



PHENOTYPE MEETING (8.23.2024) NOLAN MITSCHKE AT SALK

Start: 12.13.2021
End: 8.30.2024

CONTRIBUTIONS TO SALK

IPM: Salk Growing Spaces (Integrated Pest Management)

2-Sheet

Major Pests Protocols and Training for IPM in all Salk growing spaces

IPM System Implementation

IPM: Encinitas Greenhouse and Barn 8C

Pesticide Monitoring and Scouting

Quantifying: Automated Pest Detection System (Western Flower Thrips)

Phytotoxicity Study: Spot Treatment + Experiments

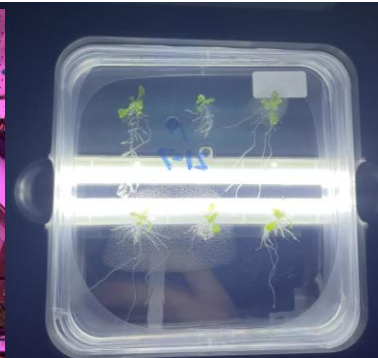
Educated Pesticide Applications

Biological Pest management (Bacteria, Fungus, Nematodes,

Predatory Insects)

Hoop House Hydroponic System

Barn 8C Sha EMS Screen



How To Look for Pests

- Interior foliage scouting
- Exterior foliage scouting
- Top, Middle, and Bottom horizontal section scouting



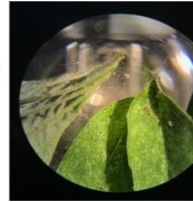
INTEGRATED PEST MANAGEMENT: SALK GROWING SPACES

- IPM: 2-Sheet
- Individual Pest Descriptions, and Photo Examples
- SOP for Integrated Pest Management Practices

IPM: 2-SHEET

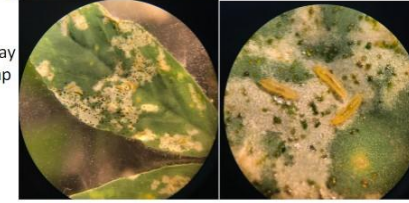
Spider Mites

- Orange/yellow-orange colored with round body, eight legs, and two spots on their back
- Thrive in dry conditions and when plants are damaged or stressed
- Create very fine but dense webs on tips of foliage with spider mites living in webs
- Around webs are very small, brown spotted patterns in foliage from piercing damage
- Pest Control product to use:
 - Spray directly with hose
 - All Seasons Horticultural Spray
 - Safer Brand Insect Killing Soap
 - Safer 3-in-1 Garden Spray



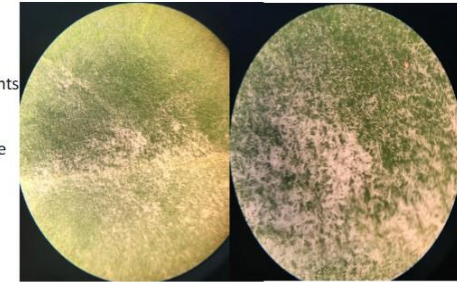
Thrips

- Long and Slender, earlier stages are yellow and adults are orange with yellow and have wings
- Thrive in warmer environments (peaking at 84 F) and on plants with damage or stress
- Damage is patches of white/gray in the plant foliage from consumption of leaf tissue
- Around/On patches of foliage damage are very small black and yellow dots
- Pest Control product to use:
 - All Seasons Horticultural Spray
 - Safer Brand Insect Killing Soap
 - Safer 3-in-1 Garden Spray



Powdery Mildew

- White and powdery structure that grows in small patches either covering entire surfaces or in round
- High relative humidity and lower air circulation environments allow powdery mildew to reproduce the best
- Once Powdery Mildew colonizes it has white, powdery growth on leaves, stems, and flowers that will dominate the plants surface area and feed until parts of the plant turn brown, shrivel, and fall off
- Pest Control Product to use:
 - All Seasons Horticultural Spray
 - Safer 3-in-1 Garden Spray



Aphids

- Oval-shaped body with yellow-green nymphs and gray adults with a slender neck and mouth area
- Normally hard to find but when infested populations clump together and look like mounds
- Thrive in any conditions but reproduce faster in warmer conditions
- Leaf damage hard to find but damage leads to yellowing of leaves. Aphids secrete "honeydew" (Clear/white color) which when left on plants allows sooty mold fungus to form (black with gray spots)
- Pest Control product to use:
 - Spray directly with hose
 - All Seasons Horticultural Spray
 - Safer Brand Insect Killing Soap
 - Safer 3-in-1 Garden Spray



Fungus Gnats

- Dark brown or black flies that are 1/8 inch long with dark, translucent wings
- Thrive in overwatered soil, primary reason for increased fungus gnat populations
- Damage not noticeable but high counts in soil lead to damage to roots and root hairs
- Pest Control Product to use:
 - Reduce watering
 - All Seasons Horticultural Spray (Only to soil not foliage)



2-Sheet is for all Salk Growing Spaces that includes pest identification information and pest control options found at all Salk growing spaces. These sheets are a quick guide to pest identifying and applying simple, user-friendly chemical treatments

Thrips

Life Cycle Stages:

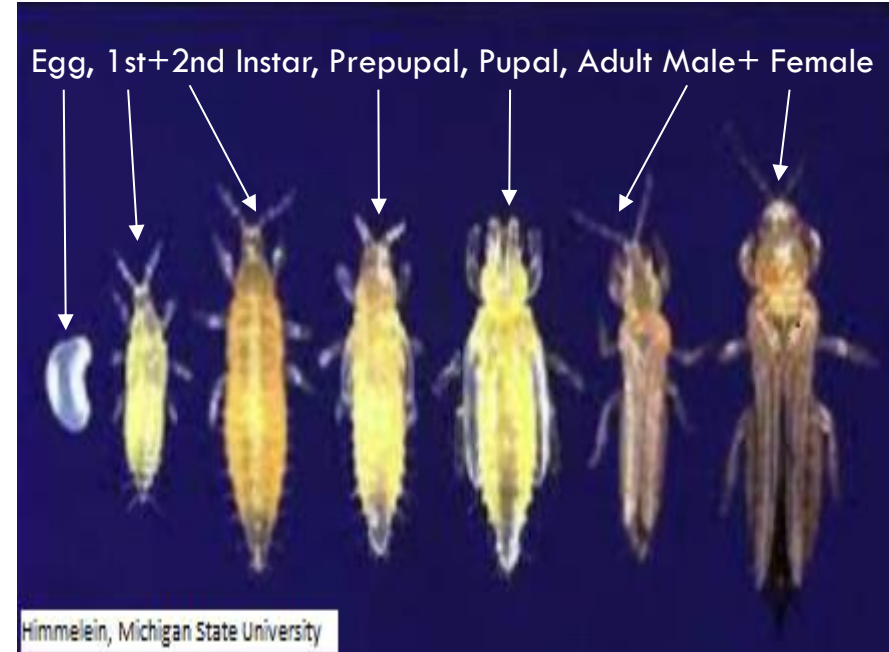
- Egg – Clear color, laid in leaf tissue (two to four days)
- First instar – Light yellow coloring with a **feeding stage** (one to two days)
- Second instar - Yellow-orange coloring still **feeding stage** then drops off plant to turf or lower leaves (two to four days)
- Prepupal –Yellow, non-feeding drops off plant to growing media or lower leaves (one to two days)
- Pupal – Yellow color non-feeding stage still in the growing media or lower leaves (one to three days)
- Adult –Brownish Orange-Yellow/ Orange-Yellow **PEAK feeding stage** and mobile is able to produce up to 300 eggs in adult life (flying or drift in air) (30 to 45 days)

Between 68-98 F Thrips can grow from egg to adult (develop population) in 7-15 days

Thrive in warmer environments (peaking at 84 F) and on plants with damage or stress

Damage is patches of white or pale green with black spots in the leaf foliage from consumption, fecal matter, and laying eggs

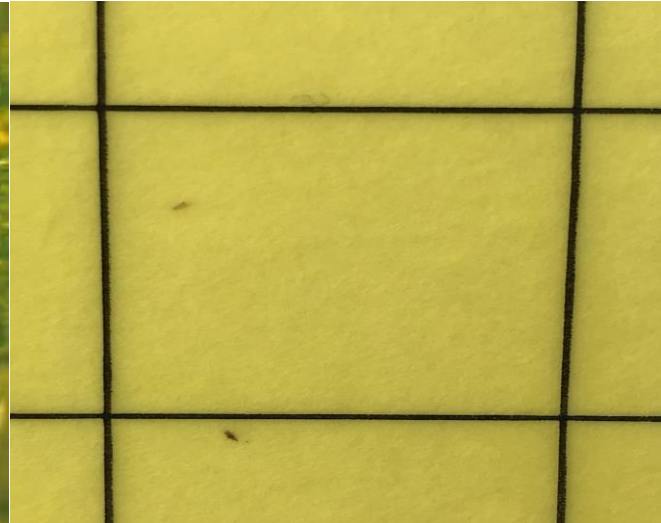
Look for physical pests when damage is seen, Thrips will inhabit top and bottom of leaves and flower foliage



•Next Steps/ Taking Management Practices:

- Make sure there are signs of active thrips on sticky cards and plant, spray when thrips are seen on plant or sticky card
- Once identified, put on safety glasses and waterproof gloves and apply specific pesticide from the schedule or a different pesticide from what was last used in the specified chamber
- Check the pesticide log in the Excel file "Salk Main Campus Pest Control Log and Counts" to see what was used last to know what not to use, then use pesticide from the schedule or a different product from the "Pesticide Inventory" tab
- Make sure to apply the selected pesticide product to all foliage including leaves, flowers, and stems of plants
 - It is important to get all regions of plant (Upper, Middle, Lower, Interior, and Exterior) with enough application that all surfaces are covered to the point of beading and dripping of pesticide off of leaves
 - Also make sure to apply selected pesticide to the bottom of leaves as well as the top

Thrips



Spider Mites

Life Cycle Stages:

- Egg: Clear and on the bottom of leaves, almost cannot see with naked eye (2 to 3 days)
- Larva: **Low feeding stage**, colorless for short period then goes under leaf to develop and molt into nymph stage (2 to 5 days)
- Nymph: **Feeding stage**, color is white with two greenish spots (3 to 8 days)
- Adult: **Peak feeding stage** appear orange-red or brown and lay 100 eggs in adult life (14 to 28 days)

Between 55- 98 F can grow, 80 F being most ideal for spider mites productivity, from egg to adult can happen in 8 days

Thrive in dry and dusty conditions, primarily low humidity and high temperature, also when plants are damaged or stressed

Create very fine but dense webs on tips of foliage with spider mites living in webs

Around webs are very small, brown and white spotted patterns in foliage from piercing damage and feces

Most commonly found at the tips of stems, leaves, and flowers with colonies preferring the highest point on plant

Also can create webbing in areas within foliage with lower airflow



Mukhopadhyay 2014

•Next Steps/ Taking Management Practices:

- Make sure there are signs of active spider mites on sticky cards and plant, spray when spider mites are seen on plant
- Once identified, put on safety glasses and waterproof gloves and apply specific pesticide from the schedule or a different pesticide from what was last used in the specified chamber
- Check the pesticide log in the Excel file "Salk Main Campus Pest Control Log and Counts" to see what was used last to know what not to use, then use pesticide from the schedule or a different product from the "Pesticide Inventory" tab
- Make sure to apply the selected pesticide product to all foliage including leaves, flowers, and stems of plants
 - It is important to get all regions of plant (Upper, Middle, Lower, Interior, and Exterior) with enough application that all surfaces are covered to the point of beading and dripping of pesticide off of leaves
 - Also make sure to apply selected pesticide to the bottom of leaves as well as the top

Spider Mites



Powdery Mildew

Asexual Life Cycle

- **Appressoria:** Powdery Mildew spores germinate asexually to form hyphae structures, these structures then grow on the plants surface to create appressoria
- **Haustorium:** Once appressoria is developed on the surface hyphal branch structures called haustorium start to develop which allow injection into host cells so that nutrients can be taken from the plant tissue **Feeding Stage**
- **Conidiophores:** The development of haustorium colonization on the plants then allows **Peak Feeding** of nutrients from the plant cells so that asexual spores called conidia, which are the building blocks conidiophores, can form which is the white, powdery structure seen when identifying the fungus (weeks to months lifespan)

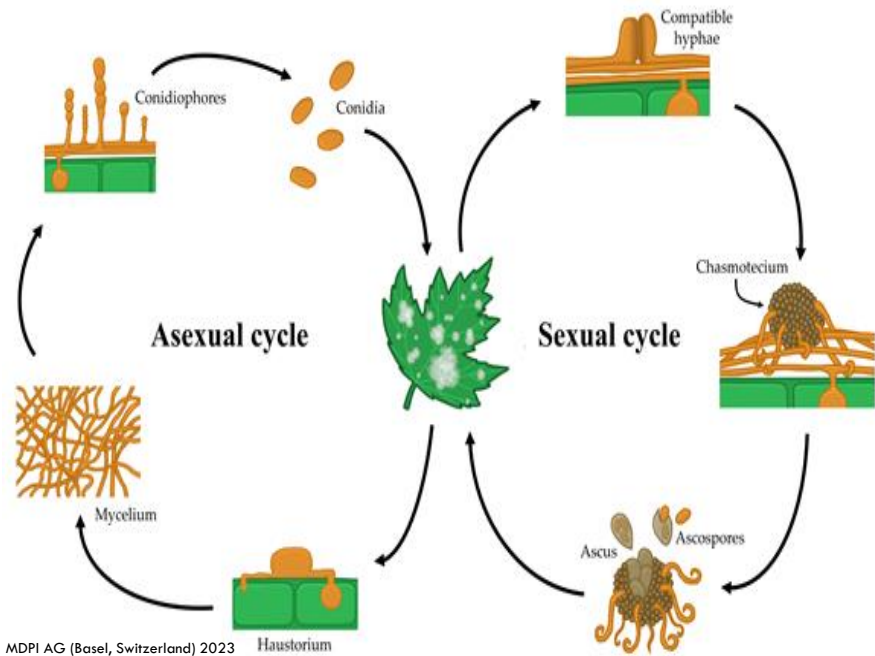
Sexual Life Cycle

- **Compatible Hyphae:** Powdery Mildew spores germinate sexually to form hyphae structures
- **Chasmotecium:** The hyphae structures colonize plant surfaces creating chasmotecium which are **feeding stage** fruiting bodies that produce Ascus containing ascospores
- **Ascus and Ascospores:** **Peak Feeding Stage** Ascus is the fruiting body that once developed produce ascospores seen by the naked eye and what is identified to be the powdery, white form characterizing powdery mildew (weeks to months lifespan)

Identified as white and powdery structure that grows in small patches or colonized surfaces either covering entire surfaces or in round, small spots

High relative humidity, lower temperatures, and lower air circulation environments allow powdery mildew to grow optimally

Once Powdery Mildew colonizes it has white, powdery growth on leaves, stems, and flowers that will dominate the plants surface area and feed until parts of the plant turn brown, shrivel, and fall off



•Next Steps/ Taking Management Practices:

- **Make sure there are signs of powdery mildew on plant, spray when powdery mildew is seen on plant**
- **Once identified, put on safety glasses and waterproof gloves and apply specific pesticide from the schedule or a different pesticide from what was last used in the specified chamber**
- **Check the pesticide log in the Excel file "Salk Main Campus Pest Control Log and Counts" to see what was used last to know what not to use, then use pesticide from the schedule or a different product from the "Pesticide Inventory" tab**
- **Make sure to apply the selected pesticide product to all foliage including leaves, flowers, and stems of plants**
 - **It is important to get all regions of plant (Upper, Middle, Lower, Interior, and Exterior) with enough application that all surfaces are covered to the point of beading and dripping of pesticide off of leaves**
 - **Also make sure to apply selected pesticide to the bottom of leaves as well as the top**
 - **Sanitize pesticide bottle, gloves, and all surfaces touched after application due to high mobility of powdery mildew**

Powdery Mildew



Fungus Gnats

Life Cycle Stages:

- Egg: Non-feeding stage clear eggs that are too small to see (4-6 days)
- Larvae: **Feeding stage** clear body with black head living in the top layer of growing media eating algae, fungi, and plant roots (12-14 days)
- Pupae: **Feeding stage** still eating algae, fungi, and plant roots with darker/black body color (4-6 days)
- Adult: Non-feeding stage black body with slender legs that live on plant foliage and fly short irregular patterns living close to host plant (10 days)

Optimal reproduction happens at 75 F with an adult that can lay 200 eggs in its life

Optimal growing conditions in damp/overwatered soil and environments with available algae, dead plant matter, and fungi to eat

Damage not noticeable but infestation seen by high counts of larvae and adults in/on soil

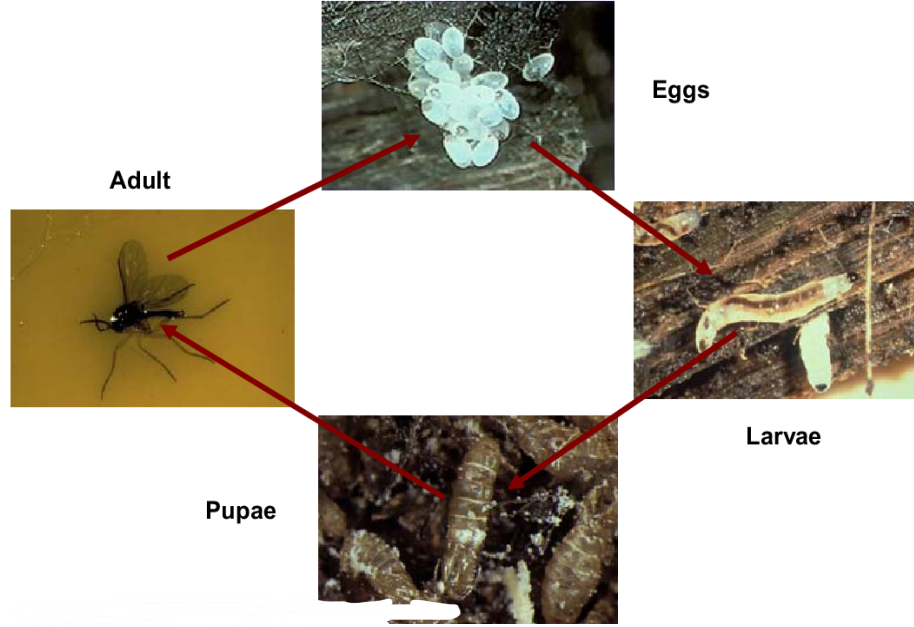
Infestation leads to damage at roots and root hairs and fungus gnats are most commonly found in the lower foliage/ growing media region of plant as well can be found in lower counts in upper foliage

Pest Control Product to use:

- Reduce watering
- All Seasons Horticultural Spray (**Only to soil not foliage**)

•Next Steps/ Taking Management Practices:

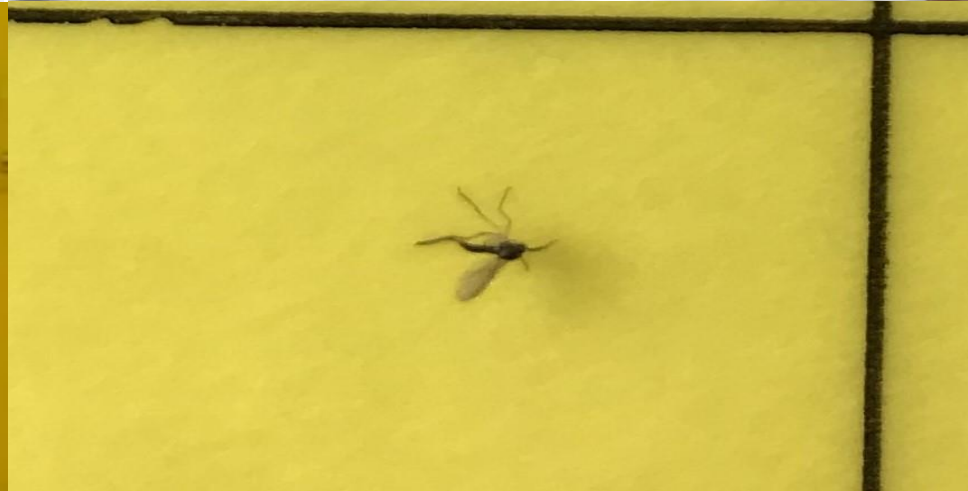
- Make sure there are signs of active fungus gnats on sticky cards and plant, spray when fungus gnats are seen on plant, in growing media, or on sticky cards
- Once identified, put on safety glasses and waterproof gloves and apply specific pesticide from the schedule or a different pesticide from what was last used in the specified chamber
- Check the pesticide log in the Excel file "Salk Main Campus Pest Control Log and Counts" to see what was used last to know what not to use, then use pesticide from the schedule or a different product from the "Pesticide Inventory" tab
- Make sure to apply the selected pesticide product to all foliage including leaves, flowers, and stems of plants
 - It is important to get all regions of plant (Upper, Middle, Lower, Interior, and Exterior) with enough application that all surfaces are covered to the point of beading and dripping of pesticide off of leaves
 - Also make sure to apply selected pesticide to the bottom of leaves as well as the top



Cycle of fungus gnats (*Bradysia* spp.) from egg to adult.

Cloyd 2009

Fungus Gnats



Aphids

Life cycle stages

- Eggs: Non-feeding stage of small, translucent eggs that are only produced from sexual reproduction, most offspring form from asexual production to nymph skipping the egg stage (2 days- months of dormancy)
- Nymph: **Feeding stage** eating Oval-shaped body with yellow-green nymphs that will molt 4 times before reaching adult stage (2-8 days)
- Adult: **Peak feeding stage** gray adults with a slender neck and mouth area (that are suited for piercing and sucking plant tissue causing damage to leaves and stems (2-3 weeks)

Optimal reproduction happens at 65-80 F with an adult that can lay 150-200 eggs in its life, or 12 a day at adult stage

Normally harder to find but when infested populations clump together and look like mounds on the stems and foliage on the upper and lower sections of the plants

When infested/ growing populations the adults are established enough to secrete "honeydew" which is a sugary liquid that ants will farm and eat

- This 'honeydew' production will cause a steady attraction of ants and if not taken care of can also lead to sooty mold to grow on the "honeydew" damaging the plant further

Leaf and stem damage from "honeydew" allows sooty mold fungus to form (black with gray spots) which is the most common way to identify aphid presence other than seeing many aphids forming together covering foliage in large, bumpy clusters

Pest Control product to use:

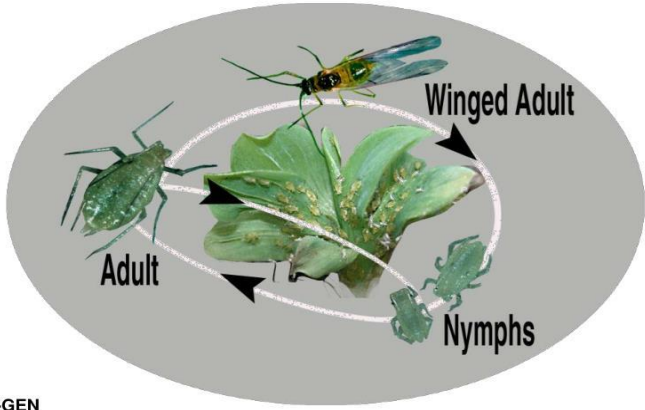
- Spray directly with hose
- All Seasons Horticultural Spray
- Safer Brand Insect Killing Soap
- Safer 3-in-1 Garden Spray

•Next Steps/ Taking Management Practices:

- Make sure there are signs of active spider mites on plant, spray when spider mites are seen especially when colonizing
- Once identified, put on safety glasses and waterproof gloves and apply specific pesticide from the schedule or a different pesticide from what was last used in the specified chamber
- Check the pesticide log in the Excel file "Salk Main Campus Pest Control Log and Counts" to see what was used last to know what not to use, then use pesticide from the schedule or a different product from the "Pesticide Inventory" tab
- Make sure to apply the selected pesticide product to all foliage including leaves, flowers, and stems of plants
 - It is important to get all regions of plant (Upper, Middle, Lower, Interior, and Exterior) with enough application that all surfaces are covered to the point of beading and dripping of pesticide off of leaves
 - Also make sure to apply selected pesticide to the bottom of leaves as well as the top

Aphid Life Cycle

Nymph to Adult:



WHITMIRE MICRO-GEN
Research Laboratories, Inc.
800-777-8570 www.wmimg.com

©Whitmire Micro-Gen Research Laboratories, Inc. 2002

Aphids



Preventative/ Monitoring

Scouting

- Checking on the plants in each growth chamber and any pests that may be living on them is important to get an idea on how to conduct pest management
- The majority of scouting should be focused on yellow sticky card counts but plants need to be visually inspected for other problems such as powdery mildew, aphids, fungus gnat populations in soil, and other pests that are not apparent on the yellow sticky cards
- To properly inspect a plant it is important to look closely at the different parts of the plant (leaves, stems, flowers, and seed pods) and regions of the plant (upper foliage, lower foliage, internal foliage hidden in more biomass dense plants)
 - You do not need to inspect every inch of plant surface but looking at multiple parts and regions of each plant is important to get an idea of the average pest pressure on each plant and in the chamber
 - If there is an area of a plant with high pest damage it is important to take extra time to scout the damaged areas to see if there is pests present or if it is damaged foliage with no pests present, this difference will help to see if spraying will be needed
 - Look at approximately 25% of each plants leaves, stems, seed pods, and flowers in the different regions of plants (upper, lower, and internal) to get an in depth scout of current pest pressure without devoting an unnecessary amount of labor to scouting
 - If time is limited for scouting more labor should be focused to sticky card counts and keeping visual inspections short

Yellow Sticky Traps

- Sticky traps are an effective form of pest control because they use chromatic attraction to lure pests toward the tape trapping and killing them no matter if these pests have formed resilience to different modes of pest control
- Make sure to have at least 1 trap set up in each growth chamber set in the most centralized point between the foliage to catch as many pests as possible travelling between plants
- Make sure to switch out the yellow sticky cards in each chamber every week or before each spray and record the scouting date, type of plant in chamber, and counts of how many thrips are on each card
- Recording thrip counts over time will be important to see which pesticide control sprays work best and to better modify spraying schedules to be most effective

Sanitation

- Keeping surfaces in the growth chambers sanitized is crucial for pest management so that contaminants are not able to thrive leading to plant damage and lowered quality of data
- Walkways and grow space should be free of soil, organic matter, weeds, and algae; Benches should be disinfected and pots, flats, and trays must be new or disinfected before entering chambers
- Each grow chamber should be sanitized with diluted physan in a 1 or 2 gallon sprayer to make sure any contaminants or pests present in the previous experiment do not survive and damage future trials in the same chamber

Management

Physical Management

- Keeping the growing chamber sanitized and free of algae, leaf litter, and fungi will be crucial to maintaining preventative management to reduce spraying and scouting
- Make sure to check first with person whose running experiment if you can remove damaged foliage
- If pests have heavy presence/infestation on a plant it is important before spraying to remove damaged or infected foliage from the plant with pruners and put into plastic bags that are sealed then removed from growth chamber and properly disposed of
- After using pruners make sure to spray with disinfectant and wash thoroughly immediately after use to prevent contamination

Biological Management

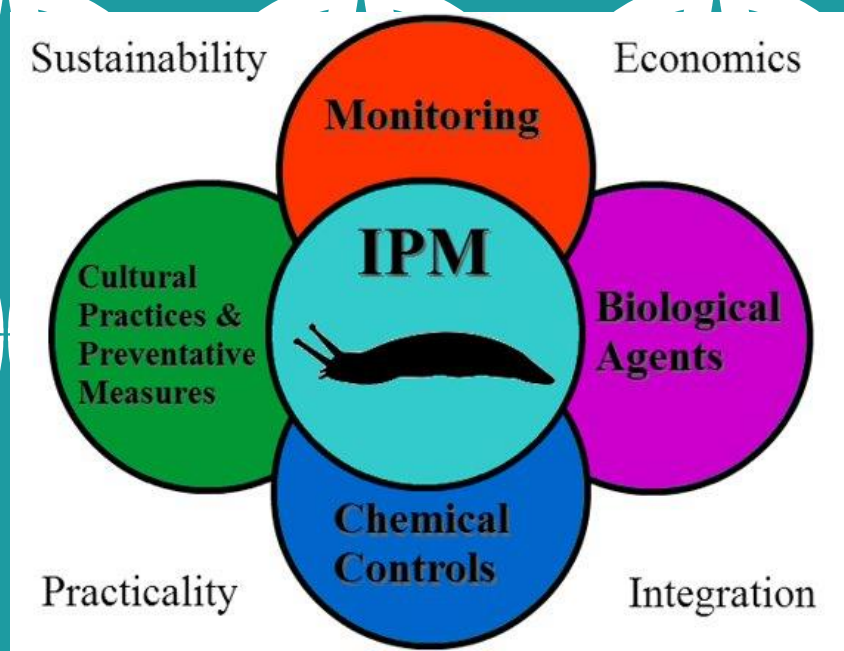
- The use of biological controls is essential to reduce chemical resilience in pest populations so that chemical controls can still be effective
- Contact the Greenhouse Team for inquiries into specific biological products used for specific pest. Some commonly used products are: bioinsecticides derived from fermentation media of fungi, bacteria, and nematodes. Other biological managements recommended are natural predators such as pirate bugs, assassin bugs, green lacewings, ladybugs, and predatory wasps.

Pest Control Product Inventory

- All Seasons Horticultural Spray (Pesticide)
- Safer Brand Insect Killing Soap (Pesticide)
- Safer Brand 3-in-1 Garden Spray (Pesticide)
- Physan (Chamber Sanitization)
- Yellow Gridded Sticky Cards with card holders and cups to stabilize (Trap and Scouting Tool)

Spraying Schedule

- Use schedule for pesticide applications over time that consists of a variety of products, pesticides have different modes of action that terminate pests using different methods of termination and cycling between products will prevent pest resistance to specific pesticides over time
- On an excel sheet keep a pesticide spray log with date, product used, pest targeted, and chamber sprayed so that data can be built to see which pesticides are and are not effective to ensure cycling of effective products to prevent chemical resilience from pest populations in growth chambers
- From the Pest ID sheet use only one method of control per treatment and make sure to spray each plant thoroughly until pesticide runs off making sure to cover:
 - all leaves, stems, flowers, and seed pods
 - Upper, middle, and lower regions of plant
 - Outer foliage and inner foliage hidden within or behind the exterior plant matter
 - Bottom side of leaves important for full coverage
- Make sure to follow all pesticide labels closely so that you know what PPE, spraying instructions, and intervals between sprays need to be followed for most effective use of products
- Before or after each spray application make sure to update the pesticide log so when thrip population counts are collected over time you can see what products work most effectively in knocking down thrips populations
- As time passes and thrip counts are recorded over time, make sure to analyze and interpret the graphs to see which pesticides need to be used, removed from usage, or if other products need to be tried



IPM: ENCINITAS GREENHOUSE AND BARN 8C

- Quantifying: Automated Pest Detection System (Western Flower Thrips)
- Phytotoxicity Study: Spot Treatment + Experiments
- Educated Pesticide Applications
- Biological Pest management
- Pesticide Monitoring and Scouting

QUANTIFYING: PEST DETECTION SLEAP PROGRAM - WESTERN FLOWER THRIPS (WFT)

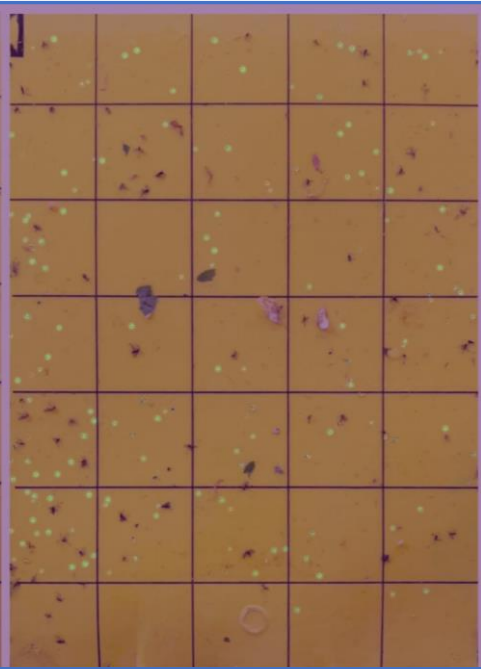
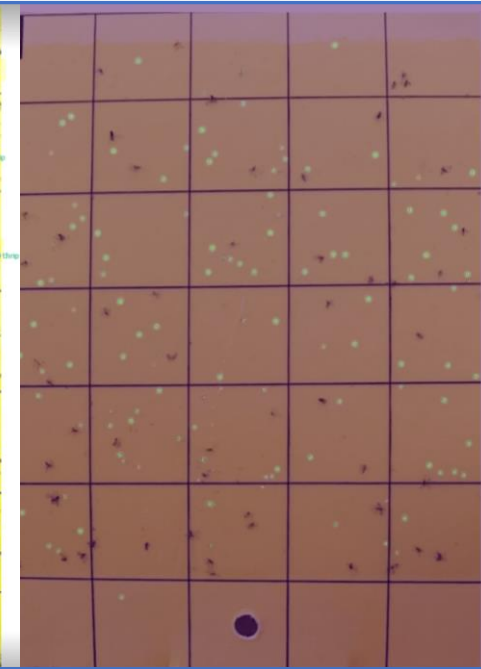
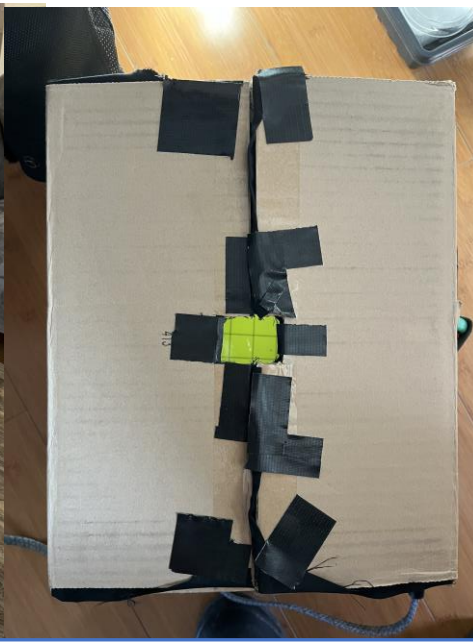
- The pest detection program is a landmark based computer vision application developed by Elizabeth Berrigan
- The program utilizes machine learning based computer vision via SLEAP application to count Western Flower Thrips from yellow sticky cards
- The goal is to improve pest monitoring in order to enhance integrated pest management methods.

Social LEAP Estimates Animal Poses (SLEAP)



SLEAP is an open source deep-learning based framework for multi-animal pose tracking (Pereira et al., *Nature Methods*, 2022). It can be used to track any type or number of animals and includes an advanced labeling/training GUI for active learning and proofreading.





PHYTOTOXICITY STUDY: SPOT TREATMENT + EXPERIMENTS

Soybean Phytotoxicity Study

	2.20.2024	2.28.2024	3.7.2024	Results
Pyrethrin Oil				Pyrethrin Oil was found to be more effective than Mineral Oil and had less phytotoxicity showing <25% thrip foliage presence on leaves after the final application. This trial showed low phytotoxicity but still caused minimal damage.
Mineral Oil				Mineral Oil was found to be less effective than the other trials with < 50% thrip presence on leaves. It also had greater phytotoxicity than Pyrethrin Oil that was damaging the plant, but not to the point of killing the plant as Spinosad is close to doing.
Spinosad				Spinosad was found to be the most effective with < 15% thrip presence on leaves. However this product has the highest phytotoxicity causing near death damage and should not be used more than once in a life cycle for Soybean.
	Pesticide Application (2/20)	Pesticide Application (2/27)	Pesticide Application (3/6)	



Control	Marathon .75x	Marathon 1x	SNS209 .75x	SNS 1x
Germination: 18/18	Germination: 13/18	Germination: 13/18	Germination: 18/18	Germination: 18/18

• Initial germination time was negatively affected by marathon, but not for SNS209

Tritek Oil (Mineral Oil) [40 mL/Gal] and Conserve SC (Spinosad) [3 mL/ Gal] and Pyrethrin Oil (PyGanics) [20 mL/ Gal]

Transgenic PennyCress Myb Redo Seeding Stage- Miracle Grow Soil

Before: 12/19/2023; Sprayed: 4:00 PM After: 12/20/2023; Observed: 10:30 AM

No Phytotoxicity --- Phytotoxicity Score: 1

#	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Pest/Disease	Chemical Used	Date/ Time	Plant Age/ Maturity/ Stage	Preventative or Reactive Control	Use Guidelines (Low Phytotoxicity and High Effectiveness)	Phytotoxicity Result (Scale 1-5)	Slide Reference	Concentration	Application Guidelines	Applicator's Name	Plant Variety Notes	Comments/Effectiveness	
14	Thrips	Tritek Oil (Mineral Oil)	2/20/2024	Vegetative Stage	Reactive	Great	No Phytotoxicity Phytotoxicity Score: 1	VYEXIOGN23 AND 3X42980YN	40 mL/ Gal		Williams 82			
15	Thrips	PyGanics (Pyrethrin Oil)	2/20/2024	Vegetative Stage	Reactive	Great	No Phytotoxicity Phytotoxicity Score: 1	8UWFF9BD AND 84867JM3YH	15 mL/ Gal		Williams 82			
16	Thrips	Conserve SC (Spinosad)	2/20/2024	Vegetative Stage	Reactive/ Preventative	Great	No Phytotoxicity Phytotoxicity Score: 1	908NM523C AND 9N0V8234TM	3 mL/ Gal		Williams 82	_Do not drench plant with Spinosad, just enough spray until light beading is acceptable for application effectiveness		
17	Thrips	PyGanics Specialty (Pyrethrin Oil) AND Conserve SC (Spinosad) AND NemAttack SF (Steinernema feltiae)	2/20/2024 5:00 PM	Vegetative Stage	Reactive/ Preventative	Great	No Phytotoxicity Phytotoxicity Score: 1	9BNJWFJJD	15 mL/ Gal Conserve SC: 3 mL/ Gal NemAttack SF: 1 packet/ Tank Mix (~5 million)		Williams 82			
18	Thrips	PyGanics Specialty (Pyrethrin Oil) AND Conserve SC (Spinosad) AND NemAttack SF (Steinernema feltiae)	2/20/2024 5:00 PM	Vegetative Stage	Reactive/ Preventative	Great	No Phytotoxicity Phytotoxicity Score: 1	NIUGPSNM51	15 mL/ Gal Conserve SC: 3 mL/ Gal NemAttack SF: 1 packet/ Tank Mix (~2 million)		A5244			
19	Thrips	Arber (Burkholderia spp. strain A396)	4/10/2024	Early Vegetative Stage	Slight Reactive/ Preventative	Great	No Phytotoxicity Phytotoxicity Score: 1	N/A	74 mL/ Gal	Foliar Spray: Apply to point of pesticide starting to bead and run off leaves.	Maverick	_Phytotoxicity was low and should be tried for broad application to entire greenhouse		
20	Thrips	Safari (Dinotefuran 20%)	5/14/2024	Early-Middle Vegetative Stage	Preventative (Granular)	Great/Good	No Phytotoxicity Phytotoxicity Score: 1 Low Phytotoxicity Score: 2 if applied twice in life cycle	KLWEGF209 AND SDAOUJ433	3 Top/ 1 Gal Pot	Granular: Apply in front of where emitters spray growing media	Williams 82	_Phytotoxicity was low and should be tried for broad application to entire greenhouse as granular _DO NOT APPLY MORE THAN ONCE TO A PLANT DURING LIFE CYCLE		

A	B	C	D	E	F	G	H	I	J	K	L	M
Pest/Disease	Chemical Used	Date/ Time of Application	Plant Age/Maturity/ Stage	Preventative or Reactive Control	Use Guidelines (Low Phytotoxicity and High Effectiveness)	Phytotoxicity Result (Scale 1-5)	Slide Reference	Concentration	Application Guidelines	Applicator's Name	Plant Variety Notes	Comments/Effectiveness
9	Aphids	Neem Oil 70% Luna Sensation (Fluopyram and Trifloxystrobin)	11/16/2023 4:30 PM	Seed Senescence Stage	Reactive	Okay	No Phytotoxicity Phytotoxicity Score: 1	70% Neem Oil: 7.4ml/gal LUNA Sensation: 2.57 ml/ gal			EXO Pennycress	_This application did not work well in controlling high infestation of aphids _Would not recommend using this product for aphid control
10	Thrips	Tritek Oil (Mineral Oil) AND Conserve SC (Spinosad)	11/22/2023 4:00 PM	Seed Senescence Stage	Reactive/ Preventative (In system for over 2 weeks)	Great	No Phytotoxicity Phytotoxicity Score: 1	Tritek Oil: 40 mL/ Gal Conserve SC: 3 mL/ Gal			EXO Pennycress	_This product combination was highly effective in thrip pressure and showed low phytotoxicity
11	Thrips	Tritek Oil (Mineral Oil) AND Grandevo WDG	11/30/2023 4:00 PM	Seed Senescence Stage	Reactive/ Preventative (Grandevo WDG)	Great	No Phytotoxicity Phytotoxicity Score: 1	PWQ4R09UD Tritek Oil: 40 mL/ Gal Grandevo WDG: 13.6 g/ Gal			Myb Redo	_This combination worked very well for low/medium thrip pressure and would be advised for future
12	Thrips	Tritek Oil (Mineral Oil) AND Grandevo WDG AND Safari 20 (Dinotefuran)	12/5/2023 4:00 PM	Seed Senescence Stage	Reactive/ Preventative	Great	No Phytotoxicity Phytotoxicity Score: 1	321S4YTGNM Tritek Oil: 40 mL/ Gal Grandevo WDG: 13.6 g/ Gal Safari 20: 4.8 mL/ Gal			Exo70a3	
13	Thrips	LALGuard M52 OD	12/5/2023	Seedling/ Early Vegetative Stage	Preventative	Good	Low Phytotoxicity Phytotoxicity Score: 2	8D80SETR80			Myb Redo	_This product showed phytotoxicity in low amounts and could be effective in future
14	Thrips	Tritek Oil (Mineral Oil) AND Conserve SC (Spinosad) AND Luna Sensation (Fluopyram and Trifloxystrobin)	12/14/2023 4:00 PM	Early/Middle Vegetative Stage	Reactive/ Preventative	Great	No Phytotoxicity Phytotoxicity Score: 1	EWDXHB9NM Tritek Oil: 40 mL/ Gal Conserve SC: 3 mL/ Gal Luna Sensation: 2.57 mL/ Gal			Myb Redo	_This combination worked well in controlling thrips _No phytotoxicity was found making this a good choice for thrip control
		Tritek Oil (Mineral Oil) AND						JMN9643SNM (Miracle Grow)			Myb Redo- Miracle Grow Soil	_This application did not cause phytotoxicity and was effective as a reactive

A	B	C	D	E	F	G	H	I	J	K	L	M
Pest/Disease	Chemical Used	Date/ Time	Plant Age/ Maturity/ Stage	Preventative or Reactive Control	Use Guidelines (Low Phytotoxicity and High Effectiveness)	Phytotoxicity Result (Scale 1-5)	Slide Reference	Concentration	Application Guidelines	Applicator's Name	Plant Variety Notes	Comments/Effectiveness
14	Thrips	Tritek Oil (Mineral Oil)	2/20/2024	Vegetative Stage	Reactive	Great	VYEXIOGN23 AND 3X42980YN	40 mL/ Gal			Williams 82	
15	Thrips	PyGanics (Pyrethrin Oil)	2/20/2024	Vegetative Stage	Reactive	Great	BIUWEP98D AND 34867JIMJYH	15 mL/ Gal			Williams 82	
16	Thrips	Conserve SC (Spinosad)	2/20/2024	Vegetative Stage	Reactive/ Preventative	Great	908NMY23C AND 9N0Y8234TM	3 mL/ Gal			Williams 82	_Do not drench plant with Spinosad, just enough spray until light beading is acceptable for application effectiveness
17	Thrips	PyGanics Specialty (Pyrethrin Oil) AND Conserve SC (Spinosad) AND NemAttack Sf (Steinernema feltiae)	2/20/2024 5:00 PM	Vegetative Stage	Reactive/ Preventative	Great	9BNJWEFJD	15 mL/ Gal Conserve SC: 3 mL/ Gal NemAttack Sf: 1 packet/ Tank Mix (~5 million)			Williams 82	
18	Thrips	PyGanics Specialty (Pyrethrin Oil) AND Conserve SC (Spinosad) AND NemAttack Sf (Steinernema feltiae)	2/20/2024 5:00 PM	Vegetative Stage	Reactive/ Preventative	Great	NIUPG5NM31	15 mL/ Gal Conserve SC: 3 mL/ Gal NemAttack Sf: 1 packet/ Tank Mix (~5 million)			A3244	
19	Thrips	Arber (Burkholderia spp. strain A396)	4/10/2024	Early Vegetative Stage	Slight Reactive/ Preventative	Great	N/A	74 mL/ Gal	Foliar Spray: Apply to point of pesticide starting to bead and run off leaves		Maverick	_Phytotoxicity was low and should be tried for broad application to entire greenhouse
20	Thrips	Safari (Dinotefuran 20%)	5/14/2024	Early-Middle Vegetative Stage	Preventative (Granular)	Great/Good	Low Phytotoxicity Phytotoxicity Score: 1 applied twice in life cycle	KLWEGF209 AND SDAOU1433	3 Tsp/ 1 Gal Pot	Granular: Apply in front of where emitters spray growing media	Williams 82	_Phytotoxicity was low and should be tried for broad application to entire greenhouse as granular _DO NOT APPLY MORE THAN ONCE TO A PLANT DURING LIFE CYCLE

PHYTOTOXICITY PHOTOS TABLE OF CONTENTS:

- Tritek Oil
- Tritek Oil and Conserve SC
- Tritek Oil and Conserve SC and Pyrethrin Oil
- Tritek Oil and Conserve SC and Luna Sensation
- Tritek Oil and Grandevo WDG
- Tritek Oil and Grandevo WDG and Safari 20
- Pyrethrin Oil
- Pyrethrin Oil (PyGanics Specialty) and BotaniGard 22 WP and Grandevo WDG
- Pyrethrin Oil (PyGanics Specialty) and Conserve SC and NemAttack Sf
- Conserve SC (Spinosad)
- BotaniGard 22 WP
- Safari Granular
- Grandevo WDG
- NemAttack Sf, BotaniGard 22 WP, Grandevo WDG
- Neem Oil and Luna Sensation
- LALGuard M52 OD
- Roma Laundry Detergent
- Marathon 1% Granular
- 3-in-1 Concentrate
- Copper Fungicide

****SEE COMMENTS ON SLIDE FOR OBSERVATIONS,
NOTES, AND MORE INFORMATION****

Tritek Oil (Mineral Oil) [40 mL/Gal] and Conserve SC (Spinosad) [3 mL/ Gal] and Pyrethrin Oil (PyGanics) [20 mL/ Gal]

Transgenic PennyCress Myb Redo Early Vegetative Stage

Before: 12/19/2023; Sprayed: 4:00 PM

After: 12/20/2023; Observed: 10:30 AM



No Phytotoxicity --- Phytotoxicity Score: 1

**TRITEK OIL (MINERAL OIL) [40 ML/ GAL]
GRANDEVO WDG (CHROMOBACTERIUM SUBTSUGAE STRAIN
PRAA4-1T): 13.6 G/ GAL
SAFARI 20 (DINOTEFURAN): 4.8 ML/ GAL**

Transgenic Pennycress Exo70a3 Seed Production Stage

Before: 12/5/2023; Sprayed: 4:00 PM




After: 12/6/2023; Observed: 8:30 AM




No Phytotoxicity - Phytotoxicity Score: 1

BIOLOGICAL PEST MANAGEMENT

Specimen Label



CAN BE USED IN ORGANIC PRODUCTION 

Active Ingredient: *Chromobacterium subsugae* strain PRAA4-1[†] and spent fermentation media*30.0%

Other Ingredients:70.0%

Total:100.0%

*Contains not less than 1,000 Cabbage Looper Killing Units (CLKU)/mg. Note: The percent active ingredient does not indicate product performance and potency measurements are not federally standardized.

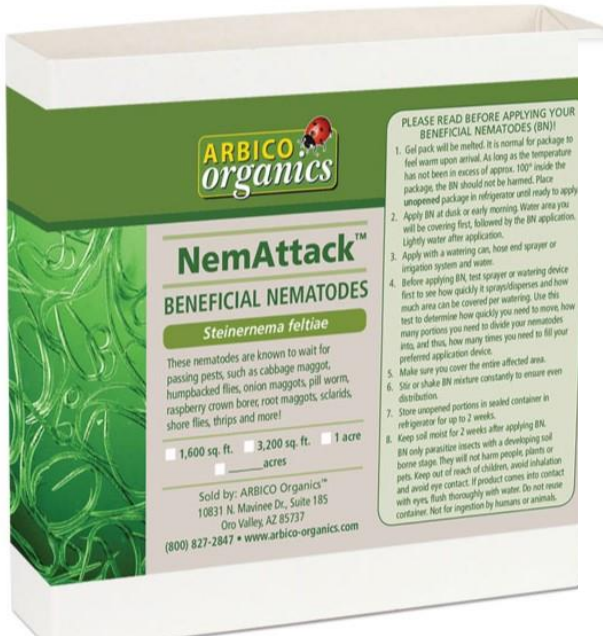
Specimen Label

 Dow AgroSciences

Conserve SC

Turf and Ornamental

Insect Control

ARBICO organics

NemAttack™
BENEFICIAL NEMATODES
Steinernema feltiae

These nematodes are known to wait for passing pests, such as cabbage maggot, humpbacked flies, onion maggots, pill worm, raspberry crown borer, root maggots, scarids, shore flies, thrips and more!

1,600 sq. ft. 3,200 sq. ft. 1 acre

Sold by: ARBICO Organics™
10831 N. Maninee Dr., Suite 185
Oro Valley AZ 85737
(800) 827-2847 • www.arbico-organics.com

PLEASE READ BEFORE APPLYING YOUR BENEFICIAL NEMATODES (BN!)

1. Gel pack will be melted. It is normal for package to feel warm upon arrival. As long as the temperature has not been in excess of approx. 100° inside the package, the BN should not be harmed. Place unopened package in refrigerator until ready to apply.
2. Apply BN at dusk or early morning. Water area you will be covering first, followed by the BN application. Lightly water after application.
3. Apply with a watering can, hose end sprayer or irrigation system and water.
4. Before applying BN, test sprayer or watering device first to see how quickly it sprays/dispenses and how much area can be covered per watering. Use this test to determine how quickly you need to move, how many portions you need to divide your nematodes into, and thus, how many times you need to fill your preferred application device.
5. Make sure you cover the entire affected area.
6. Stir or shake BN mixture constantly to ensure even distribution.
7. Store unopened portions in sealed container in refrigerator for up to 2 weeks.
8. Keep soil moist for 2 weeks after applying BN. BN only parasitize insects with a developing soil borne stage. They will not harm people, plants or pets. Keep out of reach of children, avoid inhalation and avoid eye contact. If product comes into contact with eyes, flush thoroughly with water. Do not reuse container. Not for ingestion by humans or animals.

BotaniGard® 22WP

WETTABLE POWDER MYCOINSECTICIDE

For use in controlling Whitefly, Aphids, Thrips, Psyllids, Weevils and Mealybugs in Ornamentals and Vegetables, Indoor/Outdoor Nursery, Greenhouse, Shadehouse, Commercial Landscape, Interiorscape and Turf.

Active Ingredient: *Beauveria bassiana* Strain GHA.....22.0%*

Inert Ingredients:.....78.0%**

Total 100.0%

*Based on the weight estimate of 4.78x10¹³ grams per spore.
**Contains petroleum distillates.

BotaniGard 22WP contains 2 x 10¹³ viable spores per pound.

KEEP OUT OF THE REACH OF CHILDREN

Store between 40°F and 85°F

CAUTION

See additional precautionary statements and first aid statements in attached booklet.



LAVERLAM INTERNATIONAL CORPORATION

117 S. Parkmont; P.O. Box 4109-Butte, MT 59702; Ph: (406)782-2386; Fax: (406) 782-9912
EPA Registration Number 82074-2 EPA Establishment Number 65626-MT-02

Edition:

Lot No.:

Net Contents: One Pound

Expiration Date:



Minute Pirate Bug

PESTICIDE MONITORING AND SCOUTING

-Monitoring pest populations through population trends over time on each table

-scouting each week gives an idea to the pests and seeing their change over time on what the plan of action for that week

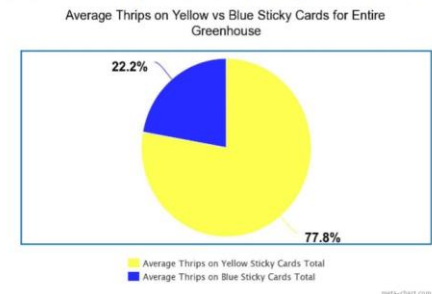
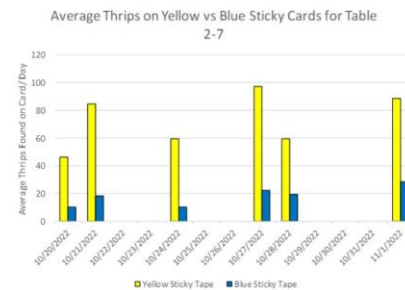
-Maintaining pest populations to tolerable populations through scouting and monitoring that the mode of action continues to be low to chemical controls used

-Monitoring:

-Scouting: Observing plant health and pest damage overtime to detect pest problems early and prevent and manage issues before they cause research losses

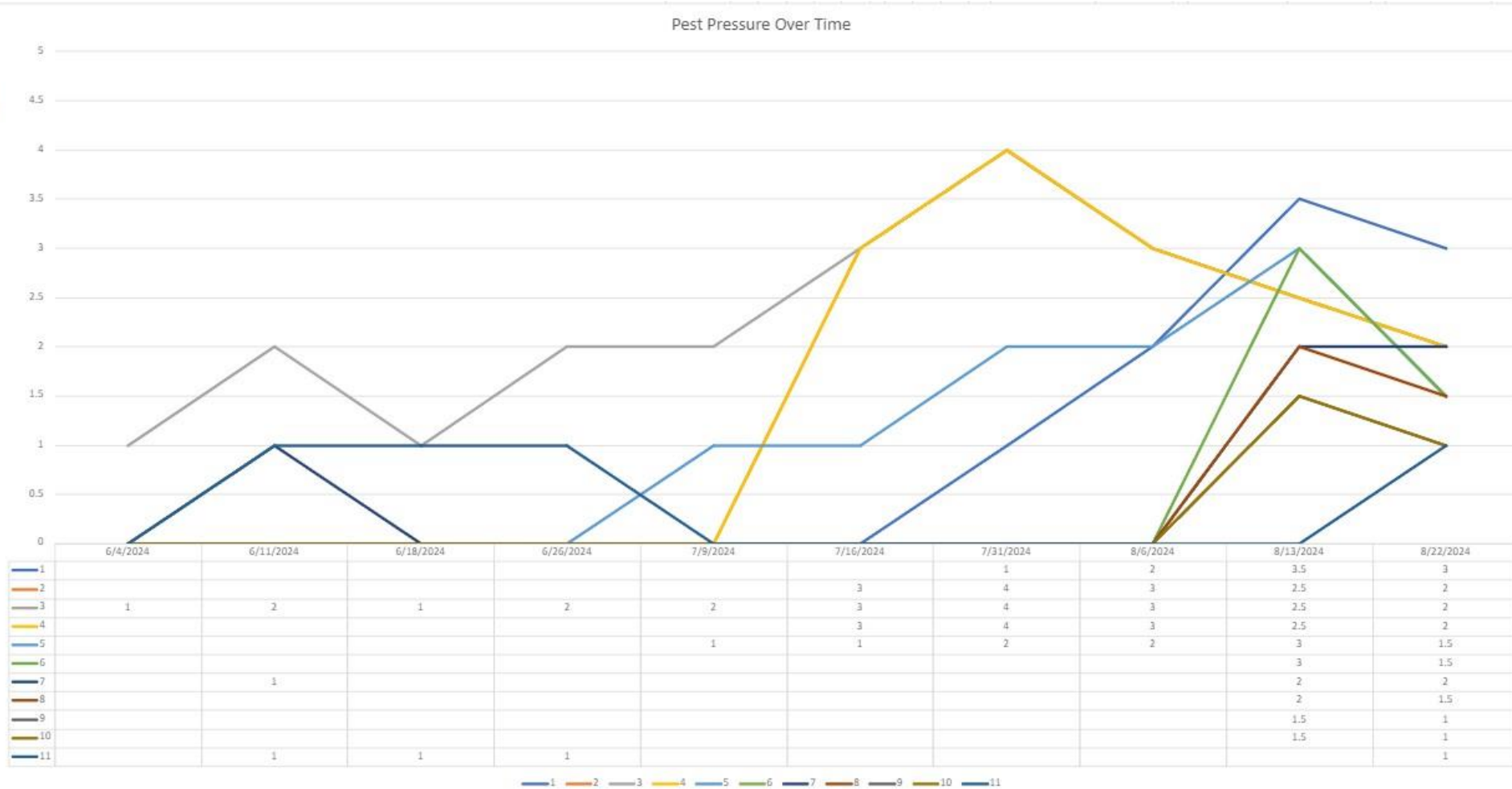
Blue vs. Yellow Sticky Cards Results

- From this experiment it was found that 77.8% of Western Flower Thrips (WFT) caught were found on the yellow sticky tape cards.
- The column graph shows WFT caught each day showing a higher efficacy of yellow sticky cards for WFT capture than blue sticky cards
- These results were used for educated application of pest management physical controls, monitoring for WFT populations over time, and future experiments using WFT counts



Date	Bay	Table	Pest Scouted: Drop Down Bar	Pest Pressure Observations (1-5: Very Low/Low (1), Low-Medium (2), Medium (3), Medium-High (4), High (5))	Plant/ Maturity with Pest Pressure	Pest Infestation Levels Comments
6/11/2024	1	2	Mealybugs	1	Rice Seed Production	_mealybugs are in low pressure and no adults seen less than seen last week but still present
6/11/2024	1	4	Thrips	2	Soybean Flowering stage	_soybean plants all have thrips present at low pressure _there are ~10 hot spots of new thrip damage with closer to medium pressure spots in foliage
6/11/2024	1	7	Thrips	1	Soybean Seed Production Stage	_Thrip damage is present but very little new thrip damage present _It was hard to find more than one thrip per trifoliolate
6/11/2024	1	9	Spider Mites	1	Sorghum Seed Production	_got on table and found ~20% of pinnacles have live spider mites and webs covering the top of the pinnacles
6/11/2024	1	10	Anthraxnose	2	Rice Seed Production	_Low coverage but ~30-40% of plants have browning tips of leaves and red spots and stripes close to browning tips
6/11/2024	1	10	Spider Mites	2	Rice Seed Production	_Spider mites seen on leaves of some rice plants _damage of very small physical damage spots on leaves _spider mites damage seen on top of leaves with spider mites on underside of leaves
6/11/2024	2	1	Ants	3	Wheat Early Vegetative	_ants and fungus gnats seen on all tables and most plants have fungus gnats in soil and ants
6/11/2024	3	4	Spider Mites	1	Sorghum Seed Production	_~10% of pinnacles have live spider mites and webs covering the top of the pinnacles
6/11/2024	3	5	Thrips	1	Soybean Flowering Stage	_Thrips are barely present with almost no hot spots _hard to find multiple thrip spots on each plant
6/11/2024	3	6	Thrips	1	Sorghum Early Vegetative	_Thrips seen in new growth funnel of leaves _old thrip damage on all plants
6/11/2024	3	8	Thrips	1	Transgenic Canola Flowering	_only 1-2 thrips seen per plant
Date	Bay	Table	Pest Scouted: Drop Down Bar	Pest Pressure Observations (1-5: Very Low/Low (1), Low-Medium (2), Medium (3), Medium-High (4), High (5))	Plant/ Maturity with Pest Pressure	Pest Infestation Levels Comments
6/4/2024	1	2	Mealybugs	2	Rice Seed Production	_primarily younger/smaller mealybugs found
6/4/2024	1	2	Aphids	1	Rice Seed Production	_Not seen as individuals but clusters of 20+ dead aphids with a few barely moving aphids present
6/4/2024	1	2	Ants	1	Rice Seed Production	_ants seen mainly on rice plants with mealybugs present
6/4/2024	1	5	Spider Mites	2	Soybean Flowering	_only one plant per table but spider mites are present on both plants
6/4/2024	1	8	Thrips	2	Soybean Flowering/Seed Production	_Thrips seen on the large soybean plants with the most pressure, closer to medium pressure, on west end of table plants on semi-damaged leaves _Thrips are at a level that they should be treated soon before early infestation begins
6/4/2024	1	9	Spider Mites	1	Sorghum Seed Production	_Spider Mites seen on a couple plants with webs starting to cover the top of seed
6/4/2024	1	9	Thrips	2	Soybean Vegetative	_Thrips are present on all plants with some hot spot leaves having 3-5 thrips present
6/4/2024	3	4	Spider Mites	1	Sorghum Seed Production	_3 plants have spider webs on the seed pod clusters and spider webs going to other seed pod clusters _either the spider mites are emerging, not present but heavily covered in spider webs, or there were some spider mites but only webs left
6/4/2024	3	4	Thrips	1	Sorghum Vegetative Seedling	_on seedlings no thrip damage present _50% of plants had 1-2 thrips in the funnel on new leaf

PEST POPULATION GRAPHS



- All tables in each bay are scouted for any pest pressure (Bay 4, Western Flower Thrips shown in graph)
- The scouting reports are then filtered by bay and pest for analysis

INTEGRATED PEST MANAGEMENT FOCUSED CHEMICAL AND BIOLOGICAL CONTROLS PROCESS

Pest Pressure Scouting/Monitoring

+

Phytotoxicity Observations and Photos

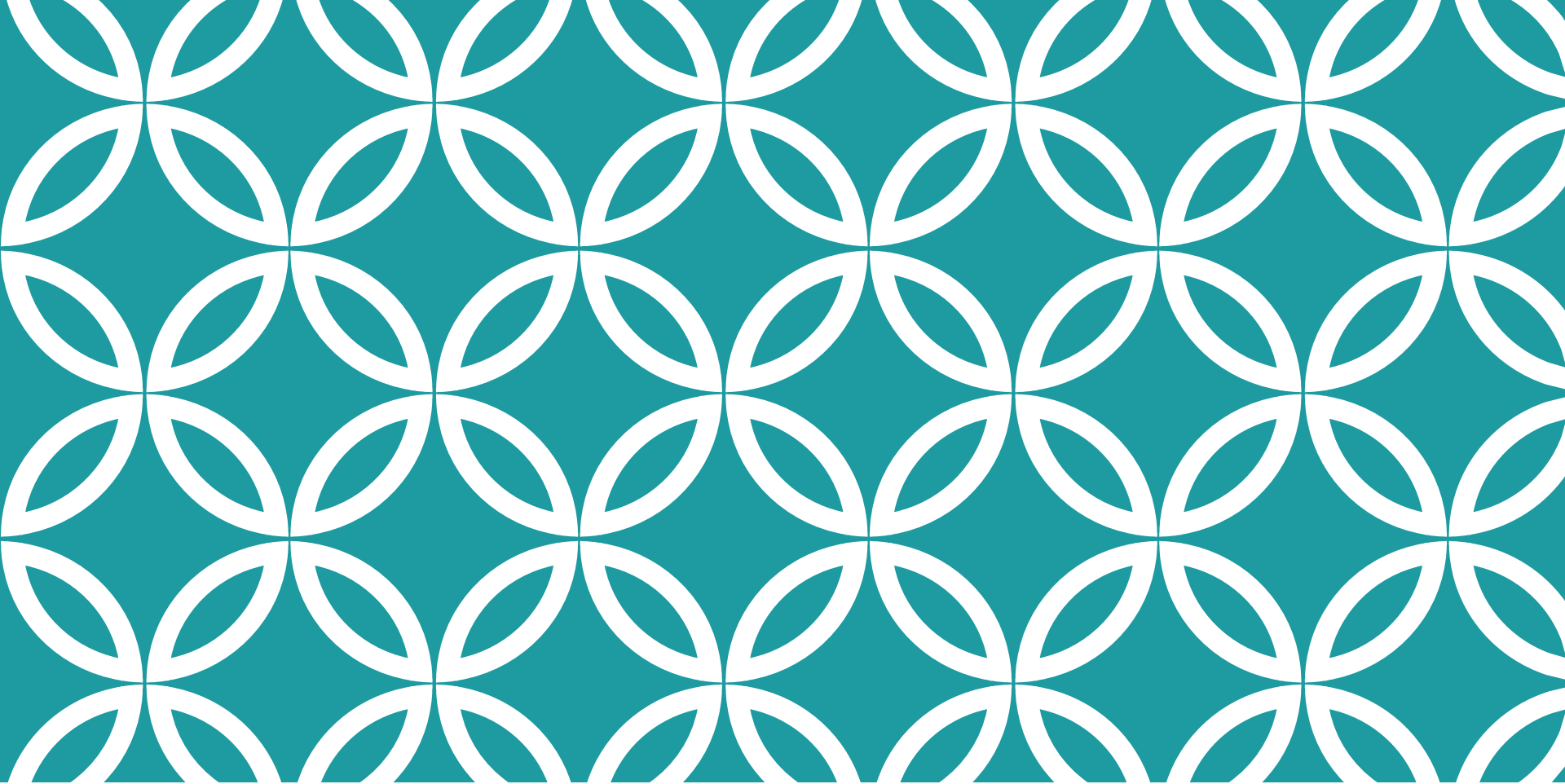
+

Pest Pressure Population Graphs

+

History of Past Biological and Chemical Management Treatments

Integrated Pest Management Focused Chemical and Biological Control
Applications



HOOP HOUSE HYDROPONIC SYSTEM

- *Typha latifolia*
- *Typha domingensis*
- Duckweed





SHA LIBRARY EMS SCREEN

Michel Ruiz
Nolan Mitschke
Natalie Gonzalez
Juan Gonzalez
Melissa Baez

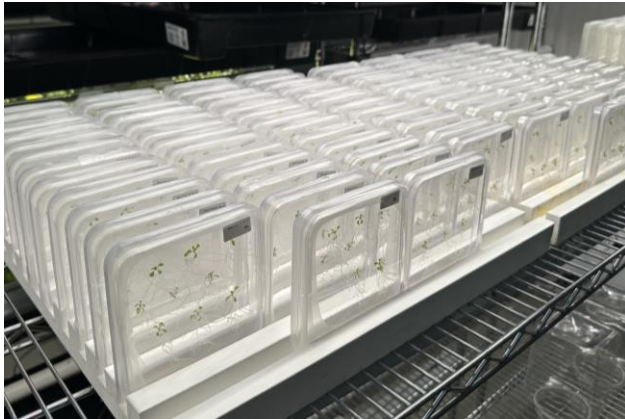
SHA EMS SCREEN PIPELINE

Harvested as 135 pools (September 2023)



Seed to seed growth

Weekly waves of 990 mutants in 200 plates each



Mutants identified in gel at 14 days

Plate Layout

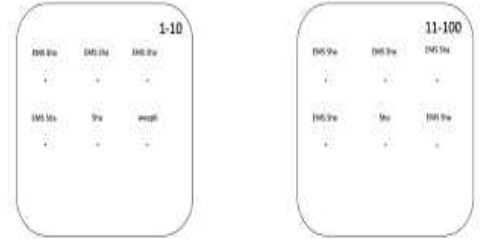


Plate labels are as follows:

Plate #
Pool #, Wave #



600+ interesting steep architecture phenotypes so far

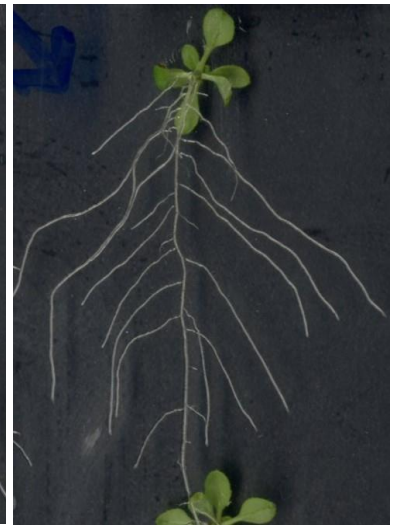
Sha



50-3-3



75-1-5



Steep Root System Architecture (RSA) mutants and Sha are grown to seed. Mutants are labeled by: Pool #- Mutant #- Wave #

TYPICAL RSA OF SHA (CONTROL) VERSUS WEEP6 (STEEP RSA PHENOTYPE CONTROL)

Sha



weep6

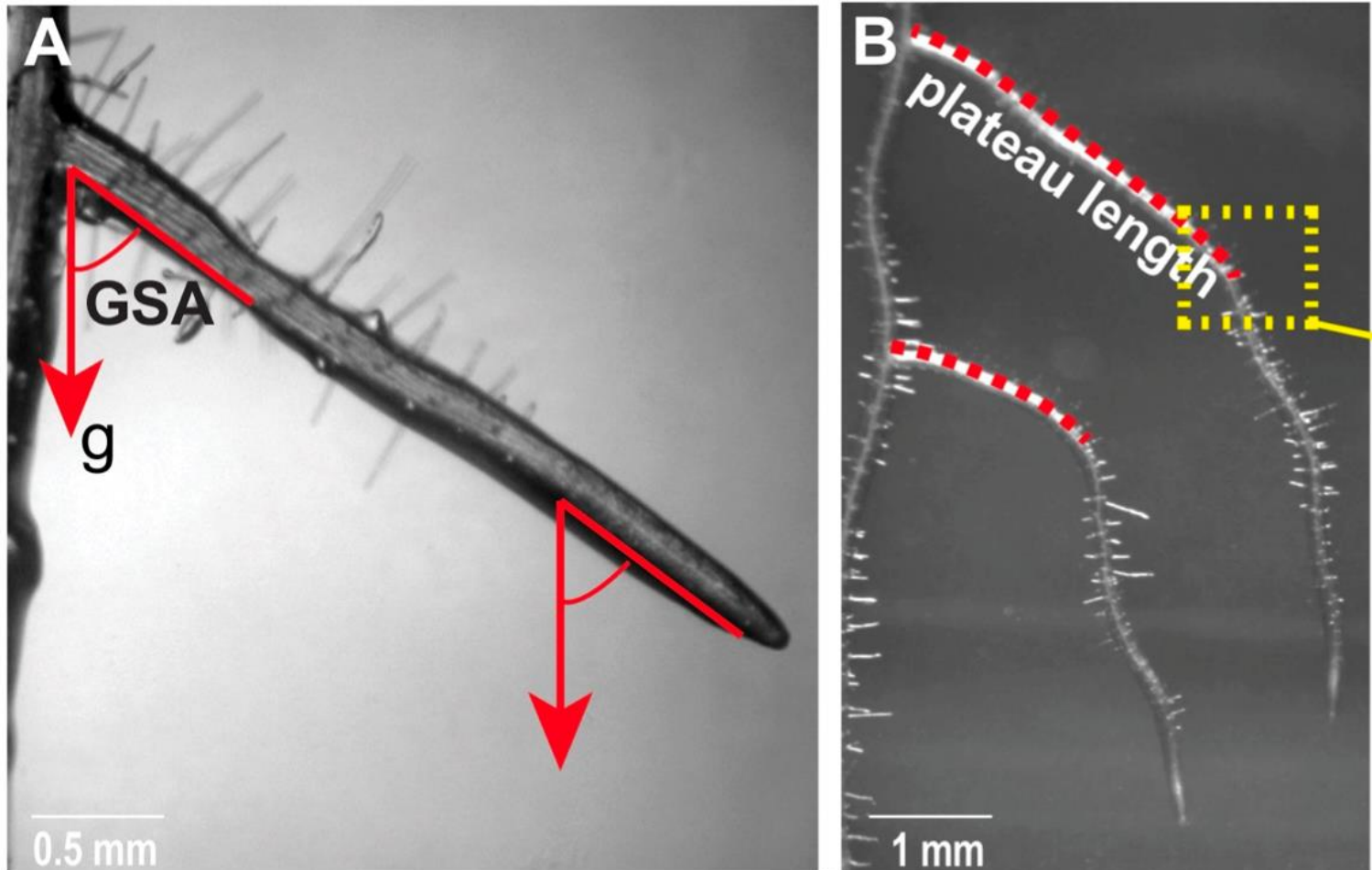


-With this screen we are trying to identify new genes that control root system architecture. For HPI purposes, we are especially interested in steep RSA because those can determine deep rooting.

-A good example of a steep root system architecture is the weep6 mutant and we use it as a control in our plates.

-We also use Sha seedlings as controls of non-mutagenized individuals

FACTORS THAT DETERMINE RSA STEEPNESS: LRIGSA AND PLATEAU PHASE



- The steepness of a RSA can be determined by different factors, one is small initial lateral root angles (LRiGSA) and a good example of this is weep6
- Another factor is the length or duration of the plateau phase. A shorter plateau phase determines a steeper RSA.

SHA EMS SCREEN UPDATE

- 231 Steep RSA Mutants found in Screen grown to seed have been harvested
- Then the 19 very ideal steep RSA mutants grown to seed will be screened again to reconfirm steep RSA phenotypic characteristics
- After reconfirming phenotypes of very ideal steep RSA lines, lines will be sequenced to locate the mutation points responsible for regulating ideal steep RSA growth



THANK YOU!

-Wolfgang Busch

-Joanne Chory

-Todd Michael

-Kay Watt

-Dharmendra Singh

-Shane Hunt

-Abraham Guerro Corona

-Phenotype Team (Shree, Hanna, Erica, Kimberly, Jorge)

-All HPI Members