McGill
MACDONALD CAMPUS

Phytorium & Research Greenhouse Manual

Contents:

Introduction

The McGill University Plant Science Department houses numerous controlled-environment growth cabinets of various sizes within its Phytorium facility, located in the Raymond Building at McGill University's Macdonald campus.

Within the Phytorium, staff and researchers have access to growth chambers capable of controlling various environmental conditions, as well as a tissue culture room and quarantine zone.

The Plant Sciences Department also provides its staff and researchers with access to a computerized Research Greenhouse consisting of seven independently operated rooms, and several additional growth chambers and benches in its basement.

The goal of McGill University's Phytorium & Research Greenhouse is to provide the Plant Science Department with access to controlled environments for research and teaching purposes.

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Purpose

The purpose of this document is to assist Phytorium & Research Greenhouse users by clearly stating their responsibilities, as well as the responsibilities of Phytorium & Research Greenhouse personnel, relating to the day-to-day operations and all research carried out within these facilities.

General responsibilities of Phytorium & Research Greenhouse users

Faculty members who routinely use space in the Phytorium and/or Research Greenhouse are expected to provide basic training and supervision to the researchers working in their labs. This includes ensuring good scientific practices are in place regarding the work conducted in the Phytorium & Research Greenhouse, as well as ensuring that all relevant McGill policies and procedures are being followed by researchers in their lab.

Users are responsible for:

1. Possessing a general understanding of plant husbandry (e.g. planting seeds, watering, soil types, fertilizer types, humidity requirements, etc.).
    - This is especially true regarding their own study organism, and should be well understood prior to beginning a new experiment.
2. Providing care for experimental organisms (e.g. watering, fertilizing, and pruning plants; if using, feeding and containment of insects and other animals; growth, handling, and containment of fungi, bacteria, and viruses; etc.).

3. Submitting a Greenhouse Space Reservation Form. All space requests will be evaluated by the Greenhouse/Phytorium committee and space will be allocated based on availability.
    - To ensure users are assigned the desired type of space (e.g. small growth chamber, medium tissue culture chamber, greenhouse bench, etc.), it is important that they are familiar with the types of available growth spaces. This will ensure that correct spaces are assigned in a timely manner.
    - It is important that every user of a space is identified on space requests. This ensures that important information can be easily disseminated (e.g. via email) to pertinent individuals associated with a project. For example, in the case of an emergency such as a power outage, it is essential that everyone whose work may be affected can be contacted.
4. Keeping workspaces clean and tidy throughout the course of their experiment. This includes:
    - Keeping walkways in greenhouse rooms accessible and free from potential tripping hazards such as cords, wires, and hoses.
    - Keeping growth chamber/greenhouse floors and greenhouse benches free of plant and soil debris.
    - Keeping growth chambers/greenhouse rooms free of excessive dirty pots/trays/refuse/material.
    - Keeping workspaces clean figures greatly into pest management, as dirty and untidy areas can be breeding sites for common plant pests.
5. Promptly notifying Phytorium & Research Greenhouse personnel if pests are detected in workspaces so that appropriate corrective measures may be taken.
6. Preventing the spread of pests/pathogens (as discussed later in this document).
7. Reporting general problems, such as equipment malfunction, as soon as possible to Phytorium & Research Greenhouse staff.
8. Promptly disposing of all organic matter, including plant and soil debris, during & at experiment end.
    - Disposed organic matter such as plants and soil must never be left inside compartments or shared workspaces, as doing so greatly increases the risk of pest/pathogen infestation. As users collect organic debris inside their workspaces, they must promptly discard the contents of their garbage at the nearest sealed disposal. In the case of the Research Greenhouse compartments, please dispose of all garbage immediately to the main waste receptacle outside behind the greenhouse.
9. Ensuring the Principal Investigator (PI) has applied for, and been accepted to use, any potentially hazardous materials such as microorganisms and/or toxins such as environmental pollutants, as per EHS guidelines (e.g. Application to Use Biohazardous Materials).
    - This includes identifying all researchers in the PI's lab that might be working with potentially hazardous materials, as well as outlining how such material will be stored and experimented with.
    - Questions regarding the storage and handling of experimental organisms, applying for the usage of hazardous materials, and any other similar questions should be directed to ehs@mcgill.ca.
10. Providing email notification to Phytorium & Research Greenhouse staff when experiments have finished in their workspaces.
    - Ending experiments periodically is important for several reasons. For example, it is difficult and impractical to calibrate environmental controls and sensors while experiments are running. Furthermore, investigating the functionality of lighting tubes, bulbs, and ballasts, as well as replacing these when necessary, is more manageable when workspaces are empty.
    - Note that billing will only terminate once email notification has been received and the workspace has been properly cleaned by its previous user(s). Also, note that under normal circumstances, no workspace may be booked by any user indefinitely. A maximum of one year will be given to any user for any type of workspace, unless a longer period is essential to research being conducted, in

which case the PI and facilities personnel must agree upon a longer period. Under normal circumstances, after one-year has elapsed, users must reapply for usage of a workspace. If there is no current waiting list for this type of space, extensions may be granted at the discretion of Phytorium & Research Greenhouse personnel. As the maximum time of one year approaches, Phytorium & Research Greenhouse staff will remind users via email of the deadline to finish their experiments and to clean and empty their workspace. Two further warnings will be given to the user: One on the date of the deadline, and one after an additional week has lapsed. If there is a waiting list for the space, and the users have not evacuated the space within two weeks of having reached their deadline, Phytorium & Research Greenhouse staff will begin the process of terminating the experiment themselves, including disposing of all experimental organisms, and cleaning of the workspace. PIs will be charged for this labor at a rate of 100$/hr.

- As of January 2021, a maximum of 3 months will be given to any user for any type of workspace reservation in the Research Greenhouse. If a longer period is required, the Research Greenhouse staff will agree upon an extension.
- Benches that are reserved by a user may not remain empty for a period longer than one month. After one month has elapsed and the space still remains empty the reservation will be canceled. Users will then have to reapply for space in the Research Greenhouse.
- It is important that both the start and end dates for the experiment are respected. The space in the Research Greenhouse is limited and needs to be shared respectively.

Additionally:

11. Users are not to occupy spaces for which they are not paying.
    - This includes storing supplies, tools, etc. on unrented greenhouse benches.
12. **Users are not to implement any sort of pest/pathogen control, including the use of sticky traps, baits, and/or any sort of pesticide (insecticides, fungicides, soaps, oils, organic/natural pesticides, etc.) This will be the responsibility of the Phytorium & Research Greenhouse personnel.**
    - This is to ensure that (1) bio-control agents are not inadvertently harmed, thus incurring a wasted expense, as well as being counterproductive, and (2) products being actively used by personnel can be monitored and assessed for effectiveness without interference from other products.
    - Furthermore, pesticides may pose health hazards to other users and personnel, especially when they are not aware of their presence.
    - If users have suggestions or ideas regarding pest/pathogen control, staff are available and happy to discuss their suggestions/ideas.
13. Users will be notified in writing or by email if their spaces are deemed excessively dirty or untidy, and prompt action will be expected. Examples of such scenarios include:
    - Large amounts of dirt or organic debris on greenhouse or growth chamber floors;
    - Large amounts of dead plants left in greenhouse or growth chambers;
    - Large amounts of dirty pots left in greenhouse or growth chambers;
    - Tools, supplies, pots, etc. taking up space that is not being paid for by the user (e.g. extra benches in greenhouse rooms);

- Creating physical obstructions (e.g. through haphazard placement of tools, supplies, etc.) blocking walkways, thereby preventing safe passage by other researchers and Phytorium & Research Greenhouse staff.

14. **Pot washing is the responsibility of the user.**
    - **Pots must always be reused and disposed of only when they are too damaged to use.**
    - **This means that, at experiment end, the user must discard of any organic matter from their pots including plant and soil debris, then bring their pots and other supplies such as trays, etc. to the nearest wash station/potting room.**
    - **Here, the user must wash their supplies and allow them to dry. If pathogens were used in an experiment, pots need to be disinfected with at ethanol (70%) after being washed.**
    - **Users will be given up to 48h to clean their pots/materials. If users fail to comply, steps will be taken by Phytorium & Research Greenhouse personnel to correct the problem. This will result in PIs being charged at a rate of 100$/hr for any time spent by Phytorium & Research Greenhouse personnel cleaning their pots/materials.**

Responsibilities of Phytorium & Research Greenhouse personnel

Phytorium & Research Greenhouse staff are responsible for the monitoring, maintenance, and administration of the Phytorium & Research Greenhouse complex. These responsibilities include:

1. Day-to-day operation of greenhouses, growth chambers, and related equipment (e.g. central control computers).
2. Providing instructional and informational support to users on procedures and protocols (i.e., through the presentation of this document to new users).
3. Receiving space requests and stocking commonly used supplies (such as soil, pots, and fertilizers).

Note: Researchers planning large-scale experiments must provide a minimum of two weeks' notice to Phytorium & Research Greenhouse personnel in order to provide sufficient time for the ordering and receipt of said supplies.

4. Assigning space to users after receiving space requests.
5. Programming and setting up environmental conditions for spaces prior to project start.
6. Working with users by discussing general plant care and Integrated Pest Management (IPM) procedures.
7. Implementing a facility-wide IPM strategy and informing users of pertinent controls in place.
8. Maintaining financial records for each lab including spaces and supplies used, as well as any additional case-specific expenses.
9. Conducting standard reviews of equipment, including routine calibration of environmental controls.

Note: Phytorium & Research Greenhouse staff are available to assist users by discussing general plant husbandry, but it is ultimately the responsibility of each user to research and understand the environmental and biological requirements for their experimental organisms before beginning a new experiment.

Health & Safety

All work carried out by Phytorium & Research Greenhouse personnel and all users of the Phytorium & Research Greenhouse must be in accordance with McGill University's Health & Safety standards. For more information pertaining to McGill University's Health & Safety guidelines, as well as Health & Safety contact information, refer to: https://www.mcgill.ca/ehs/.

Integrated Pest Management (IPM)

The McGill University Phytorium & Research Greenhouse will operate under an IPM strategy. This involves adopting and integrating cultural, mechanical/physical, biological, and, as a last resort, chemical controls in order to manage plant pests and pathogens.

One of the most important and basic aspects of an IPM strategy is workplace sanitation. By keeping work areas clean and free of soil, plant debris, and other organic matter, pest-breeding sites can be preemptively eliminated and pathogens causing common plant diseases (powdery mildew, rust, botrytis, etc.) can be minimized or avoided. In addition, in order to minimize the spread of pathogens, the prompt removal and disposal of overly diseased/infected plant material is vital. Thereafter, disinfection of the workspace is advisable.

Another important aspect of an IPM strategy is regular plant monitoring. This includes the visual inspection of work areas, often accompanied by the usage of sticky traps, to detect pests before they reach damaging levels. It is important for all Phytorium & Research Greenhouse users to be aware of the more common plant pests and pathogens that could affect their work. Pictures of plant pests/pathogens will be posted in strategic locations throughout the facility for review. Users should consult with Phytorium & Research Greenhouse personnel if they believe their workspace may be housing pests/pathogens. The sooner Phytorium & Research Greenhouse personnel are made aware of the issue, the more likely it is that the pest infestation will not reach harmful levels.

Cultural controls include proper maintenance of experimental organisms through, for example, sanitation, adequate watering, fertilization, pruning, and general care. Over/under-watering/fertilizing can be both harmful for plants and favorable for plant pests/pathogens. When possible, altering the environmental conditions of workspaces to discourage pests and encourage pest predators will be considered.

Physical controls include efforts to prevent the spread of pests to and/or from work areas (via screening and other barriers). This is covered in more detail later in this document under "Order of Entry".

Mechanical controls include the removal of pests/pathogens using manual labor or mechanical equipment, for example, handpicking, water jet application, and vacuuming.

Biological controls (or bio-controls for short) are organisms that predate upon, parasitize, or generally cause harm to plant pests. IPM strategies typically favor the usage of bio-controls over chemical controls for many reasons, and are more commonly used as a means to control pest populations. Bio-controls are particularly useful in that they are able to be employed as both preventative and curative agents of most common pests. In some cases, altering environmental conditions to favor bio-control agents may improve their efficacy.

Chemical controls include the use of natural and/or synthetic chemical compounds (pesticides) to control pest populations and pathogens. The term *pesticide* is a broad term, and includes all of the following: herbicide, insecticide, fungicide, nematicide, molluscicide, piscicide, avicide, rodenticide, bactericide, insect repellent, animal repellent, and antimicrobial. Pesticides may be divided into two broad categories: (a) conventional/chemical pesticides and (b) biopesticides. We define conventional or chemical pesticides as those having a broad spectrum of activity and thus being more detrimental to natural enemies and the environment. In contrast, bio-pesticides are pest management agents and chemicals derived from natural sources such as bacteria, fungi, viruses, plants, animals and minerals. Many biopesticides target specific pests and have little negative impact on the surrounding ecosystem and human health.

For example, biopesticides could include the use of *Bacillus thuringiensis* products, pheromones that modify/disrupt insect behavior, insect growth regulators, certain plant extracts and oils, as well as insecticidal soaps.

Since the use of conventional insecticides is sometimes a necessary part of an IPM program, it is important to remember that their use is a last-resort strategy, as the problems associated with their use have been well documented. These include the resurgence of pest populations after decimation of the natural enemies, development of pesticide-resistant populations, and negative impacts on non-target organisms within and outside the target area. One of the more serious problems is the development of resistance. Many insect pest species now possess resistance to some or several types of insecticides, and few chemical control options exist for these pests.

IPM – User responsibilities

The following is a list of steps Phytorium & Research Greenhouse users are expected to adhere to in order to prevent the introduction and spread of plant pests/pathogens within growth chamber and greenhouse work areas.

Sanitation

1. Work areas are to be kept clean, particularly on and under greenhouse benches, and free of soil debris, plant matter, plastic tags, dirty pots, and dead or senescing plant material.
2. Plant matter that is no longer being used should be placed in a sealed garbage bag and then immediately disposed of at the nearest appropriate garbage bin.
    - This is to prevent the spread of pests between workspaces that could occur if such waste materials are left in common areas such as hallways or potting rooms.
3. Plants that have been severely infested by pests/pathogens should be discarded immediately if at all possible.
4. Plants that are not being used for research and/or teaching purposes are not permitted within the Phytorium & Research Greenhouse.
5. Users must clean up after themselves once they have finished using a potting room.
    - This includes removing all soil debris from potting tables and sweeping the floor.
6. Hoses must be properly coiled and kept off the floor to prevent water damage as well as to prevent potential breeding sites for pests.
7. When possible, plants should be grown on-site from sterilized seed in new or thoroughly-cleaned pots and/or flats that been labelled with the user's name(s).

- Growing plants from seed on-site can help to prevent the introduction of novel plant pests within the facility.
- If this is not possible, all plants being brought in to the facility must first be inspected by Phytorium & Research Greenhouse personnel.
- It is very important that users reach out to Phytorium & Research Greenhouse personnel to arrange a time for such plants to be inspected before they are brought in to the facility.
- Users may be directed to quarantine and/or sterilize their plants before they are allowed to enter the facility.
- Phytorium & Research Greenhouse personnel reserve the right to refuse entry to plants and/or other organisms if such organisms are deemed to be a potential hazard to ongoing and/or future research projects.

Plant care

1. Always ensure adequate watering of plants – over- and/or under-watering may be lethal to plants, and may encourage plant pests.
   - Likewise, ensure proper fertilization of plants.
   - Before a new project begins, be aware of how to care for the plant species to be used.
2. Re-pot plants (as needed) that are intended to be kept for extended periods.
3. Notify personnel if you have a special request regarding how you wish your plants to be monitored/inspected. Unless a special request is made, all plants may be touched during inspection.
4. Remove plant parts that are unhealthy and/or infested by pests/pathogens as soon as possible.
5. Avoid overcrowding growth spaces – proper airflow is required to maintain desired environmental conditions, and thus plant health.
   - **Furthermore, controlling pest/pathogen populations is very difficult, if not impossible, when growing spaces become severely overcrowded**.
6. Before starting new projects, old plants should first be discarded from the workspace.
   - This can allow pest problems that are affecting older plants to be dealt with, and the workspace to be cleaned before new plants enter.

Upon project completion

1. Workspaces are to be cleaned by the user(s) at the end of each project.
2. Once a year, a cleaning of each greenhouse will be scheduled – this will improve our ability to control pests across the site.
   - This will mean that all greenhouse projects must be temporarily suspended, as performing a thorough cleaning will require rooms to be devoid of all research materials.

Order of entry

One of the most important and basic methods for controlling the spread of pests involves following a simple “order of entry” protocol. This means always entering areas that are pest/pathogen-free first, saving work in pest/pathogen infested areas until the end of the day, and never re-entering a pest-free area after entering an infested area. In general:

1. Never enter growth zones that do not contain your own work – this can eliminate the unintentional spread of pests from room-to-room.

2. Always move from relatively "clean" areas (i.e., no pests, or few pests) to infested areas, and never return to "clean" areas after working in infested areas on the same day. Wash or disinfect your hands before and after handling your plants.
    - For example, always do your work in growth chambers/rooms (less likely to have pests) before entering greenhouses (more likely to have pests).
3. If you work in more than one greenhouse, follow the same logic: Enter the greenhouses in order from least to most pest-infested.
4. Once a user has completed their work in a greenhouse, they should not enter a growth chamber zone until the following day. In addition, if working in the field, a user should not enter a greenhouse/growth chamber zone until the following day.
5. Moving plants around the facility is discouraged unless absolutely necessary, as doing so can spread pests and make monitoring pest populations significantly more difficult.
6. When approaching the Research Greenhouse, use the walking path, not the grass.

IPM – Phytorium & Research Greenhouse personnel responsibilities

The following is a list of specific steps Phytorium & Research Greenhouse staff will follow with respect to IPM implementation.

Pest prevention

Ensuring all workspaces are clean and pest-free prior to the start of a new experiment.

Maintenance

Regular maintenance of workspaces such as changing of lights as necessary and calibration of sensors to ensure proper environmental control functionality.

Monitoring

- All growth spaces across the facility will be inspected on a regular basis for pests/pathogens.
- Research material will be physically touched in order to conduct proper inspections, so it will be necessary to make special requests if a user does not want their plants to be touched.
- The pest history for growth spaces will be documented and kept on record, including such information as the identity and severity of infestation, and any controls that were put in place.

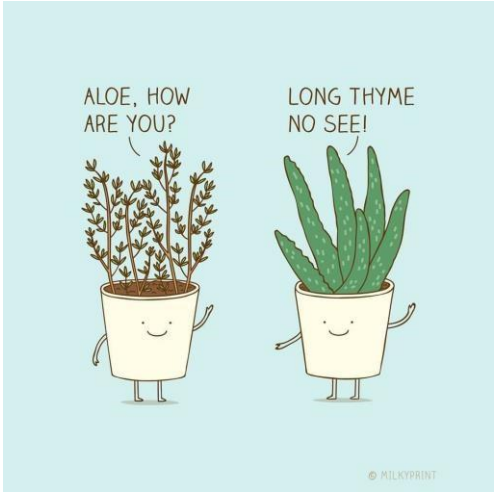
Pest control

- Upon the identification of a pest, Phytorium & Research Greenhouse personnel will implement any or all of the following methodologies of an IPM strategy: cultural, physical, mechanical, biological, and chemical.
- Chemical controls will be used as a last resort, and will generally be done with the intention of reducing pest populations to a sufficiently low level so that other forms of control may subsequently be used to keep pest numbers low.
    - If a chemical control is needed, users will be notified in advance of its application.

Communication

- When possible, users will be kept informed of the status of pest problems and any pertinent treatments currently in place.

- Phytorium & Research Greenhouse personnel are available for questions regarding pest management as well as general plant care.



1