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Success with Container Production of Twelve Herb Species

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Interest in growing herbs for the retail and wholesale market has increased greatly over the past few years. Growers who have had success in the production of bedding plants have found another profitable avenue in herb production. Herbs have cultural requirements similar to bedding plants and it should be easy for greenhouse growers to add herbs to their production schedule. The majority of herbs discussed in this article can be sown, transplanted, and finished by the grower. This publication will focus on the production of the "top twelve" herbs and provides general guidelines for seed propagation. Certain species like peppermint or oregano can be propagated vegetatively and would require growing stock plants.

Herb Species

Growing an assortment of herbs for the wholesale or retail market will increase the diversity of the grower's production list. Herbs can be classified into three groups: annual herbs, perennial herbs, and perennial shrub-type herbs (Table 1). Classifying herbs by when they are marketable in a 4-inch pot is an ideal manner in which to strategize their space requirements, fertility requirements, and marketing or shipping times. Table 1 contains summary information on production time, germination, growing temperatures, and fertility.

Advantages of Herb Production:

- *Seed is inexpensive.*
- *Germination specifications are similar to bedding plant crops.*
- *A range of substrates with varying physical properties can be used.*
- *Herbs have minimal insect and disease problems.*
- *Herbs do not require high temperatures to grow.*
- *The turnaround time is quick.*
- *The dollar value is higher with herbs as compared to bedding plants, because consumers view them as culinary plants.*

The two herb species which are the most difficult to produce are lavender and rosemary. Lavender seed requires extensive care during germination. Because the length of time required for germination is greater than other herb crops, lavender may be frustrating to establish in plug trays. Purchasing plugs may be the best option for growers. The

same can be said for rosemary, as seed propagation of rosemary is not suggested because of the possibility of infection by seed borne pathogens. Many herb growers grow rosemary stock plants and achieve good success with rooted cuttings. Besides lavender and rosemary, all other herb species discussed in this article have similar cultural requirements.

Seeding and Containers

Germination takes from 4 to 14 days at 70-75°F (Table 1). Seeds should be sown in a plug cell size, which will enable the plant to be transplantable within two to three weeks after sowing. The plugs should not become root bound in the plug tray before transplanting, as restriction of the roots may result in stunting and stalling of the crop. Recommended tray sizes, for the attainment of a well-defined root ball, range from a 72 to a 512-cell tray. The larger cell will require additional production time to reach the transplant stage, but a larger herb plug is easier to establish in the final container. Cover the trays at night with plastic sheeting to increase the germination rate, while preventing mice and other pests from disrupting the germination process. Most herb seeds are small and are multiple sown, therefore care should be taken when extracting seedlings from the plug tray to avoid root damage. Disturbing the root system will delay the crop's establishment in the final flat.

The most common flat used for finishing the crop is an 1801, but some growers also use flats which contain 12 to 24 cells. Deep celled pots are suggested for herb crops because of their ability to support a larger root mass and their high water holding capacity.

Root Substrate (Medium)

Herbs are fast growing herbaceous plants, especially when grown in a good quality soilless substrate. An ideal mix for herbs should allow for rapid root development, while maintaining good water holding capacity. Mixes that stay too moist may cause shoot growth to become weak and chlorotic due to the lack of oxygen in the substrate. The chances for root rots to occur are greater in substrates that are saturated repeatedly.

Irrigation

Careful irrigation is important in the establishment of herb seedlings. Using a misting nozzle until the first true leaves appear is recommended. Growers need to be extremely careful in controlling the amount of water pressure used to avoid washing out the seedlings. The operation's best waterer should do the initial irrigation of herbs in the finishing flats. Preventing plugs from being covered by substrate during the early stages of plug establishment is crucial for the overall uniformity and health of the crop. The difference in the plug size makes the task more challenging when the root ball is small and shoot growth is leggy. Sometimes making a series of quick and uniform applications of water is best for the initial irrigation. Once the root systems have fully developed in the finishing flat growers need to pay closer attention to the chances of substrate drying and subsequent wilting of the plants. Most herbs are very forgiving of occasional water stress, but repeated water stress can lead to lower leaf loss and a poor quality crop. Irrigation should be conducted in the mornings to allow the foliage to dry during the day to avoid the occurrence of *Botrytis* or root rot.

Nutrition

Once the cotyledons protrude from the germination substrate, the first fertilization to the plug tray can be made. For the seedling stage, fertilize at a rate of 50 to 75 ppm of N with a constant liquid feed. Rotating weekly between a 15-0-15 and 20-10-20 is recommended for the majority of herbs at N rates between 150 and 200 ppm (constant liquid feed). A clear watering instead of a fertilization is recommended for all herbs if the substrateis severely dry. By rotating these two soluble fertilizers, growers can provide calcium and low phosphorus amounts with the

Table 1. Cultural requirements of the twelve most popular herbs.

Crop	Sowing to transplant (wks)	Transplant to finish (wks)	Total crop time (wks)	Seeds per ounce[1]	Number of seeds per cell (cell size)	Germination information	Growing temperatures.[1]	Fertility requirements (20-10-20 or 15-0-15)
Annual Type Herbs								
BASIL	2 to 3	2 to 3	4 to 6	16,000	2 per cell (72 to 512)	Covered 70F- 5 days	62 to 65F	125 to 150 ppm N
CILANTRO	2 to 3	2 to 3	4 to 6	3,000	4 per cell (72 to 125) 2 per cell (288 to 512)	Covered 70F- 7 days	55 to 58F	125 to 150 ppm N
Perennial Type Herbs								
CHIVES	3 to 4	3 to 4	6 to 8	33,000	14 per cell (72 to 125) 7 per cell (288 to 512)	Covered 70F- 10 days 75 to 80F- 4 days	60F	150 to 200 ppm N
MINT	3 to 4	4 to 5	7 to 9	472,000	12 per cell (72 to 125) 6 per cell (288 to 512)	Cover lightly 75 to 80F- 8 to 10 days	55 to 58F	150 to 200 ppm N
OREGANO	3 to 4	4 to 5	7 to 9	245,000	10 per cell (72 to 125) 5 per cell (288 to 512)	Lightly covered 70F- 10 days 75 to 80F- 5 days	55 to 58F	125 ppm N
PARSLEY	3 to 4	4 to 5	7 to 9	18,000	4 per cell (72 to 125) 2 per cell (288 to 512)	Covered 70F- 14 days 75 to 80F- 8 to 10 days	60F	125 to 200 ppm N
SAGE	3 to 4	3 to 4	6 to 8	3,000	2 per cell (72 to 512)	Covered 70F- 10 days	60 to 62F	200 ppm N
SWEET MARJORAM	3 to 4	3 to 4	6 to 8	160,000	8 per cell (72 to 125) 2 per cell (288 to 512)	Covered 70F- 8 days 75 to 80F- 4 days	55 to 58F	125 ppm N
TARRAGON	3 to 4	4 to 5	7 to 9	Purchase rooted cuttings	3 plants per finished pot	Purchase rooted cuttings	60 to 65F	125 to 150 ppm N
THYME	3 to 4	3 to 4	6 to 8	124,000	8 per cell (72 to 125) 4 per cell (288 to 512)	Lightly covered 70F- 6 days 75 to 80F- 4 days	55 to 58F	125 ppm N
Shrub Type Perennial Herbs								
LAVENDER		10 to 12 wks from plugs			1 plant per finished pot (288 to 512)	Purchase plugs	60 to 65F	150 to 200 ppm N
ROSEMARY		10 to 12 wks from plugs			2 plants per finished pot (288 to 512)	Purchase plugs or rooted cuttings	65 to 70F	150 to 200 ppm N

[1] Adapted from Nau, J. 1993. The encyclopedia of seed germination. Ball Publishing, Batavia, Illinois. pp.143.

"Dark Weather Feed" (15-0-15) and adequate micronutrients and ammoniacal-nitrogen with the 20-10-20. High levels of NH_4-N (> 40% of total N) and/ or urea in a fertilizer mix should be avoided to prevent excessive stem elongation. Herbs will become soft and leggy with excessive fertilizer. To supply Mg, monthly applications of epsom salts ($MgSO_4 \cdot 4H_20$) should be made at the rate of 1 to 2 lbs. per 100 gallons of water. The root substrate pH and electrical conductivity (EC) should be monitored on a weekly basis because of the potential of salt accumulation and/ or the development of high or low pH values. An ideal pH range for herbs should be between 5.8 and 6.2 and EC levels should be maintained between 0.38 to 1.0 mS/cm for the 2:1 extraction method, 0.76 to 2.0 mS/cm for the saturated paste extraction method, or 1.0 to 2.6 mS/cm for the PourThru extraction method. (*See HIL #590, Monitoring and Managing pH and EC Using the PourThru Extraction Method for additional information.*)

Temperature

Producing herbs in a cold frame-type structure or cool greenhouse provides an ideal environment for growing compact plants. Night temperatures for most herbs should be held between 55 to 60° F, with warmer temperatures of 65 to 70° F being required for basil and rosemary. Avoid day temperatures above 85° F.

Scheduling

Scheduling herb crops can be challenging because of the variation in finishing times. With the use of a computer spreadsheet, one can establish a spring production schedule for herbs. Annual herbs like basil should be sown a week later than the perennial type herbs, and purchased rosemary and lavender plugs must be planted one or two weeks before the sowing of annual herb seeds. The most important thing to follow when growing herbs is to stay on schedule. When crops are becoming disproportionately large relative to the pot, one should separate the trays by a space of about an inch to allow for improved airflow which will help prevent stretch and outbreaks of *Botrytis*. Table 1 contains the timing information needed for setting up a schedule for springtime sales.

Major Insect/Mite Pests of Herbs

Insecticides and miticides that can be used to manage herb pests are listed in Table 2. Specific information about the most common insects and mites are discussed below.

Aphids

Aphids are soft-bodied insects with piercing-sucking mouthparts, which they use to remove plant fluids. They can cause leaf distortion, plant stunting and wilting. Aphids are also able to transmit viruses. In addition, aphids produce a clear, sticky liquid called honeydew, which is an excellent growing medium for black sooty mold fungi. Aphids tend to congregate on vegetative terminals and on leaf undersides. The two most common aphid species are green peach aphid (*Myzus persicae*) and melon/cotton aphid (*Aphis gossypii*). Aphids don't need to mate to reproduce (parthenogenesis). Females can give birth to approximately 100 to 200 live young. These live young, which are pregnant females, can then give birth to their own offspring in 7 to 10 days. Most aphids found in greenhouses are non-winged; winged aphids develop when populations are high and/or when plant nutritional quality declines. Aphids attack a wide-variety of herbs including watercress, arugula, nasturtium, oregano, dill, basil, mint, and tarragon.

Whiteflies

Whiteflies are soft-bodied insects that attack rosemary, marjoram, mint, basil, oregano, sage, thyme, and lavender. The young (immature) stages use their piercing-sucking mouthparts to extract plant fluids. Whiteflies can cause plant stunting and wilting, and leaf distortion. Similar to aphids, whiteflies also produce honeydew. The most common whitefly species are the

Table 2. Insecticides and miticides for use on herbs.			
Common Name	**Trade Name**	**REI (Hours)[1]**	**Target Pests**
Azadirachtin	Azatin	4	Aphids, Caterpillars, Fungus Gnats, Whiteflies, Thrips, Beetles
	Ornazin	12	Aphids, Caterpillars, Thrips, Fungus Gnats, Whiteflies, Beetles
Bacillus thuringiensis var. *kurstaki*	Dipel	4	Caterpillars
Bacillus thuringiensis var. *israelensis*	Gnatrol	4	Fungus Gnats
Beauveria bassiana	Botanigard	4 (WP)[2] 12 (EC)[3]	Aphids, Thrips, Whiteflies, Mealybugs
Cinnamaldehyde	Cinnamite	4	Aphids, Mites
Horticultural oil	SunSpray Ultra Fine Spray Oil	4	Aphids, Mites, Thrips, Whiteflies, Beetles
Insecticidal soap	Insecticidal Soap	12	Aphids, Mites, Thrips, Whiteflies, Mealybugs
	M-Pede	4	Aphids, Mites, Thrips, Whiteflies, Mealybugs
Steinernema feltiae	Nemasys	--	Fungus Gnats
Pyrethrin	1100 Pyrethrum TR	12	Aphids, Caterpillars, Fungus Gnats, Beetles, Mealybugs, Mites, Thrips, Whiteflies

[1] REI=Restricted Entry Interval: [2] WP=Wettable Powder formulation: [3] EC=Emulsifiable Concentrate formulation

greenhouse whitefly (*Trialeurodes vaporariorum*) and the silverleaf whitefly (*Bemisia argentifolii*). Adult females lay eggs on leaf undersides. Eggs hatch into crawlers, which move around on plants, before settling down to feed. Larvae enter a pupae stage, in which adults eventually emerge. The life cycle from egg to adult is temperature dependent, normally taking 2 to 3 weeks. Immature stage of whiteflies are generally located on leaf undersides.

Spider Mites

Spider mites, which are not insects, use their stylet-like mouthparts to remove the green portion of plants (chlorophyll) resulting in the characteristic symptom known as "stippling." They generally feed on the underside of leaves. Spider mites thrive under warm, dry conditions. The two-spotted spider mite (*Tetranychus urticae*) is the common mite pest of herbs. To correctly identify two-spotted spider mite look for the two black spots on the sides of the body. Female spider mites don't need to mate to produce offspring. As a result, populations can build-up very rapidly. The life cycle from egg to adult can be completed in 7 to 10 days at 85°F. All stages (egg, nymphs, and adult) are normally located on leaf undersides. Although spider mites cannot fly, they can easily spread when herb foliage is touching (leaf-to-leaf contact). Herbs that are susceptible to spider mites are mint, oregano, tarragon, hyssop, thyme, and lemon balm.

Thrips

Thrips are small (1/8 inch long) insects that damage plants by removing plant fluids with their piercing-sucking mouthparts. Thrips feeding can cause leaf distortion, necrotic-spotting, and plant stunting. In addition, thrips can transmit viruses. Several thrips species may attack herbs in greenhouses; however, western flower thrips (*Frankliniella occidentalis*) is the most common species. Female thrips lay eggs into plant tissue (leaves). Eggs hatch into wingless larvae that

feed on plant foliage. Thrips then undergo a pupae stage, which generally occurs in the growing substrate. Later, winged adults emerge from the pupae. The life cycle from egg to adult generally takes 2 to 3 weeks; however, at 85°F the life cycle can be completed in 7 to 10 days. Thrips populations can build-up rapidly during the spring and summer months. Adult thrips are highly attracted to yellow and blue flowers. Thrips can be easily distributed throughout a greenhouse on air currents from open doors or horizontal air flow (HAF) fans. Thrips may attack a variety of herbs including mint, oregano, and sage.

Fungus Gnats

Fungus gnats (*Bradysia* spp.) are insects, which resemble mosquitoes as adults. Large populations of adults flying around impair a plant's appearance. Larva located in the growing substrate feed on roots, which can lead to plant stunting, wilting, and even death. Both adults and larvae are capable of disseminating and transmitting plant diseases. Moist conditions may lead to increased fungus gnat problems, especially during propagation and before herbs develop well-established root systems. Fungus gnats also breed in algae. Females lay eggs into the cracks and crevices of growing substrate. Eggs hatch into larvae, which are approximately 1/4 inch long with a black head capsule. Larvae undergo a pupae stage from which adults eventually emerge. The life cycle takes 21 to 28 days, depending on temperature. Since adults don't fly very well, they are generally found near the growing substrate beneath the crop canopy. Many herbs are susceptible to fungus gnats under moist conditions.

Caterpillars

Caterpillars are the young (immature) stage of moths and butterflies. Many different caterpillars can attack herbs; these include cabbage looper, imported cabbageworm, beet armyworm, black cutworm, and swallowtail. Caterpillars damage herbs by using their chewing mouthparts to remove foliage. Winged females, which may enter greenhouses through openings such as doors, vents, or sidewalls, lay eggs on leaves. Eggs hatch into caterpillars (larvae) which feed on plant parts. Larvae will eventually produce a pupa (cocoon) and then emerge as adults. Adults do not feed on herbs. Adults may be captured on yellow sticky cards. Many herbs are susceptible to caterpillars.

Major Diseases of Herbs

The most common diseases of herbs are listed in Table 3. In general, because few fungicides are labeled for use on herbs and production times are short, most growers will rogue infected plants.

Table 3. Some common diseases, viruses, and viral-like diseases of herbs.

Crop	Problem
Basil	Powdery Mildew *Fusarium*
Cilantro	Anthracnose
Chives	Downy Mildew Rust
Lavender	Septoria Leaf Spot *Botrytis*
Mint, Oregeno, and Sweet Marjoram	INSV Powdery Mildew Rust Verticillium Wilt
Parsley	Aster Yellows Leaf Scorch (*Alternaria radicina*) Leaf Spot (*Alternaria, Phoma, Septoria*) Powdery Mildew *Pythium* Root Rot Viruses
Rosemary	*Rhizoctonia*
Sage	Aster Yellows INSV Powdery Mildew
Tarragon	*Fusarium* Root Rot Rust
Thyme	*Botrytis*

Table adapted from: Diseases and Pests of Vegetable Crops in Canada.

Crop Specifics
Below are a few crop specific pointers to consider for growing herbs.

Basil
Of the herb crops sown, basil is usually the first to transplant. Plant the plugs immediately after a well developed rootball has formed in the plug tray. Stem rot diseases such as *Fusarium* may appear in the plug tray when finished plants begin to stretch and crowd. Thin basil if there are more than 2 seedlings per cell. Planting 3 or 4 seedlings per pot will cause the finished product to look uneven and unsightly. Basil will be ready to ship 2 to 3 weeks after transplanting. If shipping is delayed then pinch the plants to 3 to 4 nodes, which will require an additional 2.5 weeks for the plants to recover to saleable size. Growers should monitor thrips, caterpillars, and slugs weekly.

Chives
Chive seedlings can be transplanted into 4-inch pots two weeks after sowing if sown at the rate of 12 or more seeds per cell. Chives, with 12 to 16 seedlings per pot gives the plant adequate size for sales after 4 weeks of growth from the transplant date. Chives require a slightly lower nutritional level of 125 ppm N than other herbs. Leaf tips will brown if dried down.

Cilantro
Cilantro, coriander, or Chinese parsley are all names given to the same plant, with use in the kitchen determining which name is used. Cilantro is prized for its leaves in Mexican and Moroccan cooking and coriander seeds are used in spice mixtures and pickling solutions. The seeds are large and seedlings should be ready to transplant in two weeks. Germination percentages are usually low in the plug tray; growers must be careful in monitoring the substrate temperature and managing irrigation. Sometimes growers will direct sow into 4-inch pots. Cilantro should be sold early in the springtime. In the southeastern climate, cilantro plants do poorly in the summer heat. Because cilantro is a long day plant, bolting will occur during the summer months.

Lavender
Lavender requires 5 to 6 weeks of growing for the foliage to cover the pot. Fertilize plants once a week with 150 to 200 ppm N during periods of active growth. During the winter months, fertilize every other week with 150 ppm N. The substrate should be kept dry, but the plants should never be water stressed. If lavender plants become leggy, and airflow is reduced to the foliage, the chances for infection by crown rotting fungi may occur. Watering in the morning hours is suggested.

Peppermint
Peppermint has a long germination time and is highly sensitive to saturated soil in the germination plug tray. Peppermint seedlings initially grow slowly and will take 3 weeks to become established, but will then grow rapidly. Because seedlings are slow growing, some growers may choose to purchase vegetative cuttings. Lowering the night temperatures to 55°F once roots reach the side of the pot is suggested. Transplanting peppermint one week before the other perennial type herbs and fertilizing with 200 ppm N will help in equaling out the shipping times with the other herb species. Whiteflies and thrips are attracted to peppermint.

Oregano
Oregano requires night temperatures around 55 to 58°F to remain compact. Fertilize oregano with 125 ppm N. Oregano is ready to ship a few days after thyme, while oregano and sweet marjoram are equal in growing time. If the plugs become stretched they can be pinched 1.5 inches in length which will promote lateral branching. Oregano attracts whiteflies.

Parsley
Parsley is very sensitive to excessive water, especially in the plug tray. Keep the substrate semi-moist during the germination process. Seed

will rot under saturated conditions. Parsley will be ready to ship 4 weeks after transplanting. Fertilize parsley on a constant liquid feed program at 125 ppm N or once weekly at 200 ppm N. Parsley is very sensitive to high EC. Lower leaves will brown if dried down. Watch for spider mites on parsley. Weekly sprays of Azatin® and Botaniguard® are suggested for parsley.

Rosemary

Rosemary is susceptible to *Rhizoctonia* and this fungus will cause unsightly scarring of the stems. Sometimes the presence of woody tissue on the stem is mistaken for the stem rot. The fungus has a deep brown appearance and the woody tissue is gray and light brown in color. Discard the plants if the symptoms are present. Rosemary plugs should be planted immediately upon arrival from the plug producer. Using two plugs in the 4-inch pot will increase water uptake. Be careful in terms of water management after transplanting. The substrate should remain dry, but the plants should never be water stressed. Plants can be lightly pinched to 5 or 6 nodes after roots have reached the bottom of the pot. This will create a fuller plant, but will add 1 or 2 more weeks to the production time.

Sage

Growing sage requires that the substrate be somewhat dry between irrigations. Light watering until root development reaches the outer edges of the pot is suggested. Fertilize sage at 200 ppm N once weekly. Flats are ready to ship in 4 weeks. Sage requires night temperatures around 60°F. Avoid cooler temperatures which create favorable environmental conditions for stem, root, and leaf rotting fungal pathogens.

Sweet Marjoram

Sweet marjoram requires night temperatures around 55 to 58°F to remain compact. The feeding schedule for sweet marjoram is 125 ppm N, constant liquid feed. If the plugs becomes stretched, they can be pinched to 1.5 inches in length, which will promote lateral branching. This will cause the plugs to become more vigorous. Sweet marjoram can become leggy at the 6th week of growth from the transplant date.

Tarragon

French Tarragon should be purchased as rooted cuttings from a reputable propagator. The plants are best grown at 55 to 60°F. Growers should pinch the plants to 1.5 to 2 inches of growth if the plants are leggy. Cuttings should be soft and non-woody for best establishment in the final container. Tarragon should be fertilized with 150 to 200 ppm N.

Thyme

Thyme plugs may become stretched during the pre-transplant stage if temperatures are above 70°F. Pinching the plugs to 1.5 to 2 inches of growth before transplanting will result in bushier plants, but only cut them back if they are stretched. Plugs have to be watered in gently, otherwise, the plugs will be covered with substrate. The seedlings are not strong enough to recover from being "blasted" with the initial watering. They do best with a constant feeding at 150 ppm N. Thyme prefers a drier substrate.

For further reading:

Laskey, M., 1991. Herbs, p. 577-581. In Vic Ball. Ball Red Book. 15th Edition. Geo J. Ball Publishing, West Chicago, Illinois.

Long, J., 1998. Herbs, p. 253-271. In Vic Ball. Ball Red Book. 16th Edition. Ball Publishing, Batavia, Illinois.

Nau, J. 1993. The encyclopedia of seed germination. Ball Publishing, Batavia, Illinois.