associated with sublethal effects on development, foraging behavior, immune system functionality, learning and memory retention, longevity, orientation, overwintering survival, and reproduction. In addition, indirect effects may be affiliated with social interactions as a result of honey bees sharing a contaminated food source.

In general, early morning or late evening applications of pesticides pose less of a hazard because this is when most bees are less active. However, this depends on temperature, as bumble bees are active at lower temperatures (40°F) whereas honey bees are active when temperatures are >50°F.

Do not apply pesticides to flowering plants or weeds. Systemic insecticides, applied as either drenches or granules, to the soil or growing medium, are less harmful to bees than foliar applications. The pesticide formulation can influence bee toxicity. For example, emulsifiable concentrates (EC) and water-soluble (WS) formulations are typically less harmful to bees than wettable powder (WP) formulations.

It is important to note that some fungicides can enhance the toxicity of certain insecticides to honey bees when mixed together. This enhanced toxicity is referred to as synergism, which means that the combined toxicity is greater than the sum of the toxicity of each pesticide applied separately. The ergosterol or sterol biosynthesis inhibiting (EBI) class of fungicides have been shown to increase the toxicity of certain insecticides in various chemical classes, including: organophosphates, pyrethroids, and neonicotinoids to honey bees. For instance, the toxicity of pyrethroid insecticides to honey bees is enhanced over a thousand fold when mixed with ergosterol biosynthesis inhibitors. In addition, mixing some neonicotinoid insecticides with certain fungicides can enhance toxicity to honey bees as much as a thousandfold.

In addition to fungicides, insect growth regulators, which are insecticides that disrupt insect growth and development, and eventually lead to death, are known to be harmful to honey bees. The three categories of insect growth regulators — chitin synthesis inhibitors, juvenile hormone mimics, and ecdysone receptor antagonists/ agonists —have been reported to be directly and/or indirectly harmful to honey bees; especially the larvae (brood).

The Fungicide Table and Insecticide Table contains Bee Precaution information based on the toxicity of oral exposure to honey bees, honey bee brood, and other bees. It is important to read the pesticide label carefully to determine the potential level of toxicity to all bee types (honey bees, bumble bees, and native bees). Furthermore, you can incorporate into pollination contracts a list of pesticides, application methods, and timing of applications that are mutually agreeable to both growers/producers and beekeepers. These tables utilize the University of California IPM *Bee precaution pesticide ratings*; a systematic review of toxicity data for most crop management chemistries found at www2.ipm.ucanr.edu/beeprecaution.

State laws may require that applicators notify beekeepers 24 hours before applying a pesticide that is directly or indirectly harmful to honey bees when; 1) the treated crop is in flower (blooming), and 2) the field is greater than a half-acre and within a half-a-mile from a registered apiary. It is important to contact your state department of agriculture to determine if there are laws or regulations that protect other pollinators (bumble bees and native bees).

For more information on bees and pesticides, refer to the extension publication, *Pesticides and Bees* (Kansas State University Agricultural Experiment Station and Cooperative Extension Service. MF3428. Kansas State University; Manhattan, KS. 8 pgs, bookstore.ksre.ksu.edu).

Organic Vegetable Production

Reviewed by Liz Maynard – Aug 2021

Organic vegetable farming is a production system that relies on biological processes and natural materials to manage soil fertility and pest populations, and to promote healthy crop growth. The federal Organic Foods Production Act regulates the use of the term “organic” to describe an agricultural product in the marketplace. Vegetables sold as “organic” must be grown and handled according to the National Organic Rule and any applicable state regulations. The National Organic Rule prohibits the use of most synthetic chemicals (fertilizers, pesticides, etc.), and requires farmers to write and follow organic production plans, as well as keep farm and field records. Fields used to grow organic crops may not have had any prohibited material applied to them in the previous three years. In addition, USDA-accredited organic certification agents must inspect and certify all operations with more than $5,000 in gross annual sales of products labeled “organic.”

Growers interested in transitioning to organic production should educate themselves about practices used in their area and plan carefully. Experience suggests that it can take a number of years for pest populations and soil nutrient cycles to adjust enough for successful organic production.

This guide includes recommendations for some inputs that are permitted in organic production, but also for many that are not. The note ‘OMRI-listed’ indicates pesticides that have been listed by the Organic Materials Review Institute (OMRI) as approved for use in organic production in the U.S. Growers should always check with their organic certification agents before using any product to make sure it meets their certifier’s criteria.

Other organic production resources include:
eOrganic, the Organic Agriculture Community of the Extension Foundation eorganic.org

Organic Vegetable Gardening Techniques (University of Missouri Extension Guide G6220) provides an introduction

to organic production techniques (available from University of Missouri Extension Publications, extension.missouri.edu/publications).

Resource Guide for Organic Insect and Disease Management (Cornell University) provides specific recommendations for pests and diseases of major vegetable crops (available at web.pppmb.cals.cornell.edu/resourceguide).

Appropriate Technology for Rural Areas (ATTRA) offers a number of publications on their website: attra.org.

The National Organic Program (NOP) offers a program handbook that provides a list of materials allowed for use in organic production, plus a complete list of accredited certification agents on their website: ams.usda.gov/nop.

The Organic Materials Review Institute (OMRI) publishes a list of products they have found to meet certified organic production criteria. For details, visit omri.org.

The Sustainable Agriculture Research and Education (SARE) program offers a number of research-based publications about pest management, including organic options. A complete catalog is available at sare.org/

If you desire organic certification, you should contact a certification agent during the period of transition to organic production. The organizations listed below have been accredited by the USDA as of August 2021.

Contact them directly for information about fees and the certification procedure. The USDA lists all accredited organizations at ams.usda.gov/services/organic-certification/certifying-agents.

Consult your local Extension office for other resources available in your area.

Organic certifiers servicing the Midwest

Some states do not have a National Organic Program certification agency headquartered in state. However, multiple certifying agencies service the Midwest region with traveling inspectors. Many take clients on a case-by-case basis, depending on the availability of inspectors and other factors. Here is a list of certifiers that are utilized in the Midwest, with notes on their service range if it is limited.

CCOF Certification Services, LLC

2155 Delaware Ave., Ste. 150
Santa Cruz, CA 95060
Phone: (831) 423-2263
Fax: (831) 423-4528
Email: ccof@ccof.org
ccof.org

Ecocert USA

2498 Perry Crossing Way, Ste. 210
Plainfield, IN 46168
Phone: (888) 337-8246 (toll free)
Email: info.ecocertico@ecocert.com
ecocert.com

Global Organic Alliance, Inc.

P.O. Box 530
3185 Township Rd. 179
Bellefontaine, OH 43311
Phone: (937) 593-1232
Fax: (937) 593-9507
Email: goaorg@centurylink.net
goa-online.org

International Certification Services (ICS)

PO Box 517
301 5th Ave. S.E.
Medina, ND 58467
Phone: (701) 486-3578
Fax: (701) 486-3580
Email: info@ics-intl.com
ics-intl.com

Iowa Department of Agriculture and Land Stewardship Organic Certification

502 E. 9th St.
Des Moines, IA 50319
Phone: (515) 281-5783
Email: katie.hyde@iowaagriculture.gov
iowaagriculture.gov/agricultural-diversification-market-development-bureau/organic-certification-program

Midwest Organic Services Association, Inc.

P.O. Box 821
122 W. Jefferson St.
Viroqua, WI 54665
Phone: (608) 637-2526
Fax: (608) 492-0470
Email: mosa@mosaorganic.org
mosaorganic.org

Minnesota Crop Improvement Association

1900 Hendon Ave.
St. Paul, MN 55108
Phone: (612) 625-7766
Phone: (855) 213-4461 (toll free)
Fax: (612) 625-3748
Email: mncia@mncia.org
mciaorganic.org

Nature's International Certification Services (NICS)

224 E. State Highway 56
Viroqua, WI 54665
Phone: (608) 637-7080
Fax: (608) 637-7460
Email: nics@naturesinternational.com
naturesinternational.com

Oklahoma Department of Agriculture, Food and Forestry Organic Certification

2800 N. Lincoln Blvd.
Oklahoma City, OK 73152
Phone: (405) 522-5924
Email: jeff.stearns@ag.ok.gov
ag.ok.gov/divisions/food-safety

Oregon Tilth Certified Organic

PO Box 368
301 S.W. 4th St., Ste. 110
Corvallis, OR 97333
Phone: (503) 378-0690
Phone: (877) 378-0690 (toll free)
Email: organic@tilth.org
tilth.org

Organic Crop Improvement Association (OCIA)

1340 North Cotner Blvd.
Lincoln, NE 68505
Phone: (402) 477-2323
Fax: (402) 477-4325
Email: info@ocia.org
ocia.org

Ohio Ecological Food and Farm Association

41 Croswell Rd.
Columbus, OH 43214
Phone: (614) 262-2022
Email: organic@oeffa.org
oeffa.org

Pro-Cert Organic Systems, Ltd.

2311 Elm Tree Rd.
Cambray, ON K0M 1E0
Phone: (705) 374-5602
Fax: (705) 374-5604
Email: ifoebo@pro-cert.org
pro-cert.org

Quality Assurance International

4370 La Jolla Village Dr., Ste. 300
San Diego, CA 92122
Phone: (858) 791-3531
Email: info@qai-inc.com
qai-inc.com

Quality Certification Services (QCS)

5700 SW 34th St., Ste. 349
Gainesville, FL 32608
Phone: (352) 377-0133
Email: qcs@qcsinfo.org
qcsinfo.org

Produce Food Safety

Reviewed by Phil Tocco, Londa Nwadike, and Ben Phillips – Sept 2021

Produce food safety aims to reduce the risk of produce contamination by human pathogens or other contaminants during field production and postharvest handling. Good Agricultural Practices (GAPs) present a set of guidelines and practices that can prevent or reduce the risk of produce contamination by a foodborne pathogen, or other contaminant, in the field and during postharvest handling. To reduce the risk of contamination by a foodborne pathogen, vegetable growers should adopt GAPs, paying particular attention to water management, waste (manure), worker sanitation/hygiene, and wildlife. All growers should utilize Good Agricultural Practices, but only certain buyers require GAPs certification and paying for a third party audit.

Growers of a certain size who grow, harvest, pack or hold certain produce types must adopt particular GAPs to be in compliance with current Federal produce safety guidelines under the Food Safety Modernization Act Produce Safety Rule (FSMA PSR). The law codifies many GAP standards and follows the same general outline of hazards seen in GAPs. Rules regarding water used in the growing, harvest, packing and storage of fresh produce are under currently under review and will be enforced in the future. The Purdue Extension Publication, *Food Safety for Fruit and Vegetable Farms: Good Agricultural Practices for Fruit and Vegetable Farms*, gives an introduction to produce food safety, and is available at edustore.purdue.edu.

Water Management

Water can be a major source of contamination in crop production. It is important to make sure that water coming in contact with the crop is of adequate quality for its intended use. Growers should monitor the quality (presence of bacteria) of irrigation and process (postharvest) water through testing.