COG's Guide to the Canadian Organic Standards*.

- In most countries, copper fungicides are considered 'mined, natural products' and are allowed for use against bacterial and fungal diseases, but the number of countries with restricted use of copper fungicides is increasing, especially in Northern Europe.
  - Copper fungicides have been used primarily to control diseases caused by Oomycetes (downy mildews and late blight), but also other foliar diseases that are difficult to control without fungicides, such as apple scab and tomato anthracnose. However, copper is not only toxic to bacteria and fungi but also to plants, especially during periods of cool wet weather when many plant pathogens thrive. At the recommended concentrations to control plant pathogens, copper is also

[5]Patriquin, D. 1988. On-farm research reveals links between nitrogen, intercrops, weeds and pests. *Sustainable Farming*. November issue.
[6]Organic Field Crop Handbook (3rd Ed.) 2017. By Brenda Frick, Laura Telford and Joanne Thiessen Martens; edited by Janet Wallace. Canadian Organic Growers.

toxic to various soil organisms such as earthworms and many microorganisms. According to the 2020 Canadian Organic Standards' Permitted Substances Lists (Table 4.2): Copper sulphate, copper hydroxide, copper octanoate, Bordeaux mix, copper oxychloride and copper oxide are permitted for controlling pests, including diseases. These substances "shall be used with caution to prevent excessive copper accumulation in the soil. Copper build-up in soil shall prohibit future use. Visible residue of copper products on harvested crops is prohibited."

- Certain kelp extracts are permitted. These extracts could become an excellent alternative to copper fungicides in organic agriculture. However, certified organic growers need to check all substances, including inert ingredients, in the products because certain extractants are not permitted.[7]

- Sulphur fungicides are widely used to control powdery mildew on various crops and scab on apples and pears (but check to ensure a specific product is permitted in organic production). They can be applied as wettable sulphur (in the field and orchards) or finely ground sulphur dust (mostly in greenhouses and vineyards). Sulphur is generally quite effective in controlling powdery mildew.
- Sodium bicarbonate (baking soda) is allowed for the control of various diseases by most regulatory agencies, but is not as effective as potassium bicarbonate. Bicarbonates are effective primarily against powdery mildews, apple scab and necrotic leaf spot diseases. The effectiveness of bicarbonates can be enhanced by an approved spreader-sticker like soap or oil.
- Mineral and plant-derived oils are particularly effective against powdery mildews, and may enhance host plant resistance. Note that organic producers should ensure all ingredients, particularly extractants, are permitted or check with their certifying body to see if a product is permitted.[8]
- Extracts from many herbs, spices and medicinal plants are being tested for their effects on various plant diseases. For example, research is being conducted on a plant-based fungicide made from a mustard extract that successfully reduces stinking smut when applied as seed treatment on wheat. **For more information on biological pest control, see <u>BIOLOGICAL PEST CONTROL</u>.**

[7] "Aquatic plant products may be extracted by using the following substances in order of preference: a) substances in Table 4.2 Extractants; b) potassium hydroxide; c) sodium hydroxide provided the amount of solvent used does not exceed the amount necessary for extraction. The operator shall provide an affidavit from the manufacturer that proves the need to use sodium hydroxide. Sodium benzoate and potassium sorbate may be used as preservatives for water-extracted aquatic plant products. All other preservatives are prohibited unless listed in Table 4.2 (Column 1 or 2) with the exception that Formulants used in crop production aids are prohibited." Table 4.2 Permitted Substances List.

[8] For Plant extracts, oils and preparations, "Permitted extractants include fats and oils (such as cocoa butter, lanolin and animal fats); alcohols; water; or substances listed on Table 4.2 (Column 2) other than Formulants used in crop production aids. Extraction with other solvents is prohibited except with, in order of preference: a) potassium hydroxide; or b) sodium hydroxide; provided the amount of solvent used does not exceed the amount necessary for extraction. The operator shall provide an affidavit from the manufacturer that proves the need to use sodium hydroxide." Table 4.2 Permitted Substances List.

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To learn more about the Prairie Organic Development Fund www.organicdevelopmentfund.org

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The Prairie Organic Development Fund (PODF) is an investment platform established to develop organic agriculture and marketing in the Canadian Prairies. PODF builds resilience by investing in organic provincial associations (Capacity Fund) and high impact programs (Innovation Fund) related to marketing, research, policy, education and capacity development that have broad public benefit to the organic sector. The fund is directed by a board made up of organic producers, grain buyers, organic brands, researchers and provincial organizations.

The **Canadian Organic Ingredient Strategy (COIS)** provides farmers with tools and support to incorporate organic farming practices that help meet the growing demand for organic foods in Canada. The tools developed as part of this project will help Canadian farmers benefit from increased knowledge and skills in organic farming methods, which can improve soil health and boost farm resilience in the face of changing markets and climate change.

Visit www.pivotandgrow.com to learn more about the tools created as part of COIS.