Recent Developments in Seed Germination of Ornamental Herbaceous Crops

Robert L. Geneve
Department of Horticulture, University of Kentucky, Lexington, Kentucky 40546

INTRODUCTION

Seed propagation is the major production system for ornamental herbaceous crops. It is also an area of propagation that has seen a tremendous increase in innovative techniques used to enhance quality plant production. Much of this innovation has developed in response to plug production of seedlings. A plug is a seedling grown under near optimum conditions in a small volume of growing medium. This increases production efficiency because more plants can be grown per unit area of greenhouse space. Seed germination is the critical initial event that determines success in plug production. This has led to increased emphasis on seed quality and techniques to enhance seed germination. This review will briefly cover the recent advances in the area of seed germination including:

1) Seed treatments to enhance germination and seedling emergence.
2) Seed vigor testing.
3) Mechanical seed sowing.

TREATMENTS TO ENHANCE SEED GERMINATION

The seed industry has invested in a variety of treatments to enhance the potential for rapid, uniform seedling emergence. The techniques available commercially include seed coating, "select" or "elite" seeds, seed priming, and pregermination.

Seed Coating. Seed coating uses the same technology and equipment used by the pharmaceutical industry to make medical pills (Kaufman, 1991). Seed coatings include pelletized and film coated seed. Pelletized seeds are coated with inert powders like diatomaceous earth. The purpose of seed coating is to provide a round uniform shape and size to small or unevenly-shaped seeds. This is very important for precise mechanical sowing. After sowing the pellet "melts" away allowing the seed to imbibe water. Flower seeds that are commonly pelletized are the small-seeded crops like ageratum, begonia, dusty miller, portulaca, and petunia. This allows for precision sowing of one seed per cell in a plug flat. However, some crops perform better with multiple seedlings in a single plug. This has led to the development of multi-seeded pellets that reduce sowing time because only one "seed unit" needs to be sown. Lobelia and alyssum are commonly sold in multi-seeded pellets.

Film coated seeds have a thin polymer film that covers the seeds. Film coating only adds 1% to 5% to the weight of a seed compared to over 1000% for pelletized seed, but this can still aid in mechanical sowing. Fungicides can be added to film coatings and this is a major benefit of film coating. Incorporating the fungicide in the polymer material eliminates the dust associated with traditional slurry applications of fungicides and the coating does not come off the seed when handled. Film coatings are usually colored to add attractiveness to the product and to avoid accidental human or animal ingestion if a fungicide has been used. Only a few species of bedding plants, like marigold, are commercially available with film coating, but additional types of seeds will probably be offered commercially as this technology progresses. Various polymers are being researched that have different properties related to temperature, oxygen, and water that could prove useful as seed treatments.

Select Seeds. These are seeds that have been "selected" from the original seed lot and promoted as having improved germination. This usually means the seeds test above 90% in the companies seed testing lab. The most common technique uses seed size and uniformity as a major criteria for separation of "select" seed from the bulk seed of the original seed lot. Select seeds can improve the number of useable seedlings in a flat and may be related to seed vigor (see seed vigor later in this paper).

Primed Seeds. Seed priming uses osmotic (osmoconditioning) or matric forces (matriconditioning or solid matrix priming) to imbibe seeds for an extended time without radicle emergence. After a specific priming time, the seeds are dried back to near their original dry weight. These seeds can be handled as normal raw seeds or pelletized prior to sowing. Seeds that have been primed will usually have higher seed vigor compared to raw seed (Bradford, 1986). Priming can provide faster, more uniform seedling emergence, especially when environmental conditions for germination are not ideal. The two bedding plant species most commonly offered as primed seeds are pansy and impatiens. However, most seeds can be primed by commercial seed treatment companies on an individual grower basis. Pansy has the largest market for commercially primed seeds because priming reduces the problem pansy experiences when germinated at high summer temperatures (Carpenter and Boucher, 1991). The grower must weigh the additional cost of primed seeds with their potential for improved seedling emergence.

Pregermination. The goal of each grower is to establish a "stand" (seedling emergence) of 100%. This provides a useable seedling in each greenhouse plug cell. In concept, pregermination can take place under optimum conditions and only seeds showing radicle emergence are sown providing near 100% stand. Pregermination is a relatively new commercial technique. Impatiens is the only pregerminated seed crop being sold in 1996. Seeds are induced to synchronously germinate and arrested as the radicle emerges (<3 mm). Seeds are then dried and stored at low temperature until used by the grower. Pregerminated seeds have a short life-time and are relatively expensive. However, better growers are establishing near 100% stands using this type of seed and it is expected that more bedding plant species will be available as pregerminated seed in the near future.

VIGOR TESTING

Although state and federal seed laws currently require only purity and standard germination tests as measures of seed quality for seed lots, seed companies and many crop producers are performing vigor tests prior to sale or use. The Association of Official Seed Analysts state that "seed vigor comprises those seed properties which determine the potential for rapid, uniform emergence, and development of normal seedlings under a wide range of field conditions" (Association of Official Seed Analysts, 1983). Standard germination tests do not always adequately predict seedling emergence. Seed vigor tests can provide a grower with additional information that can help predict germination where conditions may not be ideal. Various vigor tests have been developed and certain tests are applied to different species

(Association of Official Seed Analysts, 1983; Hampton, 1995). Vigor tests used most often for bedding plants have included seedling grow out tests, and temperature stress tests. Recently, tests using accelerated aging and digital image analysis have been developed for bedding plant species.

Seedling Growth Rate. This test is an extension of the standard germination test for percentage germination. After a period of time at a controlled temperature (this varies between species), shoot and root length or seedling weight is determined. This may be done under greenhouse conditions to determine useable seedlings for a seed lot. Recently (1995), Ball Seed Company (West Chicago, IL) introduced the Ball vigor index that employs computer analysis of video images of seedlings in plug trays after a predetermined number of days. The index is suggestive of seedling greenhouse performance. Growers are expecting to see measures of seed vigor for a given seed lot. Expect to see more digital imaging systems in the future used to access vigor in bedding plant seeds.

Cool Test. This is a standard vigor test used for agronomic crops especially corn. It uses procedures identical to the standard germination test except the temperature is lowered to 18C. A similar tool is being used to evaluate flower seed vigor. It uses a sophisticated thermal gradient table to provide various warm or cool temperatures by circulating warm and cold water under the table. This simultaneously determines the range of permissive temperatures for germination in a seed lot. Higher vigor seeds germinate better at the extreme temperatures on the table. Thermogradient tables have also been useful in determining the highest temperatures for germination in bedding plant species that might experience thermodormancy or thermoinhibition.

Accelerated Aging. This test has been commonly used for agronomic and vegetable seeds. Prior to a standard germination test, seeds are subjected to high temperatures (40 to 45C) and high relative humidity (near 100%) for 2 to 5 days. This partially hydrates the seed without permitting radicle emergence. High vigor seeds tolerate this stress better than low vigor seeds as shown by higher germination percentages in the standard germination test. The smaller seed size of most bedding plant species has meant that the systems used for agronomic species can not be applied directly. However, modifications to the standard accelerated aging protocols are being developed for bedding plant species and may prove very useful for determining seed vigor and predicting seedling emergence.

MECHANICAL SEED SOWING

Plug production requires the use of a mechanical seeder (Bartok, 1994). When evaluating a seeder, growers must consider cost as well as the seeder's ability to deliver seeds at the desired speed without skipping cells due to poor seed pickup or delivery. A grower may also need the flexibility to sow a variety of sizes and different shaped seeds. It is also important to consider the volume of flats to be seeded, and the ability to sow multiple seeds per cell. Three types of seeders are commonly available to plug growers. These are template, needle and drum seeders.

The template seeder is the least expensive type of seeder. It uses a template with holes that match the location of cells in the plug flat. Template seeders use vacuum to attach seeds to the template. Releasing the vacuum drops the seeds either directly into the plug flat or into a drop tube to precisely locate seeds in each cell of the plug flat. Templates with differently sized holes are available to handle differently sized and shaped seeds. A different-sized template is also required for each plug flat size. Template seeders work best for round, semiround, or pelleted seeds. It is a relatively fast seeder because it sows an entire flat at once. However, this is the least mechanized of the commercially available seeders. It requires the operator to fill the template with seeds, remove the excess and then move the template to the flat for sowing.

The needle seeder is a moderately priced seeder. It is fully mechanical using vacuum pressure to lift single seeds from a seed tray and deposit one seed per plug cell. Individual needles place seeds directly in plug cells or into drop tubes for more accurate seeding. A burst of air can be used to deposit seeds and clean tips of unwanted debris. The needle seeder can seed a range of sized and shaped seeds including odd-shaped seeds like marigold, dahlia, and zinnia. Although slower than the drum seeder, it is still relatively fast, sowing up to 100,000 seeds per h.

The drum or cylinder seeder has a rotating drum that picks up seeds from a seed tray using vacuum and drops one seed per plug cell. This is the fastest, most precise and most costly of the commercial seeders. Most drum seeders require a different drum for each plug flat, but newer models have several hole sizes per drum that can be selectively put under vacuum pressure. Drum seeders work best with round, semiround, or pelleted seeds. Large plug growers choose drum seeders because they seed a high volume of seeds quickly. Drum seeders can sow up to 800,000 seeds per h. Sophisticated drum seeders "eject" seeds from the drum using an air or water stream for precise seeding location in the flat.

CONCLUSION

There is a trend in the bedding plant industry toward mechanical transplanting seedlings from plug flats into larger celled containers for eventual retail sale. Mechanical transplanters are expensive, but significantly reduce labor costs and their transplanting speed can increase production. Mechanical transplanting will put even greater pressure on the plug grower to produce near 100% useable seedlings per plug flat. The ability to accomplish this starts with quality seed. The grower will require additional efforts to improve techniques to enhance seed germination and standard tests that reliably report seed vigor for any given seed lot.

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