Growing Mixes for Organic Greenhouse Production

Organic vegetable, herb and flower growers employ many diverse methods of production; however, they all rely on greenhouse growing mixes. This factsheet will focus on important things to know about soilless organic growing mixes, whether produced commercially or on the farm. Two basic types of growing mixes are examined in this factsheet; the germinating mix and the transplanting mix.

The germinating mix is usually placed in plastic trays which contain several hundred small cells. These trays are often referred to as plug trays and the seedlings grown in these trays are referred to as plugs. The germinating mix requires much finer grades of materials in order to fill these cells easily and to encourage seed germination by providing better media contact with the seed.

Germinating mix and plug trays

Seedlings being transferred into a transplanting mix (Strawberry Hill Farm, near Woodstock NB)

The transplanting mix is a coarser mix and is placed in larger containers which can vary from a 2" square cell pack to 12" pots or baskets. This mix generally contains higher levels of fertility.

Vegetable plugs are sometimes transplanted directly into the field or greenhouse beds, or into larger containers. When transplanted into these larger containers, the plants are grown for several more weeks before being sold or transplanted into the soil where they will grow until ready for harvest. Flower plugs and rooted cuttings are usually transplanted into these larger containers and grown until ready for sale.

Growers face many challenges when using "certified organic" growing mixes. For instance, there are often insufficient nutrients in the mix to produce vigorous seedlings and supplemental feeding is often required; however, the number of liquid fertilizers available for organic production is limited. In addition, these liquid fertilizers are generally not as fast acting as soluble chemical fertilizers. Attempting to add nutrients to the mix before planting creates another set of challenges. Many commercially available organic mixes are hard to wet down and irrigate because they do not contain wetting agents which allow the water to be absorbed and retained in the mix. It is often very difficult to make consistent organic growing mixes when the composition of the ingredients such as the compost is very inconsistent.

Key Facts and Information

1. Germinating mix
    a. Typical materials include:
        i. Fine particle sizes of a horticultural grade peat,
        ii. Fine size of perlite,
        iii. Medium size of vermiculite. Vermiculite is also used to cover some varieties of seed which need a light cover. Most seeds do not need to be covered after seeding.
    b. Other materials sometimes used:
        i. Compost: 5% or less by volume,
        ii. Worm castings: 3% or less by volume.
    c. Important factors about the germinating mix:
        i. pH should be in the 5.5 to 5.8 range (addition of lime will be needed),
        ii. Lower levels of fertility are required, otherwise germination and growth can be negatively impacted. The electric conductivity[1] (EC) should be in the range of 0.5 to 1.0 mS/cm (Saturated Media Extraction Test),
        iii. Must be a material that drains well. *Tip: Better to water more often than have a mix that is saturated and will not dry down as quickly as required.*

2. Transplanting mix
    a. Typical materials include:
        i. Horticultural grade sphagnum peat, and/ or
        ii. Coir fiber (coconut husks): an excellent substitute for sphagnum peat, but it must be low in salt content,
        iii. Coarse grades of perlite,
        iv. Coarse grades of vermiculite.
    b. Other materials that are often used in organic mixes:
        i. Compost,
        ii. Peat humus (the darker more decomposed peat),
        iii. Worm castings.
    c. Important factors about the transplanting mix:
        i. pH should be in the 5.5 to 6.5 range (addition of lime will likely be needed depending upon the amount of peat, compost and/or coir fiber used),
        ii. The EC should be in the range of 1.5 to 3.0 mS/cm (Saturated Medium Extraction),
        iii. Porosity and Water Holding Capacity: A good rule of thumb would be to water daily.
            a) If watering is needed more than once a day, more moisture holding materials should be added to the mix (e.g. compost, humus or castings).
            b) If watering is not needed for several days, more porous materials should be added to the mix (e.g. sphagnum peat, perlite, vermiculite or coir fiber).

[1] The electric conductivity (EC) is used to determine the amount of soluble salts or the fertility level of the media. A higher EC reading indicates a higher level of fertility.

3. Table 1- Pro's and Con's of using various materials in the organic transplanting mixes

Component	Pro's	Con's	Precautions
Peat	• Plentiful in NB, • Excellent drainage and porosity • Good moisture holding capacity (MHC)	• Dry down can be a problem • Non-renewable resource • Low pH, needs lime • Low EC, needs fertilizer and/or amendments • Hard to re-wet without wetting agent	• Make sure no prohibited wetting agents have been included • Lime is needed to neutralize the acidity of peat
Peat Humus	• Good MHC	• Reduces porosity • Not a nutrient source	• Avoid muck peat
Coir fiber "Coconut husks"	• Renewable resource • Good peat substitute • Excellent drainage • pH is higher than peat – less lime needed • Easier to rewet than peat • Better MHC than peat • Higher EC than peat	• Can be expensive compared to peat • May contain high salt levels (high EC)	• Make sure your source has low salt levels. Coir may not be suitable for germination mix
Compost	• Renewable resource • Can be a good source of nutrients • Good MHC • Good Cation Exchange Capacity (CEC) • Can replace some peat • Less lime needed • Disease suppression qualities • Contains beneficial microorganisms	• Can rob plants of nutrients (N tie-up), if not fully matured. Avoid C:N ratios of more than 25:1 • Can attract fungus gnats if made from wood based products. May require predatory insects to control pests	• Check source of compost feedstocks and methods of composting • Keep to 10 to 30% of mix • Make sure compost is fully matured to avoid ammonia toxicity • Keep % low if using poultry based compost or other compost with high EC
Aged bark	• Renewable resource • Can replace some peat	• Can rob plants of nutrients (N tie-up) • Can attract fungus gnats May require predatory insects to control pests	• Keep % low, 10% or less
Castings	• Renewable resource • Good source of nutrients • Good MHC and CEC • Contains beneficial microrganisms	• Can be expensive • Can reduce air porosity by increasing density of mix	• Keep % low, 15% or less • Above 15% the mix may become too dense
Perlite	• Helps increase porosity and good drainage	• Provides no nutrients • Cannot hold nutrients	
Vermiculite	• Provides good porosity • Holds nutrients • Good MHC • Source of Ca and Mg	• Can be expensive • Easy to crumble – must be handled very carefully	• Check source as some sources of vermiculite may contain 2 – 3% asbestos.

Supplemental Fertilization

During the winter of 2013, New Brunswick Department of Agriculture, Aquaculture and Fisheries (NBDAAF) staff conducted numerous growing mix analyses and seedling production trials. Twenty commercial and farm-made growing mixes were analyzed and evaluated through the production of basil, tomato, lettuce and broccoli seedlings (Table 2). These trials confirmed that there is a wide range in fertility levels in commercially available organic greenhouse growing mixes. Plants grown in mixes that were low in fertility often required supplemental fertilization (liquid feeding) soon after transplanting. Other mixes provided sufficient fertility for the first few weeks of growth; however, few organic mixes allowed for optimum plant growth beyond 3 to 4 weeks without supplemental fertilization.

Pictures on day 21 after transplanting. Note the variability in crop growth provided by three of the 20 growing mixes assessed (without any supplemental fertilization).

Based on practical experience, it is best to start supplemental fertilization with liquid fertilizers soon after transplanting and continue with regular feeding (once a week), even if the mix has compost or worm castings. Often organic growers start feeding young seedlings once the evidence of nutrient deficiencies are observed. Unfortunately, once a deficiency is diagnosed, it is generally too late to ensure full crop recovery and optimal productivity. Growers should always have an organic liquid fertilizer on-hand for supplemental fertilization.

Organic liquid fertilizers used for supplemental feeding are generally made from fish or plant extracts. Organic liquid fertilizers are suitable for manual watering; however, most of them are generally not compatible with drip irrigation because they tend to clog the system due to the amount of solids in the products and the biofilms they produce in the irrigation systems. Growers can benefit from including organic fertilizers and/or amendments when preparing their mix, as they may reduce the amount of liquid feeding required, provided these ingredients are of a fast release nature. Many of the fertilizers listed on the next page are very slow to release their nutrients. For most greenhouse transplants or for seedlings that will be transplanted in the field at a young age, the nutrient release may not be in time to benefit the crop; therefore, adding those types of fertilizers would not be of value nor recommended.

Organic Fertilizers

When preparing your mix, it is important not to include excessive amounts of compost or castings, as they may have an adverse effect on germination and plant growth due to excessive EC levels. Adding nitrogen rich amendments to the mix may also re-initiate the composting or decomposition process if aged bark or immature compost is part of the mix. This biological activity could also release ammonia and other organic compounds which may cause crop injury or reduce crop growth. To avoid this situation, growers should add moisture to the fortified mix several weeks prior to planting and keep the mix in a warm condition. These conditions will initiate biological activity in the mix which should then subside before the mix is used.

It is, however, important to understand that nutrients in the organic mixes are only made available to the plant through biological activity in the mix. This process requires warm ambient temperature. Many growers make use of heating benches or other methods to obtain bottom heat. For this reason, some growers prefer not to use cold water when they water their transplants by hand.

Lime used in greenhouse mixes must be of a very fine grade. The particle size of agricultural grade lime is not fine enough to quickly influence the pH of the mix and to release nutrients in a timely matter.

There are organic fertilizers and amendments which can be added to organic mixes to provide additional nutrients and attributes. However, unless a grower wants to grow-out his crops in containers, adding such materials may not provide the expected short term benefits.

List of typical organic fertilizers and amendments:

Nitrogen sources:

- Alfalfa meal (2.5 % N, slow release)
- Crab/lobster meal (6-10% N, slow release)
- Granulated chicken manure (3-4% N, slow to medium release)
- Feather meal (7-15% N, slow release)
- Blood meal (8-12% N, medium to fast release)
- Fish meal (8-10% N, medium release)
- Soybean meal (7% N, slow to medium release)

Phosphorus sources:

- Bone meal (11-14% P, slow to medium release)
- Fish meal (4% P, slow to medium release)
- Natural untreated rock phosphate (17-30%, but only 3% available, very slow release)
- Bat guano / Seabird guano (9-11% P, medium release)

Potassium sources:

- Potassium sulfate (50% K, medium to fast release, contains 11-18% S)
- Langbeinite (22% K, medium to fast release, contains 11% Mg and 22% S)
- Kelp meal (2-3 % K, slow to medium release)
- Greensand (5-7% K, very slow release)

Calcium sources:

- Calcitic lime – a good calcium source which will raise the pH
- Gypsum – a calcium, magnesium and sulfur source, which leaves pH mostly unchanged

Magnesium sources:

- Dolomitic lime – a good magnesium source which will raise the pH
- Epsom salts – a magnesium and sulfur source, which leaves pH mostly unchanged

Beneficial additives:

- Yucca plant extract (powder or liquid)– used as a natural wetting agent
- Beneficial fungi, such as Trichoderma harzianum – used as a soil drench to protect crops against root rot pathogens (pythium, rhizoctonia and fusarium); mycorrhizae – root inoculant used to increase nutrient uptake and increase plant resistance to environmental stresses.
- Compost tea – used as a soil drench to inoculate the growing mix with beneficial organisms.

**Before using any of the materials above, make sure they meet the requirement of the organic standards.*

Table 2. Typical Composition of Organic Transplanting Mixes

Characteristics and Ingredients	**Ranges[1] As found in 2013 NBDAAF Study**		**Comments and Industry Standards**
	Min	**Max**	
pH	5.3	7.0	5.5 – 6.5
**EC (*mS/cm)*	1.8	4.0	1.5-3.0 mS/cm (SME) - Based on Saturated Media Extraction (SME). Method used by PEI and NS Labs.
P Phosphorus (ppm)	1	20	5-33 P (ppm)
K Potassium *(ppm)*	180	400	75-200 K (ppm)
Ca Calcium *(ppm)*	60	380	75-250 Ca (ppm)
Mg Magnesium *(ppm)*	35	100	33-88 Mg (ppm)
Sphagnum peat	0%	80% per volume	0 – 100% It's the choice of the mix maker and the grower. The grower will need to adjust watering and feeding accordingly.
Coir fiber	0%	22%	0 – 100% Replacement for peat. It's the choice of the mix maker and the grower. The grower will need to adjust watering and feeding accordingly.
Peat humus	0%	20%	0 – 20% Higher levels may lead the mix to be too dense.
Compost	0%	30%	Higher levels are okay if compost is fully matured. Above 30%, the mix may become too dense. If compost is poultry manure based, lower rates are recommended – less than 20%.

Aged bark	0%	13%	0 – 10% Economics will dictate use of this product.
Castings	0%	5%	0 – 15% May be best suited for seedlings that will be kept for a long period of time before transplanting or for container growing. Above 15%, the mix may become too dense.
Peat humus/ Compost/Castings	11%	25%	0 – 30% Combinations of peat humus, compost and castings. Above 30%, the mix may become too dense.
Perlite	0%	20%	10 to 15% is typical. Not needed if drainage is good.
Vermiculite	0%	10%	10 to 15% is typical. Not needed if drainage is good.

[1]Data based on the analytical study conducted by NBDAAF in 2013 on over 20 growing mixes

*** Since there are several methods used to assess EC, it will be important to know which one is used by the laboratory, eg. Saturated Media Extraction (SME), the 2:1 Water to Media Extraction, or the Leachate Pour Thru Extraction. Although the units used to express the EC may be the same, the various methods will generate different readings.*

Factors which affect the EC level in the organic mix include;

1) The quantity and fertility level of the compost or worm castings used.
2) Levels of nutrients especially Nitrogen (nitrate and ammoniums forms) and Potassium (K).
3) The amount of dissolved nutrients and pH level of the water used.
4) Type of extraction used by laboratory (2:1 Water/Media Test, SME Test, Pour Thru Test).

Important things to know about your mix

1) Whether you buy a commercial mix or make your own, you should have a lab analyses of the mix you intend to use and consider doing your own bioassay on crops you plan to grow and crops that are EC sensitive (germination and seedling tests).
    a. Make sure a greenhouse soil test is used, which will include the Electric Conductivity.
    b. Make sure the pH, EC, and Potassium (K) levels are in the desired range.
2) Make sure the commercial growing mix is suitable for the type of use you are considering: (germinating mix, transplanting mix, or for both uses).
3) Find out the % by volume of peat, peat humus, compost and castings that are in the mix and make sure they are in the desired range (Table 2 -Typical Composition of Organic Transplanting Mixes).
4) Find out the % of vermiculite and perlite in the mix, if any are used.

5) Find out the % of aged bark in the mix, if any are used.

6) Find out the types of fertilizer or amendments in the mix and their %, if any are used.

7) Find out if organic wetting agents are included.

8) Determine the porosity of the mix – by feel, by appearance and by a trial if you have the time. Fill a pot with mix and add water, then see how it drains and how long it takes to dry down. If adjustments are needed, determine what ingredients are required (refer to Table 1.)

References and Resources for Organic Growing Mixes

1) *Questions from the farm, creating the optimal potting mix – Claudine Furnion and Dr. Av Singh, Perennia*

2) *ACORN's Directory of Allowable Inputs and Directory of Farm Supplies.*

3) *Potting Mixes for Certified Organic Production* – George Kuepper, Agriculture Specialist, National Center for Academic Transformation.

4) *Potting Mixes for Organic Growers* – Vern Grubinger, University of Vermont. http://www.uvm.edu/vtvegandberry/factsheets/pottingmix.html

5) *Organic Potting Mix Basics* – Michelle Wander, University of Illinois.

6) *Guide to Greenhouse Floriculture Production* – Publication 370, chapter 3 – Ontario Ministry of Agriculture and Food, http://www.omafra.gov.on.ca/english/crops/pub370/p370order.htm

7) Potting Media and Plant Propagation – Penn State Extension, http://extension.psu.edu/business/start-farming/vegetables/factsheets/potting-media-and-plant-propagation

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