

RICE HOUSES General Plant Care and Pest Control



May 2018 by William Kezele

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Introduction

Oryza sativa, or Asian rice, is an annual monocot in the Poaceae family, and is comprised of two main types, *indica* (long grain) and *japonica* (short grain). *Indica* varieties are usually grown submerged in low land areas, while the *japonica* varieties are typically grown in dry fields at higher elevations. In our greenhouses, *japonica* varieties do well in an ebb and flow irrigation set up, while *indica* rice is kept in a constant flood. It is important for us to know the type of rice to be grown in our greenhouses, so that irrigation methods can be modified for optimum plant growth.

General Plant Care

All rice at Danforth is primarily grown in greenhouses G5B and G9B, and their auto-irrigation capabilities are identical. Rice life cycles are started and finished in these houses in order to contain a known rice pathogen and the pest that carries it (See pest section below). Mist benches are built into each house to provide an optimum environment for germination and juvenile growth, so plants can start and finish their life cycle in one greenhouse.

The life cycles of various rice cultivars grown here at Danforth are between four-five months long. Since these two rice greenhouses are multiuser, or available to any lab for concurrent and varying plant growth experiments, an environmental condition that reasonably suits all rice, transgenic or wild type, has been implemented.

- Average daily temperature: 82.4°F (28°C)
- Average night temperature: 75.2°F (24°C)



- Average Relative Humidity: 30% 80%
- Day Length: 14 hours
- Supplemental Light Spread: 50/50 Metal Halide, High Pressure Sodium

All benches alternate between clear and fertilizer cycles. Clear water is reverse osmosis, or RO, water and fertilizer cycles are Jack's All Purpose Fertilizer @200ppm Nitrogen blended with our municipal water giving us an average pH of 6.5-6.9 with an average EC reading of 1.5-1.9.

Planting / Germination



-Young Rice (1 week old) on the mist bench-

1. Line the bottom of a 4"x 4"x 3" pot with a square of agrofabric or paper towel measuring 3 1/4" X 3 1/4", or enough to cover the holes.

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- 2. Place the needed number of pots in the appropriate tray. Pots can be spaced 15 per tray.
- 3. Fill pots with Turface **Profile** (Fine particle calcined clay smaller than turface MVP). Water each pot until completely moist.
- 4. Plant 2-3 rice seeds per pot, depending upon the germination rate of the seed and the intended purpose for the plants. Seeds should be planted just below the surface, fully covered by the Profile. (Thinning out seedlings post-germination is recommended to reduce fungal pest pressure, and improve overall plant health.) For best results, thin to 1 plant per pot.
- 5. Place the tray on the mist bench. Mist bench runs every 15 minutes for 45 seconds.
- 6. Fertilize daily with 15-16-17, 200 ppm N once the seed has germinated.
- 7. Allow the plants to grow for 2-3 weeks on the mist bench until transferring flats to an open bench.





-Young Rice (2-3 weeks old) on the mist bench-

Weedy Rice (Indica)

For weedy rice (Indica Variety), place all all plants on the farthest bench in the house and plug the tray with 2 stacked bulkheads/risers in order to facilitate a high tide/fill. These plants get rather large and will need much more water than smaller japonica varieties like Kitaake.

All large rice varieties like weedy rice (indica) or even Taipei 309 should be grown on the farthest bench from the door (North Side of house by exhaust fans) in order to prevent them from shading out shorter rice varieties. In order to accommodate this plant's aggressive nutrient and water needs, plants should be grown in Profile media and placed in a continuous flood irrigation.

*Please alert the greenhouse staff when any rice flats are moved within the house, especially when young rice is moved off of the mist bench and onto an open auto-irrigated bench.

For plants grown in Turface MVP:

• When turface MVP plants are young, and they are first moved over to the irrigated benches, plug the tray with a single bulkhead/riser to make sure they have enough water until their roots reach the bottom of the pots. It's a good idea to just let them grow in a shallow, constant flood for the first few weeks.





-Young plants growing in Turface-



Vegetative To Reproductive Growth Phases



- 1. Once plants are 2-3 weeks from germination, they should be moved from the mist bench to an open bench.
- 2. All rice will need iron treatments during their youth, and up through part or most of their rapid growth phase in these houses. In the AM, trays are plugged, and 20-25cc of Sprint (Iron chelate) is released into the tray. Trays remain plugged and plants remain submerged until late afternoon. Trays are then drained and reset to an ebb and flow irrigation. This treatment may need to be repeated 1x per week for 2-4 weeks throughout the rapid growth phase in order to facilitate healthy iron uptake.
- 3. All benches in 5B and 9B are set up for automatic irrigation. The water comes on for 3.5-4 minutes, turns off, then drains out of the flood trays. Total time the pots are submerged in water is roughly 10-20 minutes.



4. Panicles may be harvested once they are completely dry and brown (no green) and the seed is hard.



Growing Nipponbare Japonica Variety and Other Obligate Short Day Rice

To date, Nipponbare has failed to naturally initiate its reproductive phase in our greenhouse conditions alone, primarily due to the multiuser greenhouse's 14 hour day length. A photoperiod treatment in a chamber of 10 hour short days at 28°C for 2-4 weeks has shown to be successful to force flowering. It is recommended that the transfer into a chamber with these conditions occurs no later than 6 weeks into the plant's development.



Note: Obligate short-day varieties will likely not flower if grown with a 14 hour day length. Knowing the light requirements of your rice before planting is advised.

Harvest

Rice is ready to harvest when all seeds are brown and if you cannot easily push your thumbnail into the seed. Rice is kept on the irrigated benches until harvest is complete.

Do not remove your rice plants from the house to harvest.

In order for us to contain a particular insect pest and the rice pathogen it spreads, rice seed must be harvested and unneeded plant material discarded <u>within</u> the house.

Review our rice house seed treatment protocols below before planting.





It is important we know all seed coming into our greenhouses has been properly treated in order to minimize the chances of any new potential inbound pathogens.

After your seed is harvested, an additional seed treatment will be needed before you plant the seed within the Danforth Center or even if you intend to ship the seeds elsewhere.

Seed Treatment Protocol

All seed grown in the rice houses must first be treated. In order for us to determine that all plants currently growing in a rice house have had their seed treated before planting, we ask that you **do not ask us to treat your entire seed stock.** We will only treat the seed you intend to plant for your next experiment.

To treat your seed:

- Place the seeds you wish to be treated into a small manila envelope.
- Drop your seeds into your lab's "drop-off" drawer on top of the refrigerator outside greenhouse office 0017.
- Please write your Lab's name, date dropped off and rice variety/genetic line on the envelope.
- Log this information into the rice logbook on the refrigerator door. (Don't forget to sign your name).
- Send an email to greenhouse staff to let us know you dropped seed off to be treated.
- A greenhouse staff member will assign a label and unique number to the rice packet for tracking/logging.



- The rice will spend 3 days in a dryer with 0% relative humidity, and 35°C temperature.
- The rice will then spend 3 days in a freezer set to -20°C.
- When the treatment is complete, the rice packet will be placed in the appropriate lab's "pick-up" drawer where it can be picked up.

Along with new seed treatment protocols are new greenhouse standards and practices we ask everyone to follow in order to help us eliminate *Siteroptes avenae* from the Danforth Center.

- There will be lock boxes on each rice house containing the key to unlock the door.
 Please contact Kevin Reilly for the lock box codes. Remember to lock the door after your work in the greenhouse is completed.
- Since there are two rice greenhouses, only one will be accepting new plant material at a time while the other will contain plant material that is finishing its life cycle. Please contact greenhouse staff for up to date information.
- All new rice plantings are to be placed on the mist bench for 2-3 weeks until plant material is mature enough to grow in the standard greenhouse conditions.
- Greenhouse staff will determine optimum time to move plants from mist benches to open benches unless specific experiments state otherwise.
 Researchers, please relay this information to the greenhouse staff at the time of planting to avoid co



greenhouse staff at the time of planting to avoid confusion.

- Plant life cycles will be started and finished in these houses. If any plants are removed from the house during their life cycle, they may not return to these houses afterward. In the event this takes place, please contact greenhouse staff.
- During the time of harvesting, please discard all unwanted plant material inside the house.



Pest Control - Pesticides

The rice houses here at Danforth typically only show regular pressure from from two kinds of pests. One is easy to suppress and is generally not considered a high threat, and one is quite severe. The less concerning pests are aphids. The aphids generally cluster just beneath the seed panicle as the seed is maturing. A chemical pesticide spray of Endeavor (Pymetrozine) or Aria (Flonicamid) works well to significantly knock back the population.

The more severe pest is the microscopic mite species, *Siteroptes avenae*. This spider mite 100-200 microns in length, harbors microconidia which release *Fusarium spp*. that spreads throughout the rice rather quickly if not treated for. Because the mite spends most of its time between the leaf sheaths, pesticide/fungicide sprays are not effective. Frequent release of the beneficial predatory mite *Neoseiulus californicus* seems to keep the population of *Siteroptes avenae* suppressed to a low pressure. Below are images of *Fusarium spp*. Damage:



Other less threatening greenhouse pests:

Algae



 To control algae in the plugged, continuous flood trays, we drain them every Monday morning. Once drained, we replug the trays and turn on the RO irrigation manually. As it's running, we add 5-7mL of Zerotol to the tray. When the water level reaches the top of the drain plug, irrigation is turned off. Throughout the week, the irrigation cycles will continue to add water to these trays, diluting the Zerotol. If algae starts to get worse, you can add an additional application to the trays later in the week.

Root Aphids

• Occasionally, root aphids appear and proliferate in the flood trays. Typically, they like the trays that are plugged for constant flooding. These are the trays that we apply Zerotol to for algae. The Zerotol seems to keep them at bay, but when populations get high, an application of aphicide added to the water and left overnight seems to eliminate the aphids. A follow up application can be made if populations persist. *It is imperative to follow pesticide label recommendations whenever applying these chemicals.*

Biological Control - Applications and Quantities

Because of the microscopic mite mentioned above that vectors *Fusarium*, an application of *Neoseiulus californicus* is applied every two weeks. The below recommendations are based on predatory mites purchased from Beneficial Insectary (2,000 mites/450cc).

Release instructions:

- Turn off the lights in the house and close the shade curtain.
- As late in the day as possible when no direct sunlight is getting in the house, open bottle and apply 3-6 capfuls to every flood tray in 5B and 9B. Apply them over the top of the panicles and also at the pot level.



- Put out (1) whole bottle in 5B, and (1) whole bottle in 9B. The caps and empty bottles are placed on a tray for a couple days to allow the remaining bugs to make their way to the plants.
- The following morning, turn the lights back on and open the shade curtain.

Pest Control (General)

• In order to prevent the vectoring of *Siteroptes avenae*, or *Fusarium spp.*, do not enter the rice house with new plant material after visiting the rice house with older, infected material.

Setting Irrigation

All rice in 5B and 9B is on the same auto-irrigation set-up. Auto-irrigation cycles go off 4-5x a day depending on the media the plants are growing in. All rice gets 1-2 fertilizer cycles a day for a consistent nutrient feed, and 3 RO cycles in order to continually flush out potential soluble salt build-ups in the pots.

If all plants on a bench are planted in Profile (a fine particle calcined clay media), we run
 4 irrigation cycles a day with only 1 cycle being fertilizer. In this situation, the schedule would typically be:

7am (Clear), 11am (Fert), 3pm (Clear), 7pm (Clear)

 If all plants on a bench are planted in Turface (a coarse particle calcined clay media), we run 5 irrigation cycles a day, especially as the plants start to mature. Two of these cycles would be fertilizer cycles due to how easily the nutrient solution can leech through turface's larger pore spacing. In this situation, the irrigation schedules would typically be:

7am (Clear), 10am (Fert), 1pm (Fert), 3pm (Clear), 7pm (Clear)



• If the plants on a given bench are in mixed media, then we schedule the irrigation to accommodate the most well-drained media. This is usually Turface. Use the schedule that runs 5x a day in this situation.

Irrigation Valves

Each bench has two solenoids, one for clear water cycles, and one for fertilizer water cycles. Each solenoid can be triggered automatically from Argus programming, manually from the Argus box just outside the greenhouse, or manually from the controls on the solenoid itself. Valves and corresponding switches are labeled accordingly:





It is

recommended that fill/drain tests are conducted

after

each time a bench and its components are disassembled/reassembled for maintenance needs. When irrigation is operational during plant life cycles, switches in the Argus box should be set to "Auto" and the corresponding controls in the Argus system should reflect this. When maintenance must be performed on irrigation components, the Argus box controls should be set to "Off", or you can turn the water off manually at the valves at the back of each bench. Once the irrigation system's components are reassembled and ready for tests, simply open the valve at the back of the bench, and turn the corresponding switch in the Argus box to "On". You should see the irrigation begin filling the trays on that bench. Start your stopwatch at this time



and when the desired fill height is achieved, record the time and return the switch to the "Auto" position. Set the time clock watering schedule in Argus to match the recorded time. Note: Fill/drain tests are typically done when the flood trays are empty, so remember to account for the volume of a full flood tray of rice flats and how they will displace the water when the tray is filling. A good baseline level to set the irrigation at is when the water line gets halfway up the height of the empty tray. Further adjustments can be made throughout plant life cycles when desired. Once plants ready for irrigation are placed on the bench, make sure the Argus controls are set to "Automatic" and the valves are zoned accordingly.

Note #1: Each bench has 4 flood trays with separate lines for fertilizer and clear water cycles that run down either side of the bench. Emitters for each tray are equipped with their own valves. If you turn any of these valves to the off position, it will affect the water pressure and change the fill rate of the other trays on this bench. Observe an irrigation cycle after doing this in order to determine what time schedule adjustments need to be made in the system to ensure no trays are being overfilled.

Note #2: Mist bench curtains are intended to hang down within the flood trays below them. This way, water from the misters that collects on the curtains will run down into the flood tray and drain accordingly. Check to ensure curtains are inside trays to avoid potential algae build-ups on the flood which can be a safety hazard.



When RO is shut down for maintenance

In the event that the RO needs to get shut off for maintenance reasons, please follow these steps:

 Shut off the RO at the RO isolation valve outside the house above the door. Follow the grey RO pipe from the drop down inside the house out to the red shut off valve if you are having trouble locating it.



 Inside the house, connect the short hose from the tempered water value to the nearest RO value with a quick connect.





- SLOWLY turn on the tempered water main valve (behind door), turn on the tempered water hose connect valve and the RO hose connect valve.
- You now have tempered water running through the irrigation RO line. This will suffice as a placeholder for clear water irrigation cycles until the RO maintenance is complete.





Tempered water shut off valve behind door

Additional Information

 RO/Fertilizer only irrigation schemes have been shown to negatively affect plant health in this set up. Having a municipal water/Fertilizer blend provides micronutrients and good pH levels for optimum plant health.



- Turface MVP is good for keeping down algae on tops of pots, but it takes more iron applications to correct chlorosis. Conversely, Turface Profile will typically have fungus gnat/algae issues, but takes fewer iron treatments to correct chlorosis.
- Don't yank on plants grown in MVP or Profile. They will lodge and not stand back up again.
- When spraying pesticides, *spray a fine mist* onto the rice and do not blast them with high pressure. The weight of the spray will force the plant to lodge and they will not recover from it.
- Check for leaks daily. Stop them before they get worse.
- Odd plant vigor/phenotypes/etc can sometimes occur in the shoulder seasons. Allow the season to come into full swing and two plant generations to show these symptoms before making any blanket assessments regarding plant health/nutrition/protocols/environmental conditions. They are sensitive living organisms in an artificial environment after all. Strange things happen periodically no matter how regimented plant care is.
- When growing in turface, substituting a clear water irrigation cycle for an additional fertilizer cycle in the Summer is encouraged in order to keep up with the accelerated growth.
- Keep an eye on weekly water chemistry results. The occasional up and down fluctuation of pH and EC values directly affects rice house irrigation.
- Keep an eye on monthly water test results as well. When soluble salts get high (typically in the Winter), running fewer fertilizer cycles could help alleviate salt build-up, and running frequent RO water cycles will help prevent build-up.
- Report any solenoid or plumbing malfunctions to Facilities. They manage the repair/replacement of solenoids and plumbing.
- If any pipe or valve ever breaks or is snapped and water is flowing uncontrollably, turn off the appropriate shut off valve outside the house to stop the flow (tempered water shut off is behind the door inside the house). Alert facilities immediately to the issue.

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