2012 Michigan Greenhouse Growers EXPO: Seedling Plug Production

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About Raker

Raker is one of the 10 largest plug and liner propagators in the US. Located in Litchfield, Michigan, Raker is a 440,000 ft^2 (10 acre, 4 ha) greenhouse facility designed from the ground up for propagation. Raker specializes in produce-to-order plugs and liners shipped throughout North America, and the company has been in business for 34 years.

Raker annually produces over 150 million plugs and liners, approximately 80% seeded plugs and 20% vegetatively propagated liners. Raker grows to order, with very little spec.

Raker has extensive trial gardens open to visitors from mid July to the end of August.

Characteristics of Seed

Seed is typically an economical input and a significant advantage is that it can be stored on-site and used for multiple sowings, unlike unrooted cuttings, which we purchase each week from numerous offshore and domestics suppliers. Seed is usually is good supply compared to vegetative inputs, although there can be issues including crop failures and seed lots with low germination. Variety choice is somewhat more limited from seed than vegetative inputs in some species, as not all characteristics are easily stabilized in seed propagation.

Seed can be somewhat challenging to handle, particularly perennial seed and seed of extremely small species. Seed of different species varies widely in size, shape, and therefore ease of handling. Seed can be treated with a film coat or pelletized to make handling, particularly automated sowing, easier.

Seed lots can also include unwanted components, including seed of weedy species, off-type seed, chaff, or debris. Sometimes seed is mislabeled at the supplier, and does not contain the expected variety. Sloppy seed handling when sowing can also lead to mixed up varieties. The biggest challenge with seed is that there is often high variability in germination and seedling vigor among different seed lots of the same variety or species.

Key Factors in Germination – Moisture

Moisture is the single most important factor in seed germination. The goal is to provide enough water to allow seed to germinate without saturating the growing media. Media should be moist enough to allow the radicle to grow quickly when it emerges, but not so wet that oxygen levels are reduced in the media. Low oxygen stresses plants, slows growth, and can promote disease.

Proper moisture management is especially challenging with small seeds, trays with small cell volume, and under warm growing conditions. Irrigation booms are a valuable tool for moisture management. However, even the best boom is no substitute for attention to detail in touching up trays by hand to even our any irregular drying patterns as needed.

Key Factors in Germination – Moisture

Temperature of the growing medium drives seed germination. Different species have different optimal germination temperatures and ranges over which they will germinate. Remember that higher temperatures will also speed up the drying of a growing medium, making moisture management more critical.

Because media temperature is key in germination, bottom heat is the most efficient. Small germination areas can be created with electric heating tape systems controlled with a thermostat. Raker uses a hot water under-bench heating system. Be sure to verify temperature of the media with a thermometer to ensure it is in the desired range.

Media warms up very quickly in a warm, sunny greenhouse. During warm periods, shading and/or fog are valuable tools to both help control temperature and reduce moisture loss from trays. The less water needed, the less likely trays will be over- or under-watered.

Raker uses four primary germination environments, depending on species. The germination environments are: "cool" (64 to 68 °F, 18 to 20 °C), "bench" (72 to 76 °F, 22 to 24 °C, used for most items), "warm" (76 to 80 °F, 24 to 27 °C, used for a few warm-preferring species), and two germination chamber environments, 60 °F (17 °C) dark and 85 °F (30 °C) lit.

Generally, as seed germinates, trays can be moved to slightly cooler environments for continued growth. Particularly for species that are germinated at warm temperatures, growing on at warm temperatures may result in reduced quality.

Key Factors in Germination – Moisture

Some species require or benefit from light for germination, some require or benefit from darkness, and many are not affected by light. Light requiring species should generally not receive a media cover. Dark requiring species can be put into an unlit germination chamber or receive a media cover thick enough to exclude light.

The Raker System

Raker uses an Attention to Detail (ATD) philosophy throughout its production process. This is a basic, common-sense approach to ensuring that there is consistency in all aspects of production and culture: media, tray filling, covering, sowing accuracy, moisture management, IPM, proper crop environment for each stage of growth, and consistent crop production time.

Efficiency is a big focus, working to streamline systems without cutting corners that lead to reduced quality. The goal is improved efficiency while reducing waste. LEAN manufacturing reviews have been very helpful in this process. LEAN systems tend to have consistent, labelled work areas, so that all the needed tools and equipment are easy to find.

Raker has also spent a great deal of effort in developing standardized training and documentation of work processes, including the growing process.

Seed Storage

The rule of thumb for optimal seed storage is that the sum of the temperature (in F) and % relative humidity should equal about 80 (the previous rule of thumb was that sum of these numbers should equal 100).

Note that seed lots (particularly annual species) will decline in vigor over time, and it is very hard to predict performance of a seed lot held for 6 or more months.

Seed Organization

Grouping species by production time and germ environment helps ensure multiple items from the same box are likely to be sown together.

Media

Raker media is SunGro's standard plug mix, with a custom nutrient blend. We add calcine clay and moisture before filling trays. Calcine clay adds bulk density and cation exchange capacity (CEC). The media composition (after calcine clay addition) is: 70% sphagnum peat, 23% perlite, 7% calcine clay

There are many other options for media additives, including coir, composted bark, compost, rice hulls, etc. There is no single "ideal" media. Any media can work for plug growing if it is consistent from bag to bag, pH is 5.5 to 6.2, and trays are filled consistently.

Tray Filling

Media must be at properly moisture level for consistent tray filling. A test to see if media is properly moistened is to grab a hand full and squeeze. It should not release water, and should hold its shape when the hand is opened, crumbling when poked with a finger.

Consistency in tray filling, both within a tray and among all trays in a filling run, is a factor which strongly affects germination and plant stands. In poorly filled trays, irregularity of the tray fill can lead part of the growing media in the tray to be overly compacted and part to be poorly compacted, leading to irregular germination and difficulty watering.

In compacted trays media may not hold sufficient oxygen, and poorly compacted trays may have media settle in the cells deeply after watering. Proper tray filling is a combination of putting the right amount of media in trays and packing it into cells evenly. Consistent filling is especially challenging with small tray sizes (200 or more cells per tray). To properly fill trays, the medium must be moist but not saturated and the filling equipment calibrated properly for the specific tray being filled. Poor tray filling can cause over compaction, which greatly reduces medium oxygen levels, affecting root growth and promoting disease. In addition, inconsistently filled trays promote uneven water holding and erratic germination.

It is best to fill trays no more than a day ahead of time, to prevent them from drying out excessively before sowing. If you need to hold filled trays longer, put them in a cooler (or at least a cool area) and cover with plastic to protect them from drying out.

Sowing Accuracy

Sowing accuracy is essential for good germination and plant stands. Regardless of how high-tech a seeder is used, it is no better than the operator. An efficient sowing system requires adequate staffing to ensure that sowing accuracy of each tray can be maintained and evaluated, and to verify the correct variety is being sown.

Dibbling

A dibbler puts a depression in the center of each cell in a plug tray before sowing. This helps to ensure good sowing accuracy, with seeds placed uniformly in the centers of the cells. The dibble also creates a microclimate with high humidity in the cell, to help ensure good germination.

Seed lot tracking

It is very helpful to track the seed lot used in sowing to each tray, particularly when multiple seed lots are used. Raker uses an automated, barcode system to do so connect the seed lot used to each tray sown. We also write on the label to indicate a seed lot change when two lots are used in a single sowing, to provide a visual key to the seed lot change.

Raker Production Example

Rudbeckia 'Goldsturm' is historically the top perennial for Raker, and we produce 2 million plugs annually. Previously, we germinated Rudbeckia in a warm, lit chamber (85 F 30 C) with each tray in a clear plastic bag. Currently, we use Kieft's "tuned" 'Goldstrum' as our preferred seed form, as it can be bench germinated at 72 to 76 °F (22 to 24 °C). A 128 tray of 'Goldsturm' is sown at 2 SPC, with a 10 to 40% overstart. Plugs are grown for 9 weeks before they are ready to ship.

Sowing Equipment

Raker uses Blackmore cylinder seeders for all our sowing. Two sowing lines are connected in-line to flat filling and label printing systems. A third line used for slow-to-sow items like zinnia, marigold, dahlia, etc. is not connected to the in-line system.

Sieves can be used to remove trash, dust, and debris from seeds before loading the seeder. This helps prevent cylinder holes from becoming plugged.

Baby powder is used to improve the seeder's ability to handle and pick up seeds singly, particularly in humid conditions. Do NOT use cornstarch-based baby powder, as it will become moist and cause worse clumping of seed.

Covering Seed

Raker uses a 50:50 mix of fine vermiculite with our standard media as a seed cover. Compared to 100% vermiculite, this is much easier to "read" by eye for moisture level. (For peat media, the blacker the media, the wetter, and the more tan the media, the more dried out.)

Watering in

Using an adjustable watering tunnel ensures trays are uniformly moistened after sowing. Raker media has a small starter charge, so leaching during initial watering in is avoided.

Water quality

Water quality water is an important factor in successful plug production. Every grower's water is different, and the key is to learn how water reacts with media over time, and what modifications are needed to make to keep a system within acceptable ranges.

Raker's well water has moderate to high pH and alkalinity, so we acidify with sulfuric and phosphoric acid to bring the pH to 6.0 and alkalinity to 60 to 70 ppm. Remember that acid injection adds nutrients to the irrigation water (typically sulfur and/or phosphorous, depending on the acid(s) used), which must be taken into account when designing a fertility program.

Have water tested at least twice a year (summer and winter) by a reputable lab to identify changes in water quality. If you are using acid injection, test at least weekly to ensure that the injector is working properly.

Improving Success Growing and Handling Plugs

Tray Size

Trays with small cell volume efficiently produce large numbers of plants per square foot, but culture and moisture management in small cell trays is more challenging compared to larger volume trays. Very large cell volume trays can be easy to overwater during germination. Most growers find medium cell trays (128 to 200 cells per tray) a good compromise between easier moisture management and efficient space use.

Some species are ideally sown into the container that they will be sold in. Annual herbs, some vegetables (notably Cucurbits), annual sweet pea, and sunflowers are good candidates for sowing directly into small pots or packs. Iberis can be multiple sown into 6 inch or smaller containers and overwintered after seedlings have become well-established to produce high-quality flowering containers the next spring.

Enhanced Seed

A number of companies offer seed which has been enhanced for easier handling or for improved germination. Film coated and pelleted seed is much easier to handle, particularly for small or irregular seeds, and some "multi-pellets" include multiple seeds per pellet.

Primed seed is allowed to imbibe moisture to a certain point, then dried, so it often germinates more quickly and uniformly than untreated seeds. Perennial seed suppliers Benary, Jelitto, and Kieft all offer treated seed of some perennial species. These "secret sauce" treatments improve germination and are proprietary, but can be quite effective. Some enhanced seed products have a shelf life and may be best sown immediately.

Work with Overstart and Seeds Per Cell

One of the easiest ways to improve plant stands is to sow multiple seeds per cell. This does increase the input cost per cell, but many seed items are inexpensive enough that this can be a worthwhile strategy. It can be cost prohibitive for more expensive, F_1 hybrid varieties.

Even for in-house production of plugs, it is useful to plan an "overstart" of extra trays to ensure that enough plugs are available. Do not forget to factor the space that overstart trays require in production planning. One of the reasons Raker values its robotic replugging system is that it patches trays within two weeks of sowing, so we gain space when overstart trays are used.

Seed Treatments

Sometimes problem germinators are difficult to grow only during certain parts of the year, due to temperature or day length effects. In this case, shifting the production window to a more favorable time of year may be the best option. A germination chamber with the optimal germination temperature may also be helpful in this case, as with growing pansy in the heat of summer.

It can be worthwhile to trial in-house seed treatments for crops that consistently prove difficult to germinate. It is always best to use multiple seed lots in trialing, and always have a control of untreated trays.

Scarification can be helpful to improve germination in hard-seeded species, notably Bean Family (Leguminosae) Baptisia, Hibscus, Lupine, Lathyrus, Malva, Thermopsis. Scarification can be done by chemical means with an acid soak; through mechanical means by filing, nicking, or abrading seed coats; or by soaking seeds overnight in water heated to 190 F (88 C).

Stratification is the process of exposing seed to cold temperatures while in a moist environment. Many perennial and woody species needs stratification to germinate well. Such

species are sometimes called “frost germinators”, due to their need for a cold period to overcome dormancy. A general strategy for frost germinators is providing 2 to 4 weeks of warm temperatures (65 to 70 ºF), then 4 to 6+ weeks of cold temperatures (38 to 41 °F). Some species have “double dormancy”, and require a second warm/cold period to germinate. Fall sowing and overwintering flats outdoors or in cold frames is a traditional way to germinate these species. Seed can be placed in moist vermiculite or sand in bags in a refrigerator as another option.

Chemical seed treatment is another option. There has been increasing interest in using gibberelic acid (GA3) to improve germination in some species. The out of print references for suggestions on GA are Norman C. Deno’s *Seed Germination: Theory and Practice* and its two supplements. They can be found online in .pdf format. JL Hudson, Seedsman (www.JLHudsonseeds.net) offers GA kits for treating seed.

Buying in plugs from a specialist propagator for difficult species that you continually struggle and fail with may be a good option, and actually more economical in the long run.

Improving Success handling plugs

It is good idea to fertilize plug trays before transplanting with a moderately strong, balanced fertilizer solution (150-200 ppm nitrogen), to ensure the transplants get off to a good start. Always use a plug punch or popper to loosen plugs in trays before transplanting, to minimize the possibility of damaging the seedlings.

Pay extra attention to moisture management for newly transplanted plugs during the first week to two weeks after transplanting, to ensure they are not stressed.

IPM – Integrated Pest Management

A monitoring system should include regular scouting of sticky cards and plants in production for evidence of pests and diseases. Inspecting plant material or holding it in a quarantine area before it enters the greenhouse is also ideal. The goal is to identify problems early and treat them before a large outbreak occurs. Sanitation and weed control must be a part of a good IPM system. Reliance solely on chemicals for pest control can lead to resistance. Always practice good rotation of chemical classes when using pesticides.

Full biological control is very challenging in plug production, due to the short crop times, but there are some options that can be integrated into a conventional system.

Nematodes can be very effective to quickly control fungus gnat and shore fly larvae. Be sure to examine nematode solutions after mixing with a high powered lens or dissecting microscope to ensure that they are viable and active, and follow label instructions regarding minimum screen sizes for nozzles.

A wide range of products containing beneficial microbe products can be incorporated into the growing medium before tray filling, or applied in a liquid solution later. Designed to reduce disease problems, more and more growers are such beneficial products, with good results.

Preventative pesticide application, primarily for disease control, may be worthwhile for some species. The industry currently expects pansy and (increasingly) impatiens walleriana plugs to receive preventative treatment, for instance. It is generally more efficient and economical to treat plants in the trays before transplant.

Germination Details

Detailed germination lists are available by email request, or online at www.perennialguru.com