

Ontario Greenhouse Vegetable Newsletter

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EDITORIAL



Climatic factors impact greenhouses in many ways. A tornado is a drastic example. Earlier this month an F2 tornado damaged greenhouse operations and residential homes in the Leamington area. Fortunately there were no injuries. The cleanup is ongoing and the cooperation of neighbours, friends and business is commendable. A more subtle type of impact is the movement of pathogens or insects in the wind currents, the loss of environment controls in the greenhouse, and reduction in fruit quality. This newsletter deals with some of the pest problems resulting from such impact, and with strategies needed to maintain fruit quality.

Gillian & Shalin

Recent Product Registrations

Two new registrations have been obtained recently for greenhouse cucumber and pepper, one for management of aphids, and the other for suppression of root diseases.

Endeavor 50WG on Greenhouse Cucumber

The label for Endeavor 50WG was expanded to include greenhouse cucumber for the control of green peach and melon aphids. Endeavor 50WG works on that part of the nervous system of the insect that controls feeding. When aphids are sprayed with this compound, they stop feeding immediately, although they may remain on the treated plants for several days. Eventually the aphids die from starvation. The rate of application is 100-200 g product per ha per application. A maximum of 2 applications are allowed per crop cycle, and no more than 3 applications are allowed per greenhouse per year if multiple crop cycles occur in a year.

Rootshield on Greenhouse Pepper

The labels for Rootshield Granules Biological Fungicide and RootShield HC - Biological Fungicide Wettable Powder were expanded to include greenhouse pepper. These products contain live spores of the fungus, *Trichoderma harzianum* Rifai strain KRL-AG2.

Inside this Issue...

Recent Product Registrations.....	1
Fruit Quality	2
Tips for Using Bt Products	4
Biocontrols for Pythium Root Rot	5
Products Registered for Greenhouse Vegetables	6
Pest Alert 1—Tomato Late Blight	7
Pest Alert 2—Downy Mildew in Cucumbers.....	8
Ag Development Branch—Beyond Production Business Bundle	9

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Recent Product Registrations (cont'd)

When the fungus becomes activated, it grows onto plant roots and protects them against *Pythium*, *Rhizoctonia* and *Fusarium* spp.

When incorporated into or applied to the media, the spores become active when media temperatures exceed 10°C, and are more effective when the pH of the media is neutral or acidic. To use RootShield® Granules Biological Fungicide, mix this product at a rate of 600-750 g per cubic metre (loose) planting mix or soil. For

RootShield® HC - Biological Fungicide Wettable Powder, suspend this product in sufficient water (eg. 30-45 g/100L) to achieve uniform application and apply at the rate of 55-110 g per cubic metre (loose) of greenhouse potting mix, soil or planting beds. RootShield® HC - Biological Fungicide Wettable Powder can be applied through low pressure watering nozzles such as fan nozzles or other watering systems. Agitate to maintain suspension.

Fruit Quality

The Hottest Tomato, Coolest Cucumber and the Perfect Pepper competition was held in Leamington on June 17, 2010. The vegetables were judged for various taste characteristics (flavour, texture etc) and appearance (colour, shape, uniformity etc.). All of these characteristics are easily controlled by the grower. A key point to remember is—quality can not be added, but only maintained once the fruit is off the plant.

There are several key factors that the grower can use to increase and maintain fruit quality.



Quality in the greenhouse: Key feature is to maintain the ideal climate, fertility and watering regime and cultural practices.

Temperature

- Greenhouse
 - ◇ Temperature controls the rate of flower development, and, impacts the shape of the flower – too low a temperature causes the flower shape to change affecting the shape of the fruit e.g. flat peppers or oblate shaped tomatoes
 - ◇ Temperature affects the rate of flower development and fruit-setting which may cause uneven fruit-setting and delayed ripening within

the truss. High temperatures will also affect the shape of the fruit (e.g. pointed tomato).

Humidity/Vapour Pressure Deficit

- Rapid and large changes in humidity affects fruit shape and will result in curly or pigtail-shaped cucumbers



Curly cucumbers caused by rapid changes in vent

Fertilizer

- The electrical conductivity (EC) determines rate of growth as well as the flavour:
 - ◇ Too low an EC results in fast plant growth and rapid fruit expansion but results in watery fruit flavour
 - ◇ Too high an EC results in a slower growth and fruit development and improved flavour. However, too high an EC will result in a mealy or dry-textured fruit
 - ◇ The composition of the fertilizer influences fruit flavour. A balanced fertilizer program results in a

balanced fruit flavour, texture and colour

- ◆ Low potassium (K) and high nitrogen (N) results in:
 - * Sweeter, more watery type of fruit.
 - * Decreases the tangy/acidic flavour
 - * Fruit colour disorders (e.g. blotchy ripening, graywall)
 - * Blocky fruit
- ◆ Low calcium (Ca) will result in increase the incidence of blossom end rot (BER)



Blossom end rot in peppers

results in moisture stress on the plant. This will decrease fruit size and/or lead to BER

- Too vegetative a plant results in excess leaf and poor fruit colour whereas too generative a plant will result in fruit exposed to the sun resulting in sunscald or uneven ripening
- Watering 2 hours after sunrise and stopping 2 hours before sunset is a good guideline to use to maintain the ideal plant.
- Short and frequent watering results in a vegetative impulse to the plant while long less frequent watering will result in a more generative impulse to the plant.
- Growing media controls water availability and irrigation strategies must be adjusted to match the water-holding characteristics of the growing media to provide a steady controlled supply of water to the plant.



Graywall

Cultural practices: A well-balanced actively growing

Water

- Lack water or inability deliver water as

required the plant

crop will provide the highest quality fruit. The number of leaves can significantly impact quality. In the early stages of plant growth there is a need to maintain lower leaf numbers per plant but as the plant ages and the light levels and temperatures increase a higher number of leaves per plant helps keep the plant cool and at the same time improve fruit development.

The rate of fruit development and ripening increases when the fruit is exposed to sunlight (increased temperature) but too high a fruit temperature will cause discolouration of the fruit and or shorter shelf life.

Note: do not deleaf late in the day as the wounds will not have sufficient time to heal before sunset increasing the chances of disease infections.

Fruit pruning: remove misshapen fruit early to allow plant to expend energy on better quality fruit. In many cases examination of the flower will show the potential shape of the fruit and early removal of this flower will allow the next flowers to set and develop sooner. Plant balance (fruit to leaf) is important in maintaining rapid flower development, fruit setting and early harvest.

Time of picking: Picking should be conducted early in the day so that fruit temperature is not too high.

Post harvest

- Bruising fruit by rough handling or dropping into picking boxes/carts decreases shelf life. Place fruit in the containers and packing boxes
- A clean cut at the fruit stalk is important to allow rapid sealing of the wound and to prevent excessive moisture loss.
- Cool product as rapidly as possible. Do not store greenhouse produce below 12°C
- Do not allow condensation to form on produce
- Pack uniformly – size, colour, shape to increase product appeal.

Tips for Using Bt Products

Several commercial formulations (Dipel®, Foray® and Bioprotec®), of the bacterium *Bacillus thuringiensis* subsp. *kurstaki*, commonly referred to as Bt, are used for managing moth pests such as cabbage loopers. Bt products consist of crystal-shaped proteins and living spores.

Successful use of Bt requires an understanding of its mode of action.



Corpse of cabbage looper killed from ingesting the bacterium, *Bacillus thuringiensis* subsp. *kurstaki* applied to crop

How does Bt work?

Bt is a stomach poison that kills the insect only after it has ingested Bt by feeding on material treated with it. Only insects with a specific gut pH (usually alkaline) are susceptible to the toxic protein. The protein crystals dissolve and liberate toxins when they enter the alkaline medium of the insect's stomach. The toxins paralyze the gut causing the insect to stop feeding, usually within an hour. The toxins also break down the insects' gut wall within hours allowing the Bt spores and the gut content to invade the body cavity. This causes death by starvation, blood poisoning, and/or osmotic shock within a few days. Poisoned cabbage loopers turn from a light green of the healthy individuals, to dark brown as they decompose. For Bt to be used most effectively, consider the following tips:

Tips for improving effectiveness of Bt

1. **Monitor the crop regularly** to determine presence of caterpillars and to detect the younger, more susceptible stages as soon as they appear.

2. **Ensure good coverage** to target the very youngest caterpillars that feed only on the superficial tissue of the leaf undersides. To assist in coverage, use as fine a droplet size as possible, and apply as uniformly as possible. Addition of a spreader/sticker may improve coverage.
3. **Shorten spray intervals** to compensate for the rapid degradation of Bt by sunlight.
4. **Apply Bt during evenings** as this can help delay breakdown of the product by sunlight.
5. **Ensure proper pH of mixture.** The pH of the water before mixing should be 6.0 – 6.5. A high pH will cause breakdown of Bt and reduction in efficacy.
6. **Delay development of resistance to Bt by use of alternative control strategies.** This means use of insect screens, sanitation, and biological control agents such as *Trichogramma* sp., and rotation with a product such as the insect growth regulator, Confirm (registered for suppression of cabbage loopers on greenhouse pepper, tomato, and lettuce).



Very young larval stage of cabbage looper is very susceptible to *Bacillus thuringiensis* subsp. *kurstaki*

Biocontrols for Pythium Root Rot

Summer temperatures favour development of certain *Pythium* species in greenhouse vegetable crops, particularly cucumber seedlings. A few biological control agents are available to assist in managing this disease. Note that *Pythium* infects roots rapidly, and because the activity of biological control agents is suppressive, they must be used preventively. Commercially produced microbial biological control agents available for use in greenhouse vegetables for suppression of *Pythium* species include Mycostop, Prestop, and RootShield.

Mycostop - The active ingredient in this product is a bacterium called *Streptomyces griseoviridis*. This bacterium is active between 15°C and 30°C, and it works over a wide range of pH (5.0-8.5). It becomes inactive at temperatures above 45°C and below 5°C.

Streptomyces griseoviridis does not use live plant cells for nutrition and so does no harm to the plant; however, it requires the presence of these plant cells to actively grow and control fungal pathogens. It only grows slowly in the absence of living roots. This microbial grows on the root surface and uses root exudates and dead cells as an organic nutrient source. The antagonistic effect of *S. griseoviridis* is based on several mechanisms e.g. on competition with the pathogen for nutrients, and on parasitism by producing enzymes that break down the cell walls of the pathogen. It particularly seems to favour root exudates of cucumber. In addition to *Pythium*, *S. griseoviridis* also targets *Fusarium*, *Phytophthora* and other disease-causing pathogens.

Prestop - The active ingredient in Prestop is a fungus, *Gliocladium catenulatum* strain J1446. *Gliocladium catenulatum* suppresses other fungal pathogens by two main mechanisms, competition and parasitism. *Gliocladium catenulatum* competes with other fungi for nutrients and living space, thereby preventing them from successfully establishing on the plant. It is also able to parasitize competing fungi, resulting in breakdown of their cell walls. Work done at Simon Fraser University by researchers, Punja and Yip, with this microbial against *Pythium* on cucumbers

resulted in very good suppression when the product was applied twice and preventively to seedlings. Such results were obtained despite relatively high *Pythium* pressure. It also suppresses *Fusarium* and *Phytophthora*.

RootShield - The active ingredient in RootShield is a fungus, *Trichoderma harzianum* strain T-22. *Trichoderma harzianum* becomes active when soil temperatures are above 10°C. Control is not effective while soils remain cold and is more effective in neutral or acidic media than in alkaline media (>pH 8.5).

However, it does not persist at biologically significant levels in the absence of roots, except in highly organic soils.

Trichoderma harzianum suppresses pathogenic fungi by parasitizing them. It is able to coil around the pathogenic fungus and produce enzymes that dissolve the cell walls.

Microscopic observation of *T. harzianum* indicates that it colonizes the entire root and is extremely persistent on root surfaces. In addition, *T. harzianum*

produces other compounds that act against the pathogen. As with the other two biocontrol agents, *T. harzianum* competes with pathogens for space and nutrients. Field trials with *T. harzianum* at the University of Florida resulted in reduction of *Fusarium* crown and root rot in tomato.

It must be emphasized that these products are protective and suppressive in nature. They are not curative and should be applied preventively. All of the above products are compatible with the fungicides, Previcur® and Ridomil®, but they are best applied in separate tanks. If such biocontrol agents are used as recommended, and in combination with other strategies that minimize conditions favourable to *Pythium*, growers will be able to successfully suppress incidence of *Pythium* root rot.

Acknowledgement

This is an extract of an article previously reviewed by John Francis of Bioworks Inc. and Marja-Leena Lahdenperä of Verdera.



Young cucumber seedlings succumb to Pythium root rot

Products Registered for Greenhouse Vegetables

OMAFRA's Publication 371 contains tables of products that are fully registered, as of summer 2008, for use on greenhouse vegetables. Please see the 2009 Supplement that is available on line at: <http://www.omafra.gov.on.ca/english/crops/pub371/p371order.htm>.

The French version is also available to order and can be found on line at: <http://www.omafra.gov.on.ca/french/crops/pub371/p371order.htm>. Note that these tables do not contain emergency use registrations.

For label information on any product, go to the PMRA's (Pest Management Regulatory Agency) website at: http://prp.pmra-arla.gc.ca/portal/page?_pageid=34,17551&_dad=portal&_schema=PORTAL

For information on maximum residue limits (MRL) for pesticides in Canada, go to the link at: http://www.hc-sc.gc.ca/cps-spc/alt_formats/pdf/pest/part/protect-proteger/food-nourriture/mrls-lmr-eng.pdf. Such MRLs are also referred to as "tolerances for residues" in the US.

Full Registrations		
Product	Crop	Pest
Avid	tomato, pepper	tomato psyllid
Botanigard WP	cucumber, lettuce, pepper, tomato	whiteflies, aphids, thrips
Botanigard ES	cucumber, lettuce, pepper	whiteflies, aphids, thrips
Endeavor 50WG	cucumber	green peach aphid, melon aphid
Pristine WG	tomato	Botrytis grey mould, Powdery mildews (<i>Oidium lycopersici</i> , <i>Leveillula taurica</i> , <i>Erysiphe polygoni</i>)
Pristine WG	cucumber	Powdery mildew (<i>Sphaerotheca fuliginea</i>) suppression Gummy stem blight (<i>Didymella bryoniae</i>) suppression
Rhapsody	cucumber	gummy stem blight, Cercospora leaf spot, downy mildew, powdery mildew
Rhapsody	lettuce	<i>Sclerotinia</i> rot, grey mould, powdery mildew, downy mildew
Rhapsody	pepper	grey mould, bacterial spot and speck
Rhapsody	tomato	bacterial blight (<i>Pseudomonas syringae</i>)
Rootshield HC - Biological Fungicide Wettable Powder	pepper	<i>Pythium</i> , <i>Rhizoctonia</i> and <i>Fusarium</i> spp.
Rootshield Granules Biological Fungicide	pepper	<i>Pythium</i> , <i>Rhizoctonia</i> and <i>Fusarium</i> spp.
Scala	tomato	Botrytis grey mould
Tristar 70 WSP	pepper	aphids
Tristar 70 WSP	tomato	whiteflies

Emergency Registrations		
Product	Crop	Pest
Dibrom	pepper	Pepper weevil - emergency registration until November 19, 2010
Actara 25 WG	pepper	Pepper weevil emergency registration until November 25, 2010
Switch 62.5WG	cucumber	Powdery mildew - emergency registration until Dec. 31, 2010
Manzate Pro-Stick	cucumber	Downy mildew - emergency registration until Dec. 31, 2010
Revus (in tank mix with Manzate Pro-Stick)	cucumber	Downy mildew - emergency registration until Dec. 31, 2010

Labels are available either from PMRA's website, distributors, or OMAFRA's IPM Specialist. Please consult labels of all products before use.

PEST ALERT 1

Tomato Late Blight

General Background

Tomato late blight, caused by fungus, *Phytophthora infestans*, is significant because of the rapidity with which it can spread and destroy a crop, given the right conditions. Solanaceous crops such as potatoes, tomatoes, pepper, eggplant and various related weeds are all susceptible to this disease. There have been recent reports of late blight in potato or field tomato in several states (Michigan, Pennsylvania, Kentucky, North Dakota and New York). Warm, moist weather conditions have favoured incidence of this disease and this is a source of major concern for producers of field tomato and potato. During 2009, late blight devastated field tomato crops on the East Coast and major losses were suffered. Organic producers are particularly susceptible because of lack of effective fungicides for such production systems. Given the ease with which this disease spreads, field incidence should also be of concern to greenhouse tomato producers.



Tomato plants affected by late blight

How Does Late Blight Spread?

Spores from infected potato and tomato plant material left in fields or cull piles are easily spread by wind to infect other plant hosts. Development of this disease depends on temperature and humidity conditions. Cool nights and warm days are ideal for development of this disease. The fungus produces abundant spores when the relative humidity is at, or close to 100%, and at

temperatures between 16 and 22°C. Older, lower greenhouses, particularly those that are leaky, or any houses that have a lot of condensate dripping from the roofs, are very prone to late blight. Spores require free water or dew to infect a plant. Once the fungus has penetrated the plant tissue, it develops very rapidly at 17-21°C. Temperatures above 30°C check the growth of the fungus but do not kill it.



Symptoms of late blight on tomato fruit

Determination of Mating Types

Phytophthora infestans can exist as two different mating types (A1 and A2). In southern Ontario, an A2 mating type predominates. If only one mating type exists, the resulting asexually produced spores can survive for only short periods (hours or days) outside of living tissue, depending on moisture levels and exposure to UV radiation. Diseases from such spores are more easily controlled unless environmental conditions strongly favour the disease. However, if both mating types occur together, they can reproduce sexually to produce resistant spores (oospores) which are difficult to control, and which can survive for a very long time outside of the living host tissue. **Therefore, should symptoms of late blight be observed on tomato crops, we are requesting growers to contact us. We would like to collect samples and carry out tests to determine what mating types we have on greenhouse tomatoes.**

PEST ALERT 1

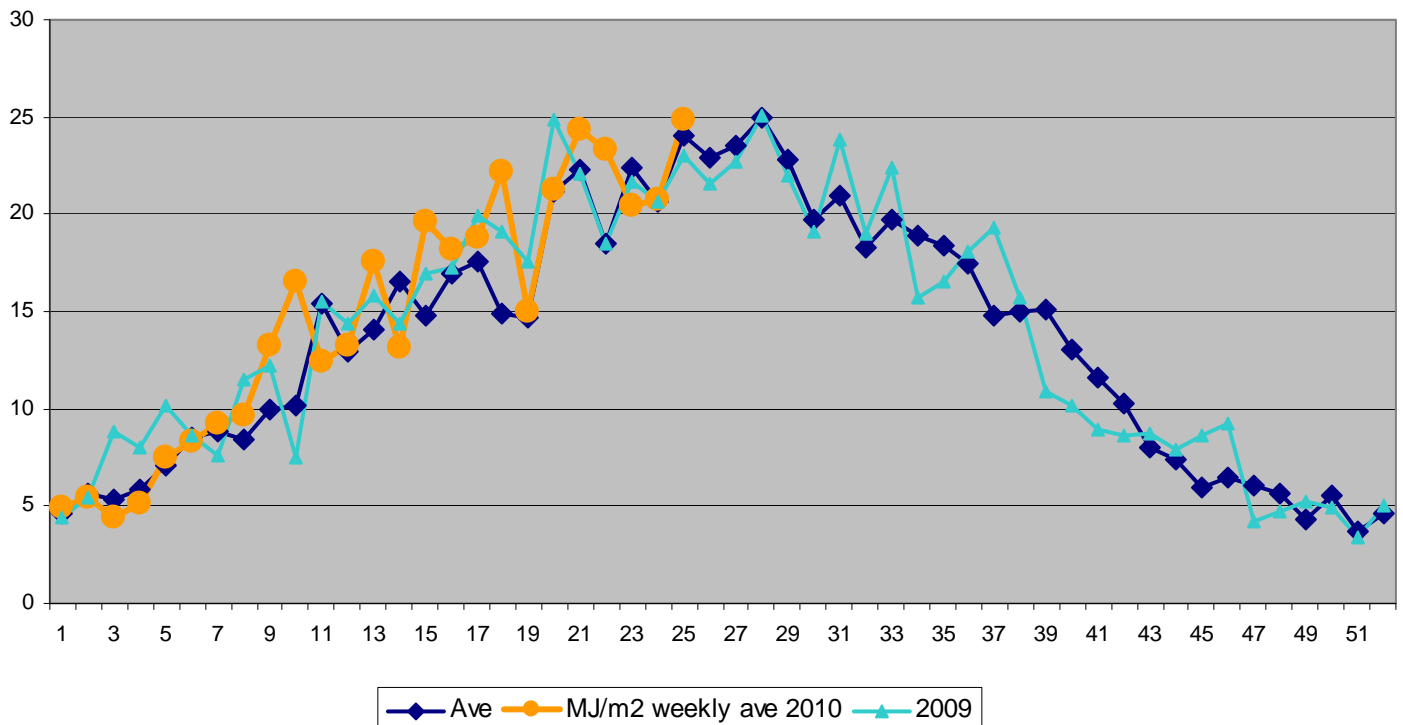
Tomato Late Blight (cont'd)

Management of Late Blight

Major strategies for managing late blight include a combination of sanitation, good control of the environment, and application of fungicides.

1. Properly dispose of infected plant material. Ensure that all infected leaves and fruit are bagged, transported in covered bins, and buried as soon as possible. Do not leave infected material in cull piles exposed in the field as this will lead to spread of the fungus back into the greenhouse, to neighbouring greenhouses, and to susceptible weeds and field crops.
2. Remove all potential host plants in areas adjacent to the greenhouse.
3. Heat and vent to keep humidity levels low. For good growing conditions and to prevent dew formation, a vapour pressure deficit of between 0.5-0.8 Kilopascals should be maintained in the greenhouse.
4. Apply fungicides as soon as disease is detected. Manzate Pro-Stick and Revus are registered for late blight in greenhouse tomato. Ensure that thorough coverage of the crop is achieved.
5. Continue monitoring the crop closely to detect any incidence of late blight and to facilitate a quick response.

Sunshine Radiation Weekly Average 2010 (MJ/m²/day)



PEST ALERT 2

Downy Mildew in Cucumbers

General Background

Cool, moist conditions during this spring have favoured development of downy mildew, a fungal disease of cucumbers (see OMAFRA Factsheet on Downy Mildew of Greenhouse Cucumber at <http://www.omafra.gov.on.ca/english/crops/facts/09-013w.htm>). Incidence of this disease in field cucumbers has been reported recently in Michigan and Ontario. This means that there will be increased disease pressure for greenhouse cucumber crops.

How Does Downy Mildew Spread?

Downy mildew infections in greenhouses usually originate from spores that are blown in from infected outdoor crops. Local field infections, in turn, are usually established by spores that are carried by moist air currents blowing northwards from warmer southern regions where the fungus can overwinter on plant material. When spores land on a wet leaf surface, they can either infect the leaves through the stomates, or release many smaller spores, called zoospores that can swim in the film of water on leaves and enter and infect leaves through stomates. Optimum temperatures for infection range between 16° to 22°C, with infection occurring more rapidly at the warmer temperatures. Infection by the fungus occurs within a few days, and thereafter, many more spores are produced which can quickly spread throughout the greenhouse via moist air currents, contaminated tools, equipment, fingers, and clothing.



Early symptoms of downy mildew on cucumber leaf



Advanced symptoms of downy mildew on cucumber leaf

Management of Downy Mildew

Managing downy mildew requires an integrated approach as follows:

1. Avoid dew formation by providing adequate heating and ventilation because this is critical to reducing incidence of downy mildew.
2. Practice strict sanitation to reduce sources of infection. All infected leaves and plants should be removed, placed in garbage bags, and properly discarded. It is particularly important to ensure that spores do not escape and infect nearby neighbouring greenhouse crops or commercial cucurbit fields (pumpkin, zucchini, cucumber, squash).
3. Manage weeds including all cucurbit plants surrounding the greenhouse. Such hosts should be removed because these may serve as reservoirs for the downy mildew fungus.
4. Provide adequate canopy aeration by ensuring that plants are sufficiently spaced and that the canopy is well pruned.
5. Avoid over-watering because this leads to soft, more vulnerable plants, and to guttation or production of droplets of moisture at the margins of leaves early in the morning. Such moisture at the leaf margins provides perfect infection sites for the downy mildew pathogen.
6. Use fungicides early and as per label directions. Manzate Pro-Stick and Revus currently have an emergency use registration against downy mildew in greenhouse cucumbers.

Agriculture Development Branch Beyond Production Agriculture Business Information Bundle Matte Story

New Business Information Bundle Encourages Farmers to Add Value to Their Operation

Value adding is all about capturing more market share by moving from producing a commodity to a product or service that has a unique offering or service advantage for the buyer or consumer.

Adding new value to a product expands your farm business. A blueberry farmer might start making and selling jams, pies, cookies, juice, fruit wine, ice cream or frozen berries. An orchard might open a pick-your-own element to the farm business. A livestock farmer may start selling freezer cuts to the public through on-farm or farmers' markets sales or targeting a niche market.

The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) launched the [Beyond Production](#)

[Agriculture Business Information Bundle](#) (BIB) in March to help farm business owners and managers think about doing more with their product.

The Beyond Production Agriculture BIB gives examples of other operations that have added value and provides links to resources about business planning, marketing, regulations, skill development and other helpful subjects.

Visit, or better yet, tell your colleagues who can benefit from the Beyond Production Agriculture BIB. It's in the business section of the OMAFRA website and specifically at <http://www.omafra.gov.on.ca/english/busdev/valueadd-bib/index.htm>.

EVENTS CALENDAR

1. Canadian Greenhouse Conference, Toronto, October 6 & 7, 2010.
2. Essex County Associated Growers Convention, Leamington, ON. November 23 & 24, 2010.
3. Greenhouse Vegetable Course. Greenhouse & Processing Crop Research Centre, Harrow ON. November 29–December 3, 2010.

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