



Herbs: Organic Greenhouse Production

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IP164

This publication discusses various marketing channels for organic herbs and assesses the economic factors to consider for small-scale organic greenhouse production of fresh-cut herbs. It also addresses production methods, including potential for hydroponic production.

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Great Basil (*Ocimum basilicum*). Photo: wikimedia.org



A crop of mint. Photo: wikimedia.org

Introduction

Organic herbs are grown for a wide variety of different markets, including the medicinal, ornamental, and culinary markets (in either fresh-cut, ready-to-eat form or as live plants). This gives producers many exciting options and markets to choose from. This publication aims to help the small-scale producer make decisions about pursuing those markets, using the extended-season growing opportunities that greenhouses offer. This publication also looks at organic small-scale production of herbs grown within a greenhouse and discusses marketing outlets, economic considerations, production methods, and tips for insect-pest and disease control.

reliable statistics and information can be difficult, however, for a limited-resource landowner. Now, given the rise in large-scale domestic herb production and an increasing amount of cheap imports supplying supermarket chains across the country, the small-scale producer's market research should concentrate on visiting local restaurants, farmers markets, local breweries, and businesses. The good news could be that as one market opportunity closes, more opportunities can open up at the local level.

Wherever you research the Web, there is increasing awareness in the United States of the potential health benefits and superior taste of fresh, locally produced food, especially in sustainable or organic systems.

Marketing and Economics

Small Producers in a Big Market

Growers are usually advised to “research any niche market carefully” before investing in it. Finding

The Organic Trade Association's (OTA's) *2017 Organic Industry Survey* showed record-setting growth in the organic sector

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Related ATTRA Publications

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Direct Marketing

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Food Hubs: A Producer Guide

Integrated Pest Management for Greenhouse Crops

Herb Production in Organic Systems

Organic Standards for Crop Production: Excerpts of USDA's National Organic Program Regulations

Potting Mixes for Certified Organic Production

Season Extension Techniques for Market Gardeners

Solar Greenhouses Resource List

Sustainable Small-scale Nursery Production

continuing during 2016:

Organic sales in the U.S. totaled around \$47 billion in 2016, reflecting new sales of almost \$3.7 billion from the previous year. The \$43 billion in organic food sales marked the first time the American organic food market has broken through the \$40-billion mark. Organic food now accounts for more than five percent—5.3 percent to be exact—of total food sales in this country, another significant first for organic.

Organic food sales increased by 8.4 percent, or \$3.3 billion, from the previous year, blowing past the stagnant 0.6 percent growth rate in the overall food market. Sales of organic non-food products were up 8.8% in 2016, also handily surpassing the overall non-food growth rate of 0.8 percent. (OTA, 2017)

Translate this trend to local restaurants, farmers markets, community markets, school and institutional food-health-awareness programs, plus the explosion of micro-breweries across the country and, in theory, there has never been a better opportunity to sell fresh produce locally.

As of 2016, there were 5,300 breweries registered in the United States, with craft brewers and breweries in various forms representing 12.3% of the market share, producing 24.6 million barrels with an estimated retail dollar value of \$23.5 billion. Together with existing and established breweries and brewpubs, craft brewers provided an estimated 129,000 jobs in 2016 (Brewbound, 2017).

The National Restaurant Association (2017) states that there are currently more than 1 million restaurants in the United States, employing 14.7 million people, which is estimated to rise by a further 1.6 million by 2027. An increasing number of restaurants are serving ethnically diverse food, meaning that they acquire a more diverse range of raw ingredients from producers, and this offers another potential market for the organic herb producer. There are numerous websites that can help you find restaurants in any area of the country; one of the best general search sites is tripadvisor.com, with other sites available, such as organicrestaurants.com. Many states and communities also compile local food guides featuring restaurants that buy and serve local produce. One example of such a guide is Farm to Table Western PA (<https://farmtotablepa.com>), a website serving the Pittsburgh area. With the rise in healthy and local eating and awareness, any organic greenhouse-herb producer within

reasonable distance of a city or large town has a good chance of locating an organic retailer, restaurant, microbrewery, or similar outlet that will buy local, fresh produce.

Anyone considering raising herbs in a greenhouse for commercial sale should do a cost-benefit analysis first. It's not possible to raise every crop in every location at a reasonable return for the producer. Premium pricing can be critical to the viability of organic greenhouse operations. Organic production costs are often higher than those for conventional greenhouses, with pest control, weed control, soil-nutrient additives, and certified organic seed often being more expensive than their conventional counterparts. Higher labor costs need to be considered for organic production, too, such as weed removal by hand versus chemical herbicides. To achieve a satisfactory return on investment, organic growers must be prepared to develop innovative production and marketing strategies.

However, first and foremost, a successful grower must develop markets in which the price for organic produce adequately compensates for all production costs. Additionally, the marketing process must be compatible with the grower's personality and business skills.

When new producers have established their production costs and the minimum acceptable profit margin, they will need to spend time researching the area where they plan to market. For instance, take note of local supermarket prices for both conventional and organic herbs, the type of produce being sold generally, and, if labelled 'local,' the type of produce that is grown in the area. Similar useful information can be obtained by visiting local farmers markets, community markets, and producers selling direct to the public.

In addition, though perhaps of secondary importance, is research into national trends and prices through websites such as USDA Agricultural Marketing Service (AMS). AMS reports current wholesale prices for conventionally grown culinary herbs (on a weekly basis) from the main terminal produce markets across the United States, as well as from a select number of farmers markets across the country. In addition, this site offers price-comparison tables between local and national produce, as well as between selected organic produce and conventional produce. Unfortunately, compiling price comparisons between organic and conventional culinary herbs

requires cross-referencing information on this site with websites such as the Maine Organic Farmers and Gardeners Association Price Report (see Further Resources section), or one of the many suppliers of fresh certified-organic culinary herbs across the country.

Once you know your production costs and your business and marketing ability, marketing strategies could include promotional samples, price (and therefore profit) reduction if necessary to maintain sales, the ability to extend your growing season, and the space to grow specialty crops for specific retailers—to name a few examples. As mentioned previously, with many supermarkets expanding their organic and specialized food ranges with supplies from large-scale domestic and foreign producers—in addition to offerings via mail order and home delivery—the small-scale producer has to work hard and be creative to establish a niche market. This does not mean trying to compete with supermarket prices and availability (though local year-round production of herbs and produce would be a definite bonus), but emphasizing the local farm to table link. Locally grown food is likely to be the freshest and most nutritious. Find local health/organic food shops, local food stores, restaurants, micro-breweries, and markets that share this philosophy. Contracting with these buyers can still pose a challenge, as many retailers will only commit to buying from producers who can ensure regular, consistent supplies throughout the year (hence the bonus of greenhouse production improving a grower's ability to supply produce year-round).

A producer who wants to supply these markets, but cannot individually guarantee the supply or quantity of produce required, could join or create a local cooperative of producers who also wish to access these markets. The advantage of this is that a collective group of producers is more capable than one individual alone of producing the quantity, quality, and consistent supply demanded by some retailers. At the cost of losing some independence as a producer, and with less control of produce pricing, the advantages could include new markets, possible machinery- and equipment-sharing opportunities, and savings in bulk purchases of seed, fertilizer, and other variable costs. For more information on ways to cooperate with other producers, see the ATTRA publication *Food Hubs: A Producer Guide*.

Other key factors that could aid success include

growing a wide variety of herbs—to reduce the risk of individual crop failure—and developing a network of buyers, if possible, to avoid dependence on one or two purchasers. Other strategies include further diversifying product offerings (e.g., micro green production) or marketing value-added products such as ready-mixed salad packs.

Overview of the U.S. Market Today

There has been a continual expansion of the domestic greenhouse-herb industry in recent years. One such example has been the rise of Shenandoah Growers, which was founded in 1989 as a family-owned herb farm in Virginia and has since become one of the leading providers of fresh herbs, living herbs, and micro greens across the United States. In addition to Virginia, they now operate out of Michigan, Georgia, Arizona, Colorado, Washington, Texas, and Hawaii, and are certified organic, producing some 30 million plants per year at time of this writing. They are arguably now the largest supplier in the country, employing the hub-and-spoke system of centrally based production and reaching out in all directions to retail markets. An expansion of their West Coast operation is due for completion in 2018 (Shenandoah Growers, 2017). In addition to the above example, other companies have both a large domestic presence and a global presence in the herb marketplace.



Packaged organic herbs. Photo: Shenandoah Growers

Although demand for fresh herbs is growing steadily in the United States, much of this demand is being met by large-scale domestic producers and low-cost imports of fresh and dried herbs. In some markets, this limits the opportunity for greenhouse growers to compete, particularly in

areas with high population densities and low-cost distribution chains for imported produce.

As a current example, basil trading at terminal markets at the time of this writing has been imported from Colombia, Israel, and Mexico (USDA-AMS, 2018).

Herbs Suited to Organic Greenhouses

Which herbs are best suited to organic greenhouse production is really an open-ended marketing question, as most herbs will grow anywhere if you are prepared to factor artificial light and heating into your production costs. For the new producer, therefore, the best approach is to contact local restaurants, food stores, micro-breweries, and other businesses and ask which herbs they would be willing to buy, in what quantity, and for what price. In addition, explore the local community and farmers markets to see what herbs are being sold there, and which are not.

Many herbs can be grown either within a greenhouse or outside in the garden; however, the tender plants such as basil, cilantro, dill, parsley, and chamomile thrive more in a controlled environment. Look for other factors, too, such as herbs that don't require specialized lighting systems or a lot of light, such as cilantro, parsley, lemon balm, chives, ginger, and mint (Marquand, 2017).

In addition, research shows that even within rural areas of the country, the three traditional staples of U.S. ethnic cuisine—Italian, Chinese, and Mexican food—are accessible to a degree, with Japanese and Indian cuisine increasing in popularity too. This opens up potential new markets in many areas for herbs such as turmeric, cardamom, cumin, ginger, fenugreek, and saffron. There are many good reference points and growing guides for these herbs and others too, such as Kaffir lime, Shiso herb, Thai basil, black cumin, and marjoram (Grant, 2016). Finally, with some experience and success behind you, start to look at other types of markets and the herbs to supply them. There are many different categories of herbs: fresh culinary herbs, dried culinary herbs, herb plants, decorative and fragrant herbs, medicinal herbs, and herbs for essential oils and dyes.

With the rise of mail-order certified-organic seed producers across the country, supplies of certified-organic herb seeds should be relatively easy to obtain. However, if organic seed is not

available, conventionally produced, non-GMO, untreated seed may be used for an organic annual herb crop, according to section 205.204 of the National Organic Standards. Reading the whole document is advisable, but two points of note within the description are listed below:

4.1 Sourcing of Seeds, Annual Seedlings, and Planting Stock

4.1.2 Certified operations may use non-organic seed and planting stock only if equivalent organically produced varieties of organic seeds and planting stock are not commercially available.

- a. Commercial availability is defined at §205.2 and refers to the ability to obtain a production input, in this case seed or planting stock, in an appropriate form, quality, or quantity to fulfill an essential function in organic production. For the purposes of this exception, an "equivalent variety" is a variety of the same "type" (e.g., head lettuce types versus leaf lettuce types) or has similar agronomic or marketing characteristics needed to meet site specific requirements for an operation. These characteristics may include, but are not limited to: number of days until harvest; color, flavor, moisture, chemical, or nutrient profiles of the variety of the harvested crop; vigor or yield of harvested crop; regional adaptation, disease and pest resistance, or the plant's utility in a crop rotation.
- b. Price cannot be a consideration for determination of commercial availability.

It is important to note here that the definition of "not commercially available" is summarized by a lack of organic seed form, seed quality, or seed quantity, "to fulfill an essential function in organic production." As stated previously, given that most certified-organic seed is now obtainable by mail order at a price (see 4.1.2.b above), and that quality should not be an issue with certified-organic seed, the only factors likely to justify purchasing non-organic seed are seed form and seed quantity. This will still be subject to interpretation by the accredited certifier for a given operation.

For propagated perennial herbs, greenhouse herb producers often take cuttings from their own "mother plants." This gives producers that are already certified a decided advantage over start-up businesses because they can procure organic

There are many different categories of herbs: fresh culinary herbs, dried culinary herbs, herb plants, decorative and fragrant herbs, medicinal herbs, and herbs for essential oils and dyes.

starts at any time without a waiting period and at little cost. Growers seeking first-time organic certification or switching to a new certifier, as well as individuals planning to construct greenhouses for organic production, would do well to secure their perennial herbs early in the mandatory three-year transitional period. After certification of a greenhouse operation, any new perennial stock must come from a certified-organic source or be raised for at least one year under an approved organic management system before products derived from these plants can legally be sold as organic. This applies to foundation stock for potted-plant production, as well as perennials for fresh-cut herb production.

Production Methods

Greenhouse production methods for herbs are similar to those for greenhouse-grown vegetables. There are some practices, however, that are specific to herb production. Fertility and irrigation, for example, must be managed somewhat differently. Too much water or fertilizer may result in poor establishment of slow-growing seedlings or semi-woody cuttings. This can also lead to excessive growth rates (especially basil, chives, and dill), or lower essential-oil content, resulting in diminished aroma or culinary value. Greenhouse temperatures for herbs are about the same as for bedding plants: day temperatures of 70 to

75°F and a night temperature of 60°F. In addition, low light and overcrowding will cause plants to ‘stretch’ for the light, reducing culinary quality and oil content. It is important to provide maximum light in late winter and early spring in greenhouse herb production.

Although it can be done, few producers raise herbs in soil inside greenhouses. More often, herbs are raised in a soilless medium (i.e., a potting mix) within pots or as plugs for transplanting. To be certified organic, greenhouse-grown herbs must be raised in a certified-organic potting mix. Commercial potting mixes typically contain wetting agents and synthetic fertilizers that are not allowable in organic production, requiring organic growers to either mix their own or purchase a certified-organic mix. Most organic potting mixes are based on good-quality compost amended with peat moss and perlite or vermiculite and supplemented with organic fertilizers like bone meal, feather meal, and kelp. Such a mix would be suitable for herb production, with one variation. Because most herbs are native to regions having neutral or slightly alkaline soils, the optimum pH for herbs is 6.0 – 7.0. Most soilless mixes have a pH somewhere between 5.0 and 6.0, so they have to be amended with lime before use. The ATTRA publication *Potting Mixes for Certified Organic Production* provides more information.

In addition to the ATTRA publication *Herb Production in Organic Systems*, other points of reference include these publications (more information is available in the Further Resources section):

The New Organic Grower by Eliot Coleman (1989), which has a chapter on “winter gardening” that provides information for USDA Hardiness Zones 3 to 6 on technologies helpful in modifying a home-garden system for commercial production. *The Winter Harvest Handbook* (2009), also by Eliot Coleman, and *The Year-Round Vegetable Gardener* by Niki Jabbour (2011) provide easy-to-follow seasonal guides, useful tables including daylight hours at different latitudes, construction projects, and good planting guides.



Herbs, flowers, and microgreens. Photo: NCAT



Trays of basil, sunflowers, and peas. Photo: NCAT

Table 1: Herb Production Guide. *Data compiled by NCAT from various sources.*

Herb	Propagation Method	Start seeds Indoors before last frost	Minimum soil temperature for germination	Seed spacing	Harvest	Uses	Type
Basil	Seeds, Transplants	6-8 weeks	70°F	10"-12"	Pick leaves when 6"-8" tall	Culinary	Annual
Borage	Seeds, Division, Cuttings	Not recommended	70°F	15"	Leaves and flowers	Culinary	Annual Biennial
Chervil	Seeds	Not recommended	55°F	3"-4"	Pick up to 66% of leaves	Culinary	Annual Biennial
Chives	Seeds, Division	8-10 weeks	60°F-70°F	4"-6"	Pick leaves down to base	Culinary	Perennial
Cilantro Coriander	Seeds	Not recommended	60°F	1"-2"	Leaves before stalk grows	Culinary	Annual
Dill	Seeds	Not recommended	60°F-70°F	12"-18"	4-5 leaves or more	Culinary	Annual
Fennel	Seeds	4-6 weeks	60°F-70°F	9"-12"	Young leaves and seeds	Culinary	Annual
English Lavender	Seeds, Cuttings	8-12 weeks	70°F-75°F	24"-36"	The buds before flowers open	Ornamental Medicinal	Perennial
French Lavender	Transplants	Not recommended	n/a	15"-18"	Flower stalks	Ornamental Medicinal	
Lemon Balm	Seeds, Division, Cuttings	6-10 weeks	70°F	18"	Leaves-cutting stems 6" from top	Culinary Ornamental	Perennial
Lovage	Seeds, Division	6-8 weeks	70°F	24"	Stalks and leaves	Culinary	Perennial
Oregano	Seeds, Division, Cuttings	6-10 weeks	70°F	8'-10"	Leaves as needed	Culinary	Tender Perennial
Parsley	Seeds	10-12 weeks	70°F	6"-8"	When stem has 3 segments	Culinary	Biennial
Rosemary	Seeds, Division, Cuttings	8-10 weeks	70°F	36"-48"	Young stems and leaves	Culinary	Tender Perennial
Sage	Seeds, Division, Cuttings	6-10 weeks	60°F-70°F	24"-30"	Lightly harvest leaves in first year	Culinary Ornamental	Perennial
Sorrel	Seeds, Division	6-10 weeks	60F-70F		Tender leaves	Culinary Medicinal	Perennial
Spearmint	Division, Cuttings	Not recommended	n/a	12"-24"	Harvest leaves to flowering	Culinary Medicinal Ornamental	Perennial
French Tarragon	Cuttings, Transplants	Not recommended	n/a	24"-36"	Harvest leaves regularly	Culinary Medicinal	Perennial
Thyme	Seeds, Division, Cuttings	6-10 weeks	70°F	8"-9"	Leaves and sprigs through summer	Culinary	Perennial

Hydroponic Production

Hydroponics is the production of plants in a soil-less medium, in which all of the nutrients supplied to the crop are dissolved in water. Such systems are commonly used in the production of greenhouse herbs. Hydroponic systems come in many different forms, but can be categorized into six main types (see Table 2). Some of these systems can be adapted to aquaponics too, as illustrated in Figure 1.



Basil in a hydroponics system using baskets and clay pellets to stabilize the root system. Photos: NCAT

Most conventional hydroponic systems are highly specialized, controlled-environment production systems, and both organic and conventional systems work on the same principles of supplying nutrients in solution to grow out plants. The principal difference between the two is that the conventional systems provide chemical compounds for nutrient supply and the maintenance of soil pH levels, while in the organic system, compounds are derived from organic fertilizers that will dissolve in water, such as fish meal, dried

Table 2: Principal Types of Hydroponics Systems

Source: Nosoilssolution.com

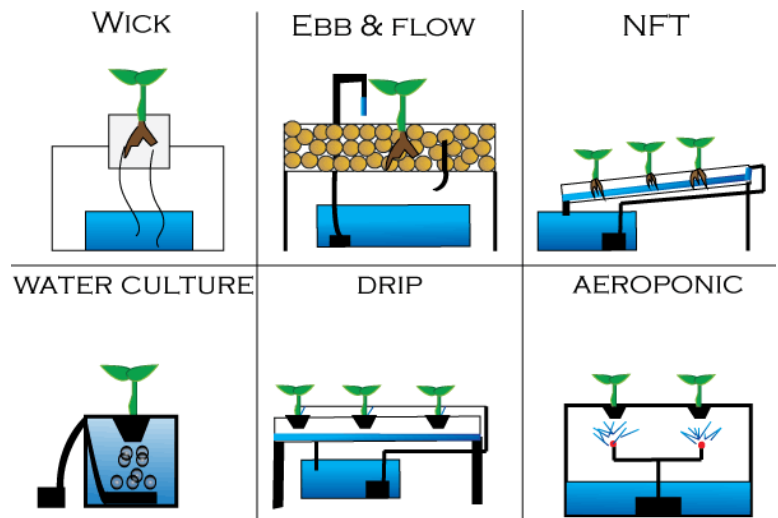
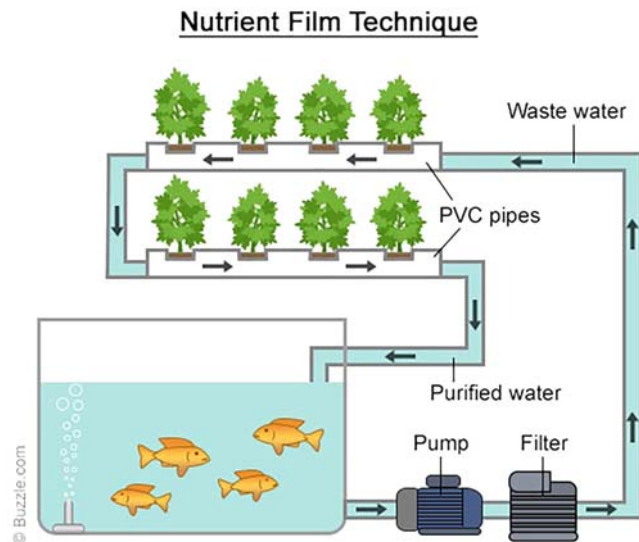
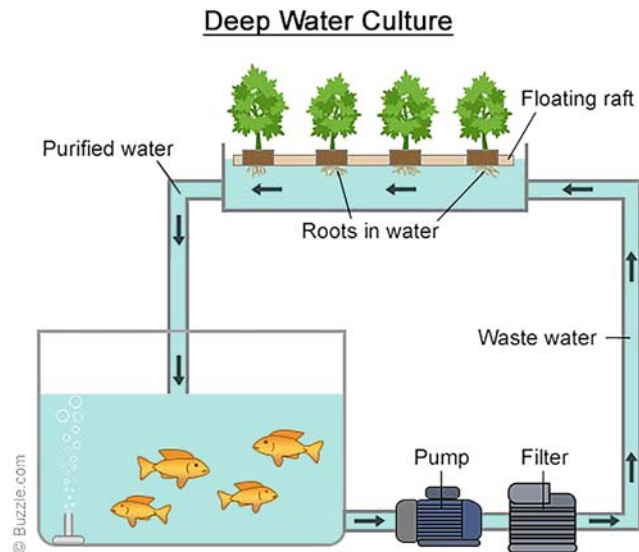


Figure 1: Hydroponic Production Adaptations to Aquaponic Systems

Source: Buzzle.com



blood, and guano. The micro-organisms within them help regulate both the soil pH and the availability of nutrients. Hydroponics *in a very controlled environment* has the advantages of minimal water use, more-controlled plant production, and a more uniform produce, helping the producer to guarantee regular supplies of standard produce to vendors and markets. For the smaller producer, the greater income potential of a hydroponics system that is less automated, and has limited climate control, over organic greenhouse production of herbs in potting mixes, pots, or in soil beds is more questionable. There could be substantial capital investment in a fully automated, climate-controlled hydroponics system, which may only make sense economically above a certain scale of production.

Cultural control within an IPM program starts with keeping work areas clean, tidy, and uncluttered whenever possible.

In November 2017, the National Organic Standards Board (NOSB) narrowly passed a vote recommending that the USDA's National Organic Program certify hydroponic systems that meet organic standards. Some major producers had received certification ahead of this decision, but the majority of growers producing herbs in hydroponic systems up to this point have been producing conventional herbs with synthetic nutrients, or producing herbs grown to organic standards using approved natural nutrients. The NOSB decision could significantly change the organic greenhouse-herb production market in the near future.

Integrated Pest Management

Insects and diseases are a major challenge to greenhouse production. Integrated Pest Management (IPM) is an important tool in the management of these pests. The primary goal of IPM is to optimize pest control in an economically and ecologically sound way. IPM involves the integration of cultural, physical, biological, and chemical practices to grow crops with minimal use of pesticides. Monitoring, sampling, and recordkeeping are used to determine when controls are needed to keep pests below an economically damaging threshold. One of the principles of IPM is to provide a continuum of options for pest control, starting with cultural controls, physical controls, biological controls and, as a last resort, chemical controls (within the chemical group approved for organic production). Get to know the specific pests likely to be encountered in your area that are relevant to the herbs you plan to grow.

Cultural Control

Cultural control within an IPM program starts with keeping work areas clean, tidy, and uncluttered whenever possible. This helps prevent insect pests from establishing permanent colonies within the production area and overwhelming any control measures once plant production resumes. Remove irrigation lines if not needed over winter, maintain clean walkways, and weed non-cropped areas, both in and around buildings. If producing crops over winter, keep stored equipment clean, and clear unused beds of vegetation—either removing it or incorporating it into the soil as green manure. Insects such as spider mites and thrips tend not to move much during the winter, and therefore removal of vegetation that could protect populations in cold weather will help to control them. Similarly, a greenhouse that can be left empty and clean for a week between crops in the summer, and sealed to create hot dry conditions, can help to control mite infestations. Ventilation mesh screens need to be kept clean at all times, too (see below).

Physical Control

Physical control methods are employed to prevent pests gaining access to the plants, or the building itself, where possible. This is challenging, as summer production aligns with both peak insect activity and the need to maximize airflow through greenhouses to prevent excessive heat buildup. High tunnels and temporary structures are usually equipped with roll-up sides to ventilate them, which limits the effectiveness of pest control, though an increasing number of high tunnels are being fitted with extractor fans, screens, and roof vents more commonly found in greenhouses, to provide controlled airflow while keeping the building sealed.

Screening can greatly reduce the entrance of common greenhouse pests such as thrips, aphids and whiteflies, as well as some less-common pests, such as plant bugs and various moth pests, that can become major pest problems when pesticide use is reduced or not an option. Screens provide airflow through a greenhouse, either as a supplement to extractor fans, or as a stand-alone system. There are concerns as to whether screens can provide sufficient airflow, particularly when using fine-mesh screens to exclude smaller insects such as thrips. Therefore, growers will need to

compromise by using a mesh size that will provide both reasonable airflow and some control of airborne pests, as part of an IPM plan.

Physical control of pests within IPM programs also includes various forms of trapping, and there are many products on the market that are approved for certified organic production, such as pheromone traps for moths and roaches, blue sticky paper traps for thrips and leaf miners, and yellow sticky-paper traps for aphids and whiteflies, as well as general purpose traps for insects. There are many options for humane trapping of mice, voles, rabbits, and other vertebrate pests, too.

These traps also serve to identify the type of pest you have and the estimated level of infestation, which is an important part of the biological control program described below. They can also aid in deciding which predator insects need to be released to eradicate the pest problem.

Biological Control

Biological control of pests within an IPM program involves the introduction of predatory organisms—usually insects—that will prey on specific pests. However, predatory organisms can also include arthropods and microbial control agents such as the examples listed below. A cornerstone of this method of control is pest monitoring and identification, as described in the physical control section above, with insect trapping being a means of both eradication and identification for the biocontrol measures described here.

Here are some examples of different classes of biocontrol organisms and modes of action:

- Arthropods, which include spiders, mites, scorpions, and woodlice, for instance, as well as all insects
- Flies, such as predatory midges, hunter flies, and hover flies
- Beetles, such as ladybugs and ground beetles, which control aphids, mites, cutworms, slugs, and cabbage flies
- Predatory mites, midges, lacewings, and beetles, which feed on prey including thrips, whiteflies, spider mites, aphids, and fungus gnats, but otherwise live independently from their prey
- Parasitoids, such as microscopic parasitic wasps, which control stink bugs, caterpillars, and aphids by laying their eggs in the host insect

- Microbial biological control agents such as nematodes, fungi, bacteria, and viruses that kill pest insects by entering the body and releasing bacteria, or by infection, as in the case of pathogenic fungi. Many of these naturally occurring fungi and bacteria are the basis of pest-control products and have to be registered in many countries in the same way as pesticides.

Another tip to aid biological control, is to add flowers to areas of herb production within greenhouses. Doing this provides a habitat for predatory insects and prevents them from migrating out of the greenhouse after the initial pest infestation has been eradicated. This prevents the expense of having to buy a second set of predators to release if the pest infestation reoccurs. It can also help add biodiversity to the area and balance the ecosystem, attracting other natural predators, such as spiders, and pollinating insects, such as bees.



Braconid wasp. Photo: Scott Bauer, insectimages.org



Seven Spotted Lady Beetle. Photo: David Cappaert, insectimages.org

Chemical Control

As mentioned previously, the last-resort control method within an IPM program is chemical control using pesticides allowable by the National Organic Standards. One reason this is the final option is the extra care needed in selecting products that are specific enough to avoid harming beneficial insects—particularly if you have invested in biocontrol predators as part of your IPM program.

Look for products with the Organic Materials Review Institute (OMRI) seal, which is the sign a material has passed this organization's technical review and is compliant with current organic certification. Remember that any pesticide product used in organic production must be listed in your operation's Organic Systems Plan, even if the product is OMRI-listed.



This seal appears on products that have been found by the Organic Materials Review Institute to comply with the regulations for organic production. Graphic: OMRI

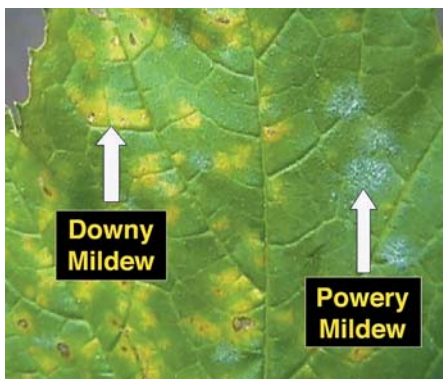
A good website for viewing the current range of commercially available organic materials is planetnatural.com/product-category/organic-gardening. It offers a comprehensive list of OMRI-listed fertilizer, soil amendments, and pest-, weed-, and disease-control products. In addition,

this website and others host Q&A threads, as well as many supported articles and videos on current topics and issues related to IPM. Other sites to reference include the ATTRA Ecological Pest Management Database, at attra.ncat.org/attra-pub/biorationals/, and OMRI.

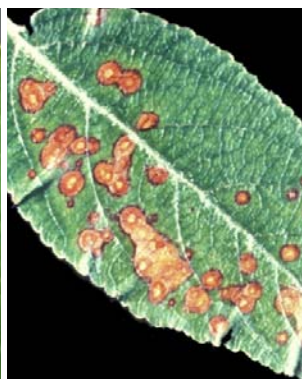
Diseases

The most common diseases in greenhouse herb production are fungal diseases, including botrytis, damping-off, powdery mildew, and root rots. Vascular wilts are also common in herbs. These diseases can cause tremendous plant loss in just a few days if conditions are favorable and no control is in place. Open beds, raised beds, and temporary structures such as hoop houses can prevent disease buildup from year to year due to weather exposure, whereas greenhouses—with poor air circulation, dense plant canopies, plant crowding, and high humidity—can increase the incidence of disease. Preventing disease buildup in greenhouses is very similar to the cultural control part of the IPM plan mentioned earlier to control pests: i.e., remove diseased plants, keep walkways and exterior areas weed-free, keep equipment clean, and maintain good air circulation through the structure. In addition to these basics, there are additional practices that may help:

- Use irrigation techniques that minimize leaf wetness. Avoid late afternoon and nighttime irrigation.
- For herbs grown in ground beds, rotate plant families.
- Use only clean stock for propagation.
- Control insects that vector disease.



Powdery mildew. Photo: David. B. Langston, insectimages.org



Botryosphaeria canker, white rot. Photo: University of Georgia, insectimages.org



Green Peach Aphid. Photo: Scott Bauer, insectimages.org



Spider Mites. Photo: Charles Olsen, insectimages.org

Table 3: Some Key Pests and Diseases of Potted Herbs Grown in the Greenhouse

Source: Pundt and Smith, 2010.

Plant	Pest(s)
Basil	Primarily thrips, also aphids, whiteflies, Botrytis blight, downy mildew, fusarium wilt, Impatiens Necrotic Spot Virus, Pseudomonas Leaf Spot, Pythium and Rhizoctonia root rots, Rhizoctonia web blight
Lavender	Aphids, leafhoppers, mealybugs, spider mites, whiteflies; Primarily Phytophthora crown and root rots, also Rhizoctonia crown and root rots, Pythium crown and root rot, Botrytis blight, leaf spot diseases
Lemon Balm	Primarily spider mites, also aphids, leafhoppers, thrips, Botrytis blight, powdery mildew
Lemon Grass	Spider mites, thrips, rust
Lemon Verbena	Aphids, spider mites, and whiteflies
Marjoram	Whiteflies, Botrytis blight
Mint	Primarily whiteflies, spider mites, also aphids, leafhoppers, thrips, crown and root rots, powdery mildew, Rhizoctonia web blight, rust (peppermint and spearmint)
Parsley	Aphids, thrips, primarily root rots, also Botrytis blight, damping off, Rhizoctonia web blight
Rosemary	Aphids, leafhoppers, thrips, whiteflies, Primarily powdery mildew, also bacterial leaf spots, crown and root rots caused by Phytophthora, Pythium and Rhizoctonia, Rhizoctonia web blight
Rue	Aphids, whiteflies, crown and root rots
Sage	Primarily whiteflies, also aphids, leafhoppers, spider mites; Primarily powdery mildew, also Phytophthora crown and root rot
Scented Geranium	Aphids, whiteflies, bacterial blight (<i>Xanthomonas</i>), bacterial fasciation
St. Johnswort	Anthracnose, powdery mildew, rust
Tarragon	Thrips, powdery mildew, rust
Thyme	Aphids, thrips, Botrytis blight, crown and root rots, Rhizoctonia web blight

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Further Resources

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