

Pennycress

General Plant Care and Pest Control



Written May 2018 by William Kezele

Introduction

Thlaspi arvense, or field pennycress, is a winter annual in the Mustard family (Brassicaceae). This plant yields many benefits to the soil in agricultural operations as a cover crop, but also shows great promise as an oilseed crop for biofuels and as a high protein supplement for animal feed.



Because it is a winter annual, pennycress is grown here at the Danforth Center within our environmentally controlled growth chambers or in our A/C houses. Either a cold vernalization period or seed cold treatment is necessary in order to emulate winter conditions and facilitate the plant reproductive cycle for the production of seed.

Planting, cold treatments, bagging and harvesting are typically managed by researchers, but all other aspects of plant care, such as watering, fertilizing and pest control, are managed by Danforth greenhouse staff.

Environmental Conditions

- Average daily temperature: 68°F (20°C)
- Average night temperature: 66.2°F (19°C)
- Average Relative Humidity: 30% - 80%
- Day Length: 16 hours



- Supplemental Light Spread: 50/50 Metal Halide, High Pressure Sodium
- Shelf Lights: 49W T5 High Output Red fluorescent lights and 49W T5 High Output Blue fluorescent lights

Planting / Germination

In a greenhouse environment, pennycress' life cycle is typically in the range of 90-140 days, depending on the experiment. Within that time, various cultivation procedures are followed to ensure pennycress is healthy and productive for its research purposes.

- Seeds are planted into 72 plug trays filled with Metromix 360 soilless media for germination. At this stage, cells should only be watered in with RO, or reverse osmosis water, either by bottom watering or by gently watering in each cell as it dries out. Once seeds germinate, take care not to let the seedlings dry out. When the top surface is fairly dry, add a little water, but do not overdo it and waterlog the young plants.
- After 2-3 weeks, plugs are transplanted into larger pots containing Metromix 360 media. At this stage, an all purpose 15-16-17 fertilizer/municipal water blend can be applied on Monday, Wednesday and Friday with RO being used all other days. Water pots that are *dry on top to a depth of ¼" down, not dry all the way through the pot.*
- It is important to note young pennycress grown in soilless media does not like to be waterlogged. At this stage, and every stage up until the rapid growth phase, these small pots (typically 2.5" - 3.5" pots) do not have to be completely soaked when watered. It has been observed here at the Danforth Center that young pennycress prefers light waterings when young. Encouraging a more frequent wet/dry cycle seems to favor healthy root growth. Waterlogged pots during juvenility seem to have a negative lasting effect on the plants' ability to uptake nutrients that can reverberate throughout a good portion of its life cycle. If young plants are exposed to high amounts of sunlight throughout the day, check them 3x a day to ensure they aren't subject to drought

stresses. Under gentle artificial light, or all other conditions, check young plants 2x a day.

- Transplant pot sizes depend on various experiments which can also be identified by the color of the stake in the media:
 - 1 Gallon pots are used for seed increase as the larger pot allows for the plant to grow larger as well, producing more seed.
 - 3.5" pots are used in the breeding experiments. Red stakes mark wild type parent plant types used for making crosses, or deliberate interbreeding. Yellow tags mark the progeny of those wild type plants.
 - 2.5" pots are for putative genetic transformants and are marked by a lavender stake.
 - 3" pots are used for plants which are intended to be floral dipped for genetic transfer (*Agrobacterium*-mediated transformation), and are also marked with a lavender stake.
 - Orange stakes denote changes in plant sampling.
- Once transplanted, pennycress that was started in the greenhouses typically lives the rest of its life cycle out in the same greenhouse. One exception would be when plants are floral dipped, they stay in a dark room overnight before returning to the greenhouses the following morning. These plants will then be spaced to every-other cell in their respective trays to encourage better growth conditions, such as better airflow to help prevent the spread of fungal pathogens such as powdery mildew, more sunlight per



plant, facilitating a faster wet/dry cycle by allowing improved airflow within the rosettes, slowing the proliferation of pests in hard-to-see dense vegetation, etc.

Reproductive Growth Phase

- When plants reach their reproductive cycle, a dominant shoot will emerge from the rosette crowned by a terminal inflorescence. In the weeks leading up to this stage, it is crucial that biological pest control be applied to protect the emerging meristem from Western Flower Thrips (See pest control section). If Thrips are present on the plant during this time and left unmanaged, meristem dieback will occur, eliminating any chance of a healthy terminal inflorescence. Additionally, pots will begin to dry out more frequently in this phase. In the AM on warm, sunny days when media is just starting to look dry, water in the pots to prevent exposing the plants to potential drought stress due to their increased water/fertilization needs during this period.



- As the plant's height increases, staking will be needed to prevent lodging and to continue encouraging uniform, upright growth. Alert researchers just before staking is needed allowing them time to address the issue before lodging begins. A hyacinth stake and twist-ties work just fine.

- Once seed pods are filled and maturing, they will begin to yellow. At this time, researchers will bag their plants to prevent potential seed loss.

- Once plants are bagged, they will stay where they are to finish out their life cycle. Placing flats on the top shelves in the sunniest parts of the house seem to speed this process up. Irrigation can be lessened quite a bit at this stage as water use begins to taper off. Allowing the tops of pots to dry out between waterings and dramatically decreasing the fertilization regimen is advised to encourage dry down and to prevent the plant from sending up new shoots.

- When the terminal seed pods have fully matured to a dry, brown state, researchers will place a do not water sign in that flat to signal the end of irrigation to these plants.

- Once the entire plant is dried down, the seeds can be harvested, and remaining plant material discarded.



Jiffy Peats

Flats of jiffy peats will occasionally show up in the “New Plant Material” greenhouse from time to time. These plants are for field trials. They are grown for 10 days in our greenhouses then vernalized for 14 days before being planted in the field. Bottom water jiffy peat flats with RO water until they are soaked through, then dump the flood tray. Dome these flats until germination, then remove.



Pest Control

The first line of defense for preventing pest outbreaks is to make sure no infected plant material ever enters a pest-free house. Additionally, be sure to water the four cold weather houses in order of plant age (youngest, least-infected plant material to oldest, most-infected plant material).

Pesticides

The pests pennycress is primarily affected by on a regular basis here at the Danforth Center are Thrips, Aphids and Powdery Mildew. Thrips are generally managed by biological control (see below). For the other two:

- Aphids: spot spray small breakouts with either Aria or Endeavor as soon as you see them. They usually like to hang out on the under sides of pennycress leaves or on the stems while the seed pods are maturing. Once the population begins to spread through



the house, spray all affected plants, and those adjacent, with a fine mist of low-mid concentration Endeavor (Pymetrozine) or Aria (Flonicamid). This usually knocks them all back for a decent period of time. The rosettes are quite dense for some of these plants making efficient pest scouting more difficult, so spraying adjacent plants proactively is advised. By the time their presence is seen throughout the house, even in small clusters, their population has usually already grown more than is easily observed.

- For Powdery Mildew, spray all plants proactively with Procidic (Citric acid) @5mL per 24oz of RO 2x a week. If Powdery Mildew persists, spray the house with Strike (Triadimefon). Two applications usually arrests its spread for quite some time. Continue with Procidic treatments the following week.

Biological (Beneficial Insects)

Thrips are always present in these houses, and if left alone, will multiply and decimate young plants.

- We use *Hypoaspis miles* and *Neoseiulus cucumeris* for Thrips control. Apply weekly to all young plants up until, and just after, the bolting phase. It is crucial to maintain a healthy population of these insects on the pennycress throughout the first half of their life cycle in order to prevent excessive juvenile plant damage and to thwart meristem dieback during the initial bolting phase.
- **Each week**, I apply 1.5 bottles of each insect (roughly 75K *N. cucumeris* insects and roughly 37.5K *H. miles* insects) between the “New Plantings” house and the next youngest “Mature Plant Material” house. Continue applying to all plants that have not yet, or just started, bolting and also to any crossing block plants until crossings have been made successfully.
- Apply by shaking the bottle like you are adding spice to a dish. Sprinkle over plants and at pot level in order to maximize coverage.
- When applying these insects, turn off the lights and close the shade curtain. If you can push the application to as late as sunset and beyond, that would be best.
- The following morning, turn the lights back on and open the shade curtain.



Beneficial Nematode Application

- For **fungus gnats and thrips (inactive pupa stage) control**, water beneficial nematodes in weekly. Remove packet from refrigerator, and once it reaches room

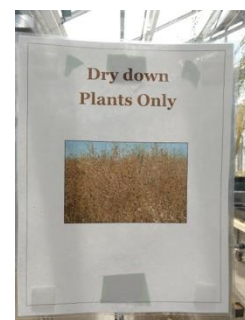
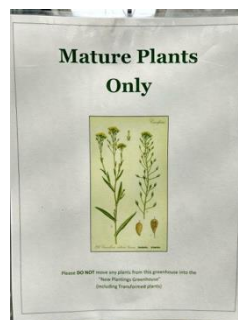


temperature, add packet + 3 gallons of RO water to tank. Use a siphon and fertilizer water from the wall when applying. I like to allow as many pots as possible get dry on top so as many plants as possible can be watered with nematodes on this day. Fungus gnat control is essential in these houses due to the lower temperatures and length of time certain pots stay wet after watering. Pop in and out of the houses all morning and early afternoon, watering only the plants that are borderline too dry. By 1-2pm, water in all plants in all cold weather houses with nematodes except anything that is still soaked from its last watering and refuses to dry out. I do not encourage applying more water to any pots that are already saturated.

Cold Weather House Rotation

Here at the Danforth Center, we rotate our four cold weather houses on an aggressive schedule in order to stop pest proliferation before it starts. Around the time the latest house still accepting new plant material fills completely up, another house should be ready to sanitize and reopen to accept the next new plant material. Keep an eye on the state of these houses in order to facilitate this rotation and accommodate the researchers' needs. If the current dry down house has too much remaining dry plant material in it to begin the sanitation process, please contact all researchers on the PTR's of these plants and let them know you will need them to harvest/remove their plant material in order to expedite the process. In the event where there are only a few flats that need to come out of the house before you can begin the sanitation process, move them into the house with the most mature plant material, and alert the relevant researchers of the move.

- There are four houses in the rotation. One will always be for "New Plantings Only", one will be

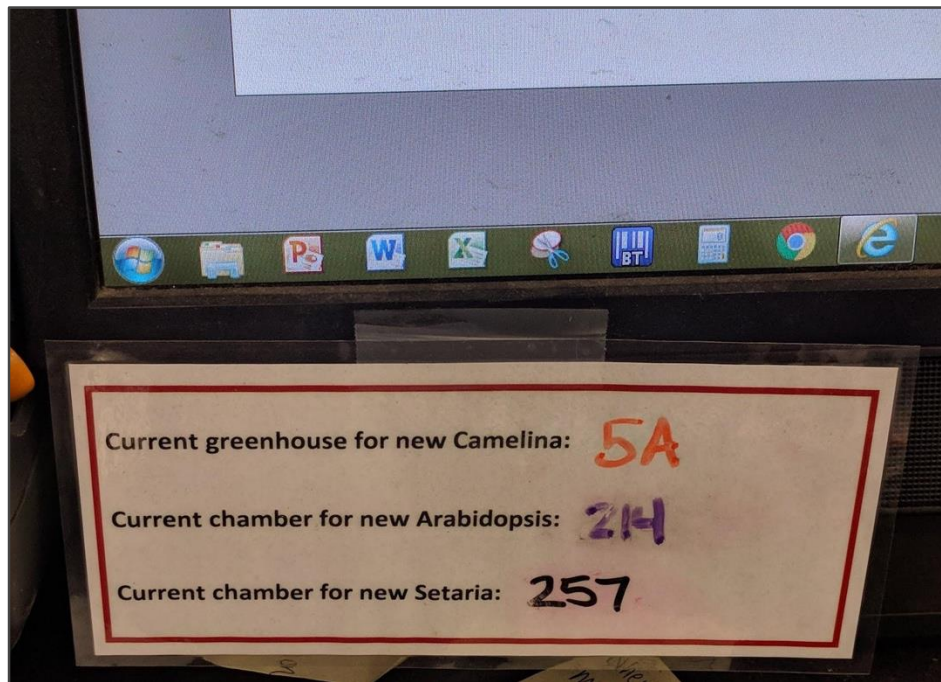


“Maturing Plants Only”, one will be “Mature Plants Only” and one will always be “Dry Down Material Only”. *Make sure each house has the correct corresponding sign on its door.* (“New Plantings”, “Dry Down”, etc.)

Sanitation Procedure



- Sanitize all trays, shelves, walls, floor, drain, etc. with Physan. Please wear a mask, gloves and long sleeves when using this chemical to prevent exposure.
- Place the trays back into the sanitized house one cleaned, and set the house to bake. Turn off misters to keep humidity as low as possible, and set high temps to at least 90F. These houses have a hard time getting this hot in the cooler months, but they can maintain the temperature in the warmer months (especially the south side houses).
- Turn off the shelf lights from the Square D control in 4A* (Square D procedure starts on page 11).
- Lock the door, and let the house ‘bake’ for at least 3 days with low humidity and high temps.
- When you are ready to reopen the house, return the environmental conditions to normal, turn on all the lights, unlock the door, place the “New Plantings” sign on this door, rotate all other door signs accordingly and write the newly sanitized house number on the laminated card attached to the PTR computer monitor in the potting room (shown below) so researchers know where to place new material.

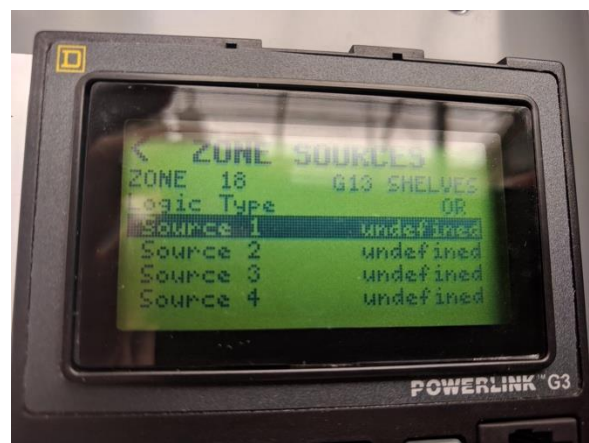
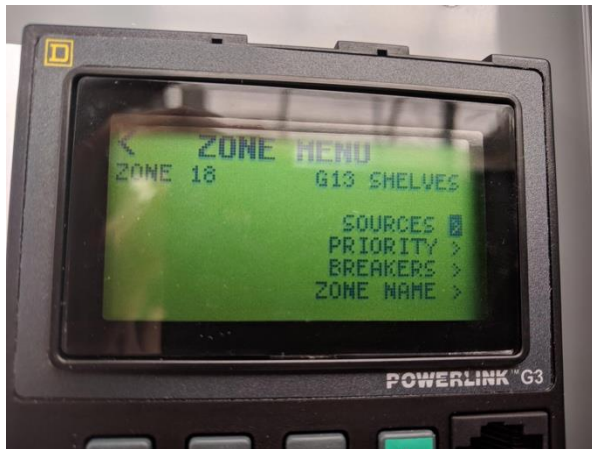


*Square D Procedure

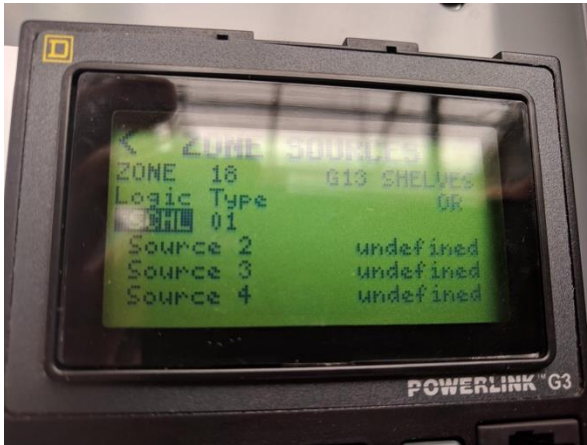
There are only 4 keys on the panel. Use arrows to navigate through sections, and the “+” and “-” buttons to cycle through options. The green button is also the “enter” button.



1. From the Main screen, enter the menu at the bottom right.
2. Select "Zone", press enter.



3. Cycle through zones with "-" and "+" buttons to find the house lights you intend to adjust.
4. Enter into "Sources" of selected zone.
5. Highlight "Source 1" and cycle through the options until it says "Schedule 1"



6. Once source is set to "Schedule 1",
navigate to the upper left hand corner arrow and hit enter. You should hear a buzz come from the fuse box. This means the lighting schedule was initiated.
7. Navigate back to the main screen by selecting the upper left hand corner arrow and hitting enter until you get there.

For additional information, contact Kevin Reilly: kreilly@danforthcenter.org