Brenda Hedges
1187 Maple St.
Waterbury Ctr., VT 05677
June 29, 2004
802-244-8103
greystone1@adelphia.net

FNE03-468 Organic Plug Production: Evaluating growing media, fertilizer, and economic feasibility.

Summary: New England organic growers are waking up to the advantages of using plugs in their crop production. Small producers can save time and money by purchasing plugs. They save the expense of owning and operating a greenhouse and their plugs are delivered to their door ready to grow at transplant time. Larger producers, with their own greenhouses, can shorten crop production times and possibly costs by growing their own plugs.

This project researched the economic feasibility of operating an organic plug production facility in the northeast and compared the efficacy of three media types and two fertilizers.

Objectives:

1. Evaluate the economic feasibility of organic plug production as an enterprise by researching the costs and expected income of a 30 x 96 greenhouse.
2. Compare Intervale Germination Mix to Fafard Organic Compost, and a peat based media in regards to germination, growth rates and damping off.
3. Compare Squantos Secret to SeaPlus Liquid fertilizer in combination with the differing media to analyze plant growth and nutrition.

Key Findings:

1. Organic Plug production is economically feasible in the northeast based on projections for a 30x96 greenhouse. Growing plugs actually produces more income per square ft. of production space than growing traditional bedding plants.
2. Intervale Germinating Mix performed better overall than did the Fafard or peat mixes.
3. Intervale Germinating Mix and Squantos Secret fertilizer had the best germination rates of all the media/fertilizer combinations.
4. Fafard Compost and Squantos Secret fertilizer produced the second best germination and growth.
5. There were no problems with damping off in any of the media/fertilizer mixes.

6. Ph and EC levels in plug flats vary considerably with differing media and organic fertilizers. Organic growers will benefit from learning to test and analyze these aspects of plug growth.
7. Organic plugs held on the bench better than conventionally grown plugs.
8. Organic plugs draw an initial charge of nutrients from the media and don't require supplemental fertilization until week four of production.
9. In general, organic plugs do better in larger plug sizes, i.e. 105's as opposed to 288's. The plugs grown organically draw most of their nutrients from the media and therefore require more media to produce high quality plugs.

Economic Feasibility:

Analysis of the economic feasibility of organic plug production was based on purchasing and erecting a 30x96 double poly greenhouse with ebb and flow benches and supplemental lighting as well as an environmental control system.
Cash flow projections include loan proceeds to purchase the greenhouse and equipment. A greenhouse this size, with 600 sq. ft. reserved for a head house, can hold 864 trays at a time. An average income per flat based on conventional prices, for bedding plants is $31.00. An average for field crops would range more towards $18.00 per tray. Projections were made using the income for bedding plants and was based on sales of 1088 trays.

Expenses for our projections used actual seed, media, and fertilizer costs. Utility and other overhead costs were based on our own records from prior years or on other local grower costs. The projected season is from December through May based on the growing season for plugs in Vermont.

Based on these projections, a plug grower in Vermont could expect to have a net loss of $1,683.00 the first year of operations. The second year, based on two full turns of the greenhouse would show a profit of $3,907.00. Our analysis supports the premise that an organic plug business would be profitable in the northeast, given enough of a market to support sales of 1800 trays per year.

Evaluating Growing Media and Fertilizer

In order to test which media and fertilizer worked best, I set up six groups of seventeen trays each for a total of 102 trays. Each set of trays had a different combination of media and fertilizer. Three media and two fertilizers were tested. Fafard Organic Compost, Intervale Germinating Mix and peat with lime and vermiculite were used as the test media. Sea Plus Liquid and Squanto's Secret were the fertilizers chosen for the tests. Liquid fertilizers were chosen based on the need to deliver fertilizer through an irrigation system for quality plug production.

Plug trays are usually 10" wide by 20 inches long. Within this space can be as few as 50 cells or as many as 512 cells that actually hold the seedling. Each seedling has a small amount of soil for its development. Within this small space the growing media must

provide nutrition for the seedling, it must have an acceptable level of pH for availability of nutrients and it must provide an environment where roots can grow and function.

The small volume of soil in each plug cell makes the media subject to rapid fluctuations in moisture content, aeration, pH and soluable salts. Producing high quality plugs requires careful monitoring of all these aspects. In additional, physical and chemical properties of the media are important as well. Composts vary in their ability to hold water, their porosity or the size of the particles in the compost and the amount of aeration possible around the particles. The three media tested varied substantially in these properties.

The Fafard organic compost was dark, dense and made up of even sized particles. This compost is formulated to a standard pH of 6.2. The best aspect of the Fafard compost was that it was highly consistent with no foreign matter. Its worst aspect was that it was too dense a mix to use for plugs. The compost also compacted too readily. Vermiculite was added to this compost in order to test it for use in plug production.

The Intervale Germination mix is made up of fairly dark particles of various sizes. This mix is lighter than Fafard and can be used unaltered for plugs. The germinating mix is produced with a pH of 6.1, well within the range for seedling production. The best aspect of the Intervale mix is that it can be used right out of the bag. The biggest drawback to it is that in some bags you'll find large particles of wood and other debris that are too large for using in plug trays. You may need to screen these large particles out in order to fill smaller cell sizes.

The last media tested was a soilless mix of peat, vermiculite and lime. This mix was the lightest and most porous of the three. Dry organic fertilizers could have been added to this mix but I wanted to use it as a base line to test for the efficacy of the liquid organic fertilizers. The particles in this mix were quite small and allowed for less aeration of the roots but its water holding capacity was quite good. A drawback to this media was that it needed to be mixed and it was difficult to get the media hydrated. The peat is fairly resistant to water.

The two liquid fertilizers tested were Squanto's Secret which is made from liquified fish protein and has a formulation of 2-4-2. Sea-Plus I is made from liquid fish with seaweed and is 3-2-2 (N-P-K). Of the two, the Squanto's Secret worked best with the irrigation system. There was particulate matter in the Sea Plus which would plug the screens as the fertilizer was taken up into the system. This would lead to little or no fertilizer getting through to the plants until the screens were cleaned.

In order to measure our results, germination rates of the test varieties were counted and recorded. Growth rates were noted throughout the test period and samples of the plugs were sent for foliar analysis upon completion of the five week growing period. In addition, the plugs were given to another grower to transplant out and grow to maturity. Field notes were recorded during this period.

It is easy to surmise that the plugs grown in the peat mix had the poorest performance. In both germination and growth rates, the peat plugs were behind the other two groups. The peat plugs also dried out most rapidly. The Intervale Compost had the highest number of plants germinating with the Fafard group having the second highest number.

Of the six groups tested, the Intervale Compost with the Squanto's fertilizer had the highest overall growth rate. This group was closely followed by the Fafard and Squanto's Secret combination. Overall differences in height of the plugs between these two groups at four weeks of age was less than ½". Foliar analysis illustrated that the Fafard group had higher levels of nitrogen, calcium, and phosphorous but less potassium than the Intervale group.

Reports from the finish grower stated that all the test groups combining compost and fertilizer were of equal size and health within two weeks of being transplanted out. This finding led us to believe that regarding overall growth there were not significant differences between the composts and fertilizers chosen for this research. The differences in germination rates were worth considering and the Intervale Compost came out most favorably.

The availability of nutrients to seedlings is determined by the pH of the media. The best results are obtained with media that starts at 6.2 to 6.9 pH. When media pH is higher than 6.5, micronutrients can become deficient and calcium becomes excessive. When pH is less than 5.5, micronutrients become excessive and macronutrients become deficient for most crops. It is critical when growing plugs to monitor pH and electrical conductivity (EC) to be able to prevent nutritional deficiencies. Part of our project was to test for pH and EC. A pH and electrical conductivity (EC) meter was purchased as part of this project. It was used to test pH and EC at the beginning and the end of the growth cycle. Peat moss can have a pH as low as 4, making it unsuitable as a media by itself. Below is a chart illustrating the results of some of our pH and EC tests.

Media	pH	EC
Intervale out of bag	5.87	.53
Fafard- out of the bag	6.63	3.34
Interval-end of growing cycle	7.15	.31
Fafard-end of growing cycle	7.8	8.63

These results would indicate that pH goes up with the addition of organic fertilizers, rising above the ideal range for optimum nutrient absorption. This was noted as discoloration and yellowing on some of the plugs late in the trial period. The topic of pH and EC in plug production is complex and these measures are affected by many factors including media, water, fertilizers and the plant itself. Although I found this initial foray into performing and analyzing my own tests helpful, it was apparent that I need to learn much more about how these factors interact to be able to benefit from the information.

EC tests in particular, showed wide spread results. I am not certain if this was due to improper sampling, improper calibration or if the results were correct. A better understanding of this topic would help in preventing nutritional deficiencies and would lead to better quality plugs in organic production.

Project Outreach:

Dissemination of the results of this research has been ongoing since completion of the trial in July of 2003. An article documenting the study and results has been published in the Natural Farmer Magazine which goes out to subscribers throughout the northeast. A two hour workshop was given at the NOFA Winter Conference in February of 2004. Over 35 growers participated in this workshop. On farm tours have been given to several other growers and results of the trial have been discussed. An article has been submitted for inclusion in Cultivating Connections and Growing Farmer's Network but has not been published yet. The 2003 summer workshop list was already finalized by the time work was completed on this project and family obligations have prevented me from presenting one this year.

This project has generated a great deal of interest amongst fellow growers. Very little research has been done in the area of organic plug production and it is my hope to continue testing the interactions of media and fertilizers to eventually be able to produce consistently high quality organic plugs.

July 20, 2004 Brenda Hedges

Organic Plug and Transplant Production

NOFA Conference
Brenda Hedges
February 21, 2004

Pros of plug production:

1. Less labor and time needed to transplant plugs.
2. Seedlings grow more rapidly and uniformly in plug trays.
3. No set back due to transplant shock.
4. Losses from root rot are greatly reduced.
5. Increased production per square foot of greenhouse space.
6. Less chance for disease to spread.
7. Can be held for delayed transplanting.

Cons of plug production:

1. Grower required to change production method.
2. More difficult to produce plugs yourself.
3. High initial costs for equipment and greenhouse space.
4. Specialized knowledge and techniques required for growing plugs.
5. Greater cost per seedling for plugs.

Should you grow your own plugs?

Reasons to grow your own plugs:

1. Self-reliance and control, grow what you want, when you want.
2. Cheaper cost per plug, no shipping charges, no profit margin to the grower.
3. There may not be availability in your area for the plugs you need.

Factors to consider when deciding to grow plugs:

1. Can you provide the space and expertise to grow what you need?
2. How much of an investment will you need to make to grow your own plugs?
3. Do you have the time necessary to grow plugs?
4. Is it cost effective for you to grow plugs?
5. Do you have high quality water?
6. How early do you have to start up your greenhouse to grow plugs?

Take the time to figure out the cost of production vs. buying. What works best for your farm?

SARE Grant Tests and Results

In growing plugs, the differences between organic and conventional production come down to the media and fertilizer. Whereas conventional growers use soilless mixes for their plugs, organic growers use various composts blended with peat and vermiculite or perlite. Different types of organic fertilizers or rock powders can also be added to the mix. Mixes can be customized depending upon the needs of the seedlings being grown. There are several good composts available on the market that can be purchased by the bag or in bulk.

In order to test which media and fertilizer worked best, I set up six groups of seventeen trays each for a total of 102 trays. Each set of trays had a different combination of media and fertilizer. Three media and two fertilizers were tested. Fafard Organic Compost, Intervale Germinating Mix and peat with lime and vermiculite were used as the test media. Sea Plus Liquid and Squanto's Secret were the fertilizers chosen for the tests. Liquid fertilizers were chosen based on the need to deliver fertilizer through an irrigation system for quality plug production.

Plug trays are usually 10" wide by 20 inches long. Within this space can be as few as 50 cells or as many as 512 cells that actually hold the seedling. Each seedling has a small amount of soil for its development. Within this small space the growing media must provide nutrition for the seedling, it must have an acceptable level of pH for availability of nutrients and it must provide an environment where roots can grow and function.

The small volume of soil in each plug cell makes the media subject to rapid fluctuations in moisture content, aeration, pH and soluble salts. Producing high quality plugs requires careful monitoring of all these aspects. In additional, physical and chemical properties of the media are important as well. Composts vary in their ability to hold water, their porosity or the size of the particles in the compost and the amount of aeration possible around the particles. The three media tested varied substantially in these properties.

The Fafard organic compost was dark, dense and made up of even sized particles. This compost is formulated to a standard pH of 6.2. The best aspect of the Fafard compost was that it was highly consistent with no foreign matter. Its worst aspect was that it was too dense a mix to use for plugs. The compost also compacted too readily. Vermiculite was added to this compost in order to test it for use in plug production.

The Intervale Germination mix is made up of fairly dark particles of various sizes. This mix is lighter than Fafard and can be used unaltered for plugs. The germinating mix is produced with a pH of 6.1, well within the range for seedling production. The best aspect of the Intervale mix is that it can be used right out of the bag. The biggest drawback to it is that in some bags you'll find large particles of wood and other debris that are too large for using in plug trays. You may need to screen these large particles out in order to fill smaller cell sizes.

The last media tested was a soilless mix of peat, vermiculite and lime. This mix was the lightest and most porous of the three. Dry organic fertilizers could have been added to this mix but I wanted to use it as a base line to test for the efficacy of the liquid organic fertilizers. The particles in this mix were quite small and allowed for less aeration of the roots but its water holding capacity was quite good. A drawback to this media was that it needed to be mixed and it was difficult to get the media hydrated. The peat is fairly resistant to water.

The two liquid fertilizers tested were Squanto's Secret which is made from liquefied fish protein and has a formulation of 2-4-2. Sea-Plus I is made from liquid fish with seaweed and is 3-2-2 (N-P-K). Of the two, the Squanto's Secret worked best with the irrigation system. There was particulate matter in the Sea Plus which would plug the screens as the fertilizer was taken up into the system. This would lead to little or no fertilizer getting through to the plants until the screens were cleaned.

In order to measure our results, germination rates of the test varieties were counted and recorded. Growth rates were noted throughout the test period and samples of the plugs were sent for foliar analysis upon completion of the five week growing period. In addition, the plugs were given to another grower to transplant out and grow to maturity. Field notes were recorded during this period.

It is easy to surmise that the plugs grown in the peat mix had the poorest performance. In both germination and growth rates, the peat plugs were behind the other two groups. The peat plugs also dried out most rapidly. The graph below illustrates germination rates for the three media types. The Intervale Compost had the highest number of plants germinating with the Fafard group having the second highest number.

Of the six groups tested, the Intervale Compost with the Squanto's fertilizer had the highest overall growth rate. This group was closely followed by the Fafard and Squanto's Secret combination. Overall differences in height of the plugs between these two groups at four weeks of age were less than ½". Foliar analysis illustrated that the Fafard group had higher levels of nitrogen, calcium, and phosphorous but less potassium than the Intervale group.

Reports from the finish grower stated that all the test groups combining compost and fertilizer were of equal size and health within two weeks of being transplanted out. This finding led us to believe that regarding overall growth there were not significant differences between the composts and fertilizers chosen for this research. The differences in germination rates were worth considering and the Intervale Compost came out most favorably.

Resources:

1. Plug & Transplant Production, Ball Publishing, Roger Styer and David Koranski

Resources Cont'd

2. Organic Plug and Transplant Production, ATTRA, www.attra.ncat.org
3. *Grower Talks,* Ball Publishing Co., www.growertalks.com
4. *Greenhouse Grower,* Meister Publishing Co., 37733 Euclid Ave., Willoughby, OH 44094, Phone: 440-942-2000
5. *GM Pro,* Branch, Smith Publishing, phone 800-434-6776 or www.greenbeam.com
6. Grower Talks: Plugs II, Debbie Hamrick, Ball Publishing
7. Ball Culture Guide, Jim Nau, Ball Publishing
8. Bedding Plants IV, Ball Publishing
9. Greenhouse Bedding Plant Production and Marketing, Alberta, Canada www.agric.gov.ab.ca/agdex/200/8183001.htm