



Disease management in ornamental nurseries

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Pest prevention

Most crop problems can be anticipated & avoided

Often prevention is the least expensive, most effective, and only control option available

By the time plants appear unhealthy it's too late

Key pest prevention techniques include:

- Planning crop production & IPM in advance
- Good sanitation & exclusion
- Properly managing the environment & cultural practices

Environmental & cultural practices

Each crop requires specific growing conditions; drastic fluctuations from proper conditions predispose crops to damage

Use proper cultural practices i.e. fertilization, irrigation, temperature, lighting, etc.

Be certain growing media has the aeration, drainage, & salinity necessary for good growth

Good team work among essential employees is a must for success

Scouting or Monitoring

-foundation of IPM program-

Early detection & identification enables the nursery to:

- reduce plant damage
- improve plant quality
- reduce production costs
- avoid production delays & increase profits
- proper use of pesticides

Fungicide Classification

Classified by mode of action (MOA)

Example: Subdue Maxx or Subdue GR

MOA- nucleic acid synthesis

Target Site- RNA

Polymerase1

mefenoxam

Common name-

FRAC Code- 4

If a pathogen is resistant to a fungicide it's usually resistant to all fungicides in that class

Fungicide resistance

Resistance occurs when a fungus develops a genetic mutation at the target site that reduces its sensitivity to a specific fungicide

If a single fungicide continues to be used, the fungicide-sensitive portion of the population is suppressed over time, and only the fungicide-resistant portion of the population remains

This population goes on to reproduce and becomes the majority. Eventually, the fungicide is ineffective because this majority of the fungal population is no longer susceptible to it.













Evaluate and compare the efficacy of preventative & curative fungicides for managing anthracnose

Host: *Sansevieria trifasciata* 'Laurentii'

Pathogen: *Colletotrichum sansevieriae*

Plants were grown in 3-gallon containers containing Fafard potting soil amended with Florikan 18-6-8 slow release fertilizer.

Experimental units were a plant treated with a single fungicide treatment, with 6 repetitions in a randomized complete block design with sub-sampling.

Fungicides were mixed in 1.0 gal total volume, and applied as a foliar spray until runoff (approx 16 fl oz per plant). Four applications for each treatment.

Plants were inoculated with a spore suspension of 1×10^5 spores/ml. Inoculum was sprayed on plant foliage until runoff.

Treatments:

1. Non-inoculated control
2. Inoculated control
3. Disarm 480 SC (fluoxastrobin) @ 16 ounces/100 gallons; 14 d
4. Pageant (pyraclostrobin + boscalid) @ 18 ounces/100 gallons; 14 d
5. Heritage (azoxystrobin) @ 6 ounces/100 gallons; 14 d
6. Concert (propiconazole + chlorothalonil) @ 28.5 ounces/100 gallons; 14 d
7. Affirm WDG (polyoxin D zinc salt) @ 0.375 lbs/100 gallons; 7 d
8. Torque (tebuconazole) @ 7 ounces/100 gallons; 14 d
9. Xeroton X3 (hydrogen peroxide + acids) @ a 1:1500 dilution; 7 day spray interval

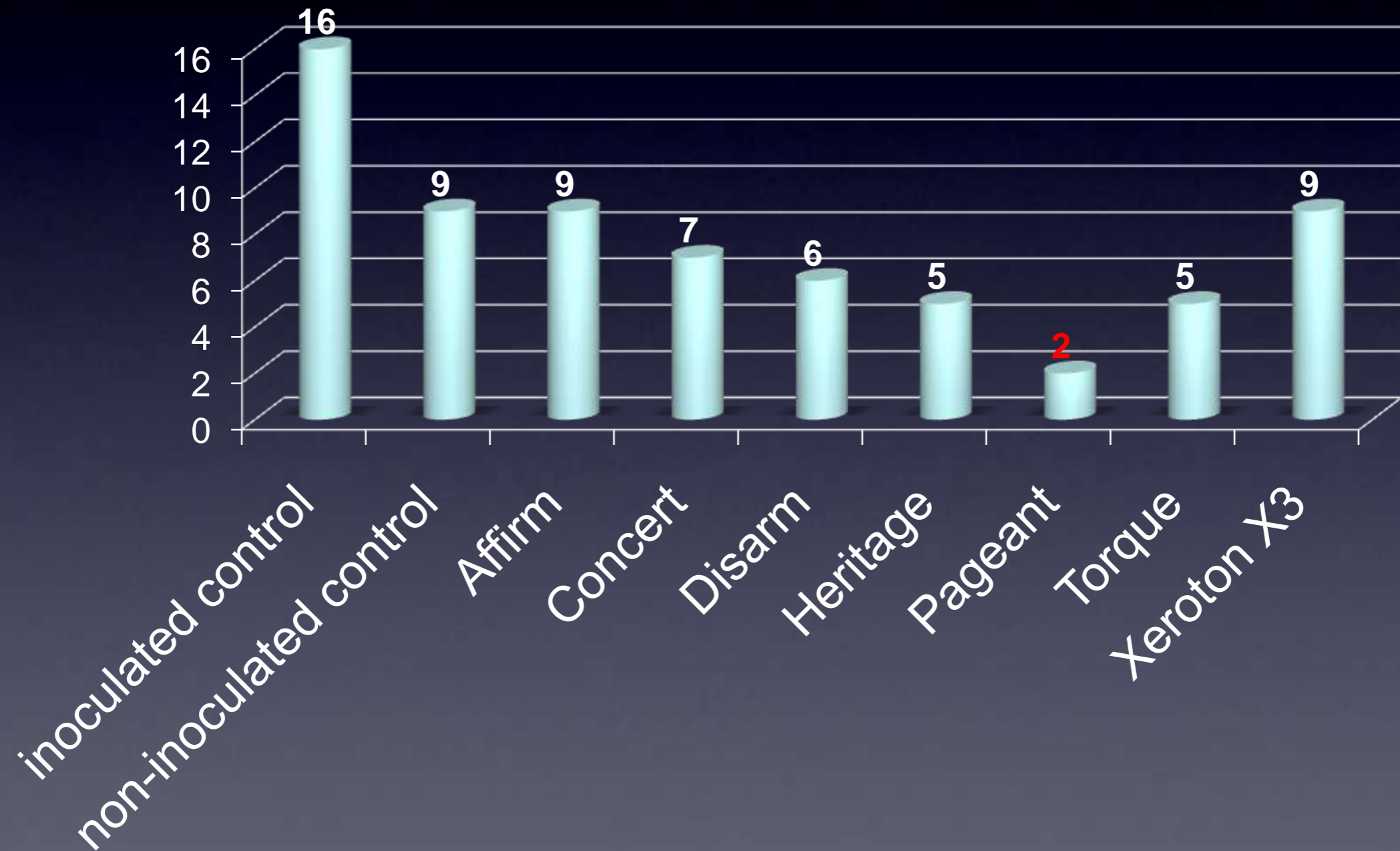
Curative Trial

Disease levels for 9 treatments to control anthracnose. Disease measures were number of symptomatic leaves, number of lesions, disease severity, and marketability. Values within each column with the same letter do not differ significantly based on means separation using Tukey's Studentized Range (HSD). All treatments were applied as foliar spray. Marketability is the number of marketable plants out of the six experimental units for the given treatment.

Product	Rate	Number of symptomatic leaves	Number of lesions	Severity	Marketability
1-Non-inoculated control	---	27.25 ± 10.14	97.75 ± 52.71	11.63 ± 6.36	0
2-Inoculated control	---	36.00 ± 12.81	103.75 ± 35.69	16.50 ± 6.59	0
3-Disarm 480 SC (fluoxastrobin)	16 fl oz/100 gal	23.75 ± 8.77	72.50 ± 29.21	10.00 ± 3.49	0
4-Pageant (pyraclostrobin + boscalid)	18 oz/100 gal	25.75 ± 8.72	74.25 ± 33.27	10.25 ± 4.31	0
5-Heritage (azoxystrobin)	6 oz/100 gal	55.50 ± 30.80	74.00 ± 30.46	9.35 ± 3.36	0
6-Concert (propiconazole+chlorothal)	28.5 fl oz/100 gal	33.00 ± 14.22	89.00 ± 42.73	15.00 ± 7.27	0
7-Affirm WDG (polyoxin D zinc salt)	0.375 lbs/100 gal	26.50 ± 4.92	58.00 ± 11.58	12.75 ± 2.39	0
8-Torque (tebuconazole)	7 fl oz/100 gal	32.50 ± 5.33	82.25 ± 19.14	12.00 ± 1.96	0
9-Xeroton X3 (hydrogen peroxide + acids)	1:1500 dilution	37.50 ± 8.05	50.50 ± 9.13	13.75 ± 1.31	0

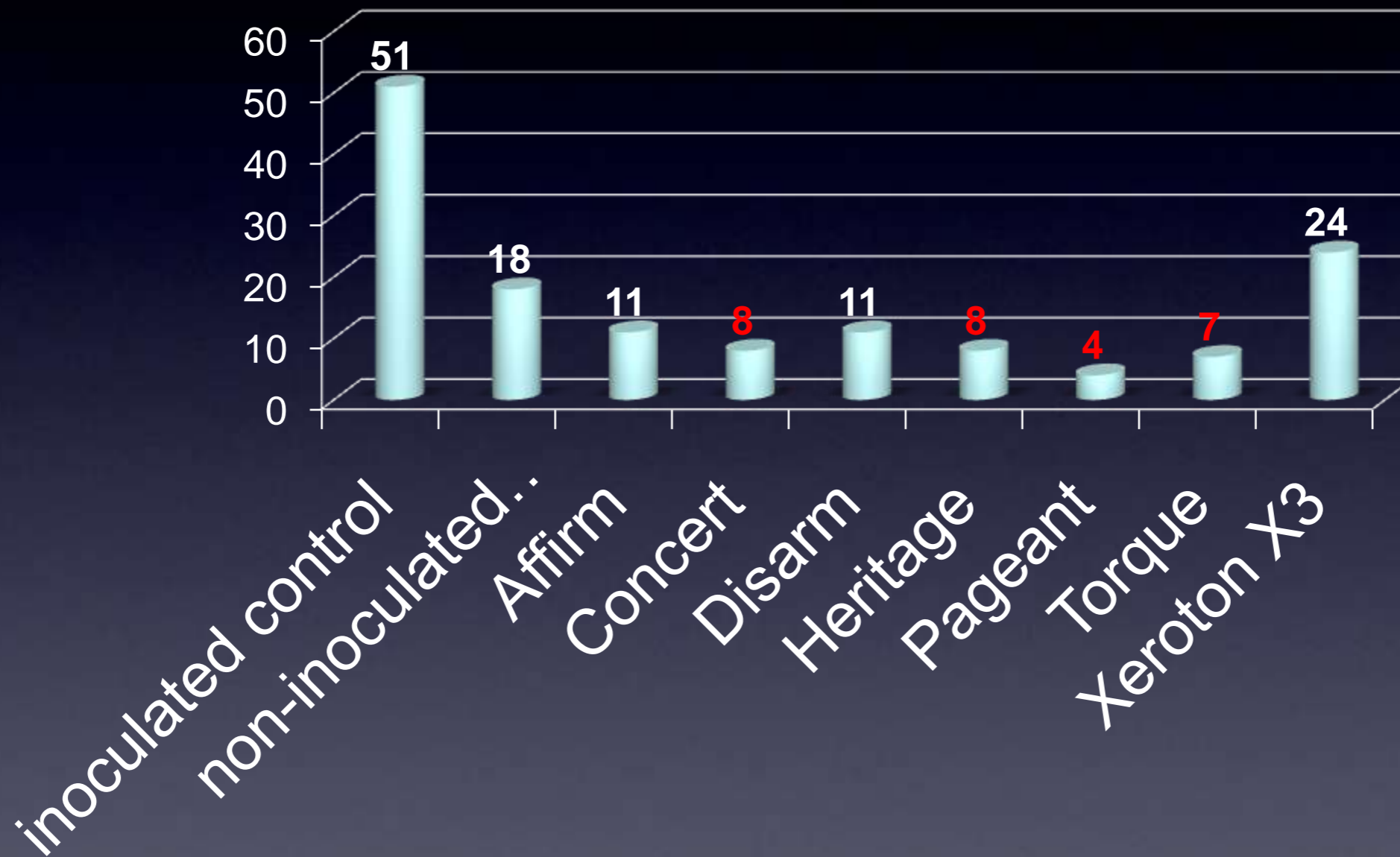
Preventative Trial- Anthracnose

of symptomatic leaves



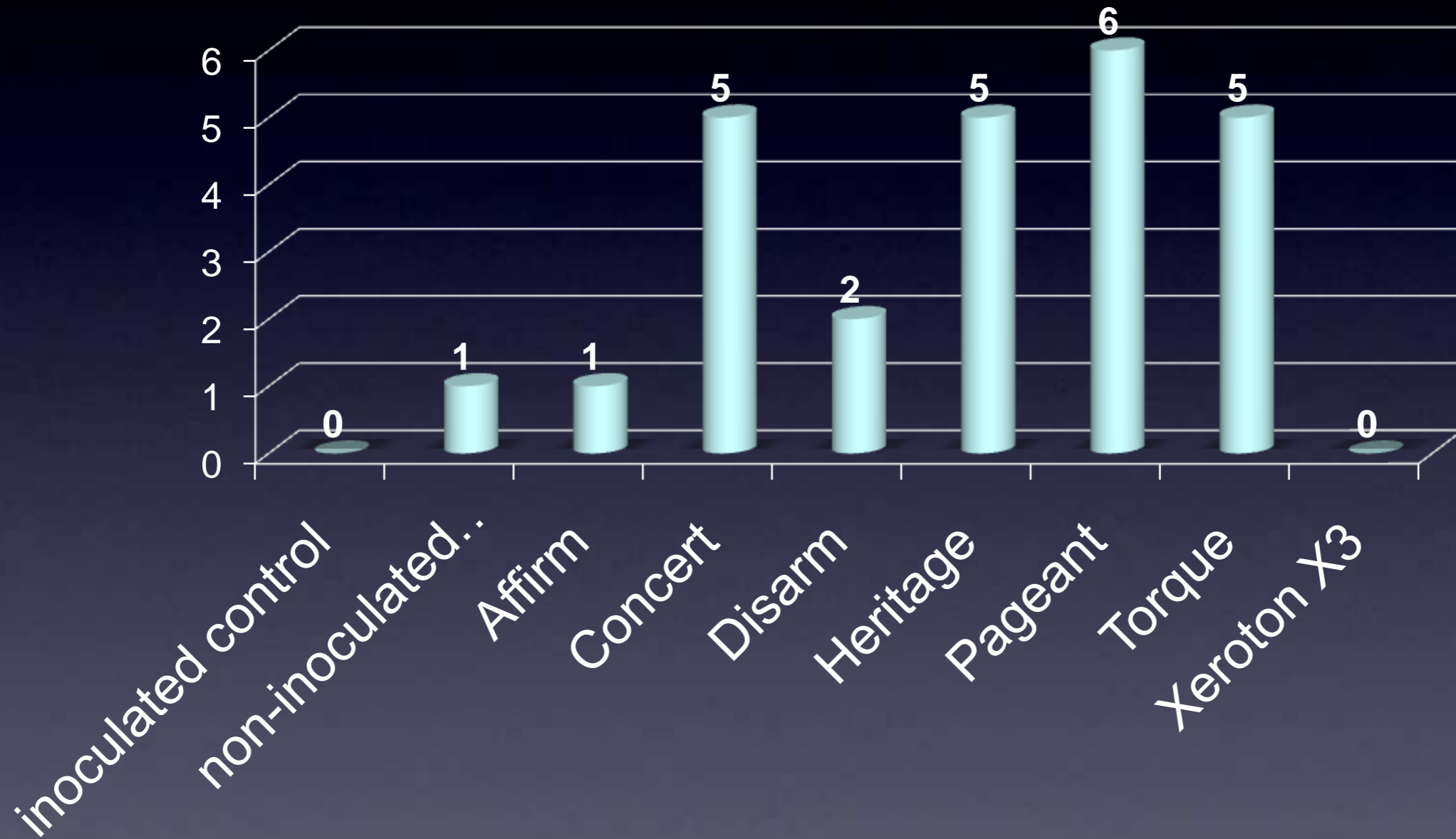
Preventative Trial- Anthracnose

of lesions

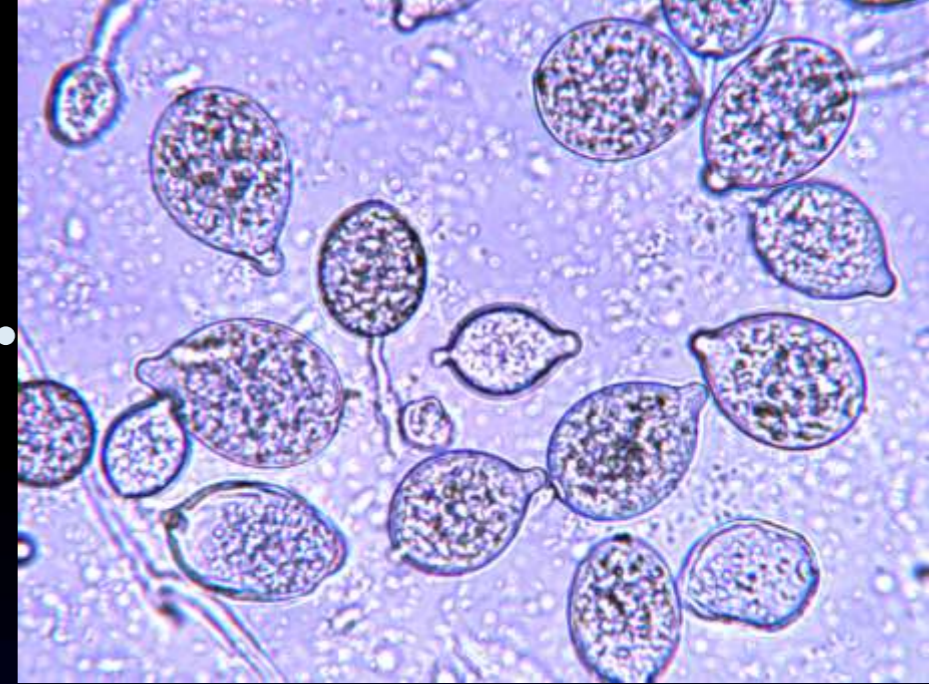


Preventative Trial- Anthracnose

of marketable plants



Phytophthora spp.



P. nicotianae, *P. palmivora*, *P. cinnamomi*, & *P. tropicalis*

Root, stem & crown rot; foliar blights/rots

Affected tissues turn water soaked

Lesions eventually coalesce and the tissue rots often turning black as the disease progresses















Phytophthora spp. -management-

Moisture control is crucial

Increase distance between plants

Effective weed control

Use drip irrigation or water early

Rogue and discard severely
affected plants

Preventative fungicide treatments

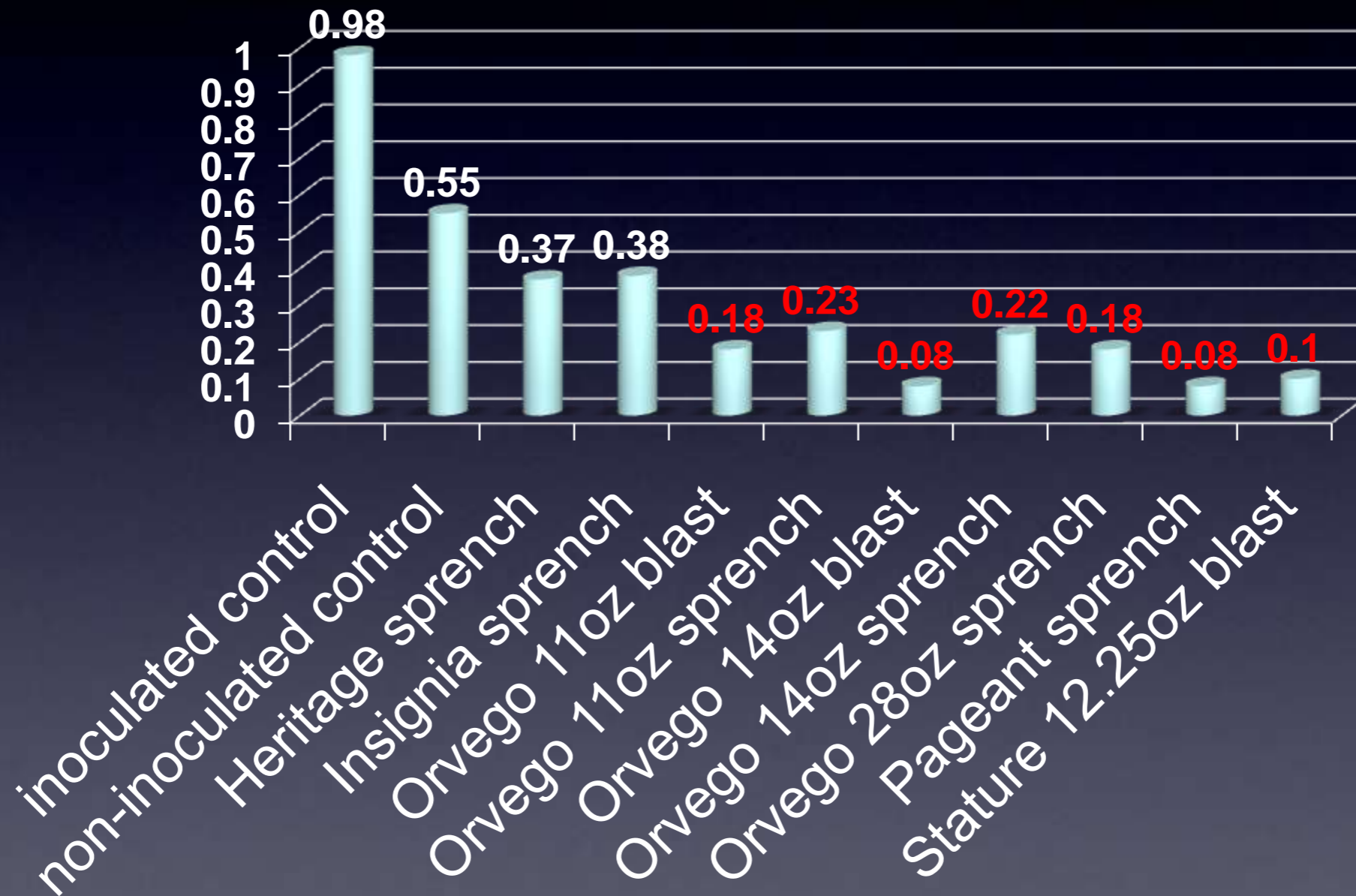
Disease severity data for Phytophthora root/crown rot and foliar blight is given as a percentage, which was calculated by taking the midpoint of each rating category. Marketability is the number of marketable plants out of the six experimental units for the given treatment.

Fungicide	Rate/100 gal; 14 day	Application method	% Severity (foliar blight)	% Severity (root rot)	Marketability
1. Non-inoculated control	---	---	0.55 b	1.08 a	1
2. Inoculated control	---	---	0.98 a	1.50 a	0
3. Orvego	11 fl oz	Sprench	0.23 cd	0.08 b	5
4. Orvego	14 fl oz	Sprench	0.22 cd	0.00 c	5
5. Orvego	28 fl oz/	Sprench	0.18 cd	0.00 c	6
6. Heritage	3 oz	Sprench	0.37 bc	0.25 b	3
7. Insignia SC	8 fl oz	Sprench	0.38 bc	0.25 b	3
8. Pageant	12 oz	Sprench	0.08 d	0.00 c	6
9. Orvego	11 fl oz/	Air blast	0.18 cd	0.44 b	6
10. Orvego	14 fl oz	Air blast	0.08 d	0.25 b	6
11. Stature SC	12.25 fl oz	Air blast	0.10 d	0.33 b	6

Column means indicated with the same letters are not significantly different ($P \leq 0.05$) based on Student Newman Keuls test

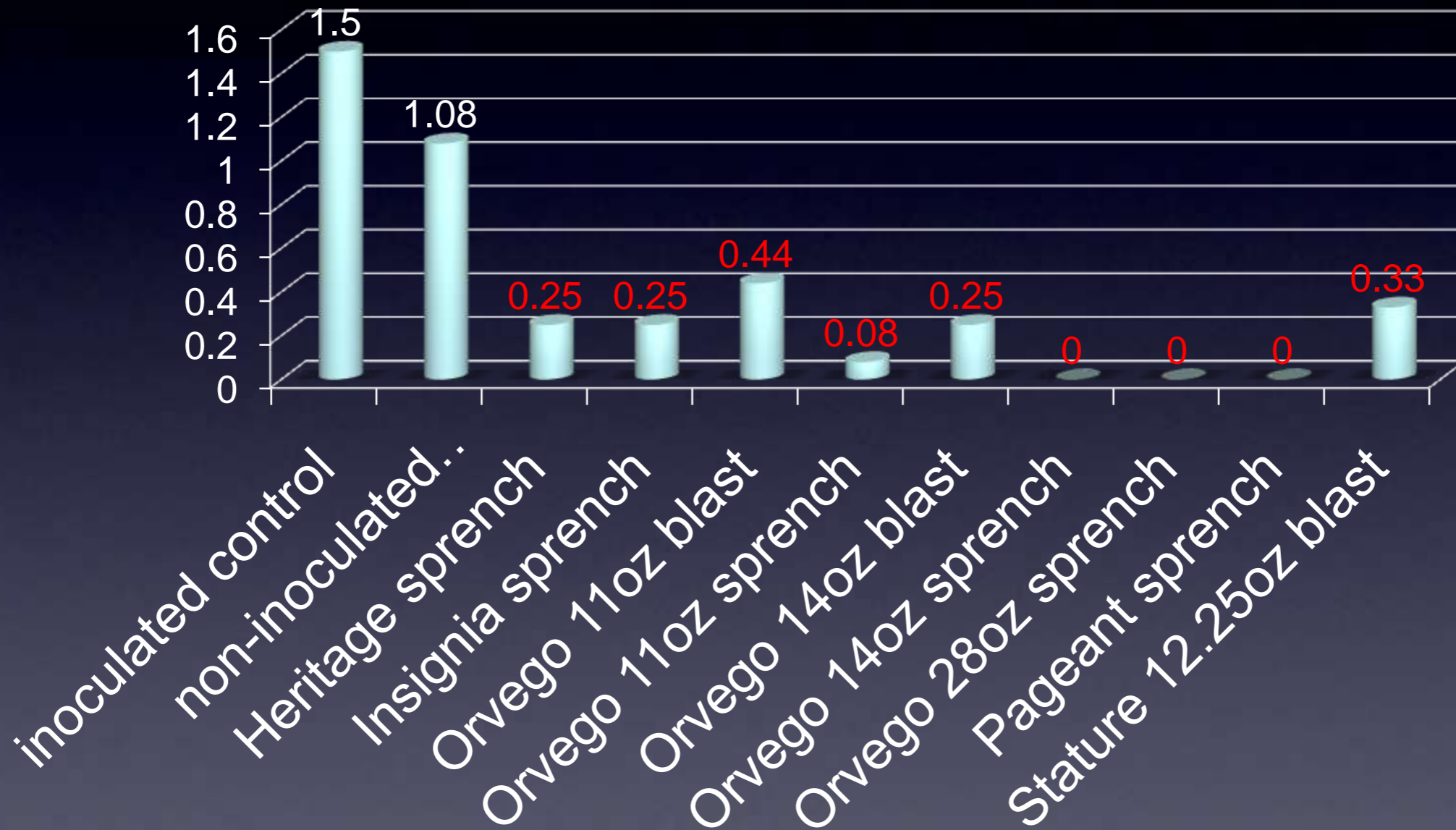
Foliar blight- Phytophthora

% severity

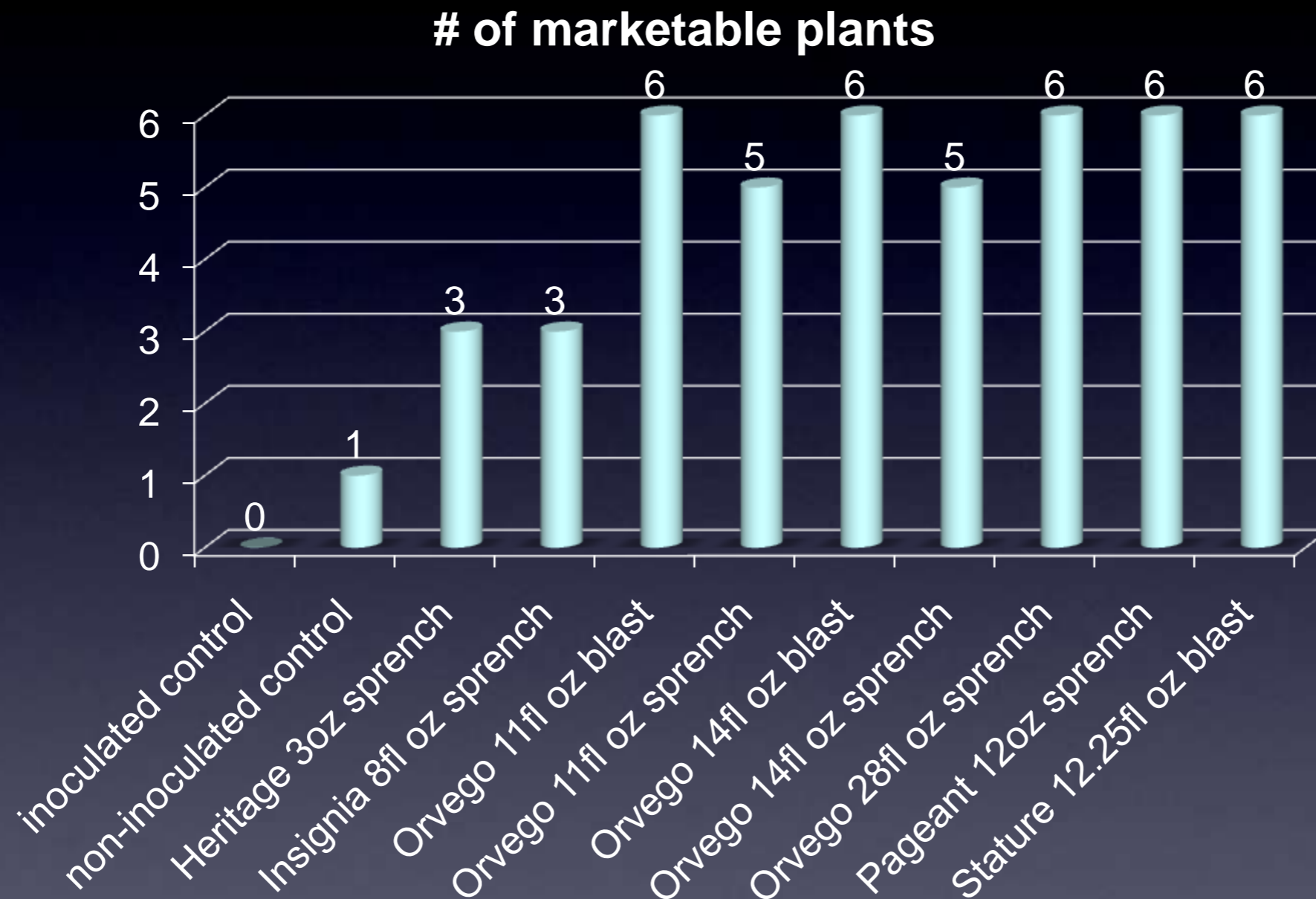


Root rot- Phytophthora

% severity



Marketable plants- Phytophthora



Myrothecium leaf spot

Fairly wide host range with *Dieffenbachia*, *Hibiscus*, *Mandevilla* and *Spathiphyllum* very susceptible

Excellent opportunist that readily invades weakened or damaged plant tissue

Younger plants are more susceptible, but management is necessary throughout the crop cycle





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Ian Maguire UF/IFAS/TREC

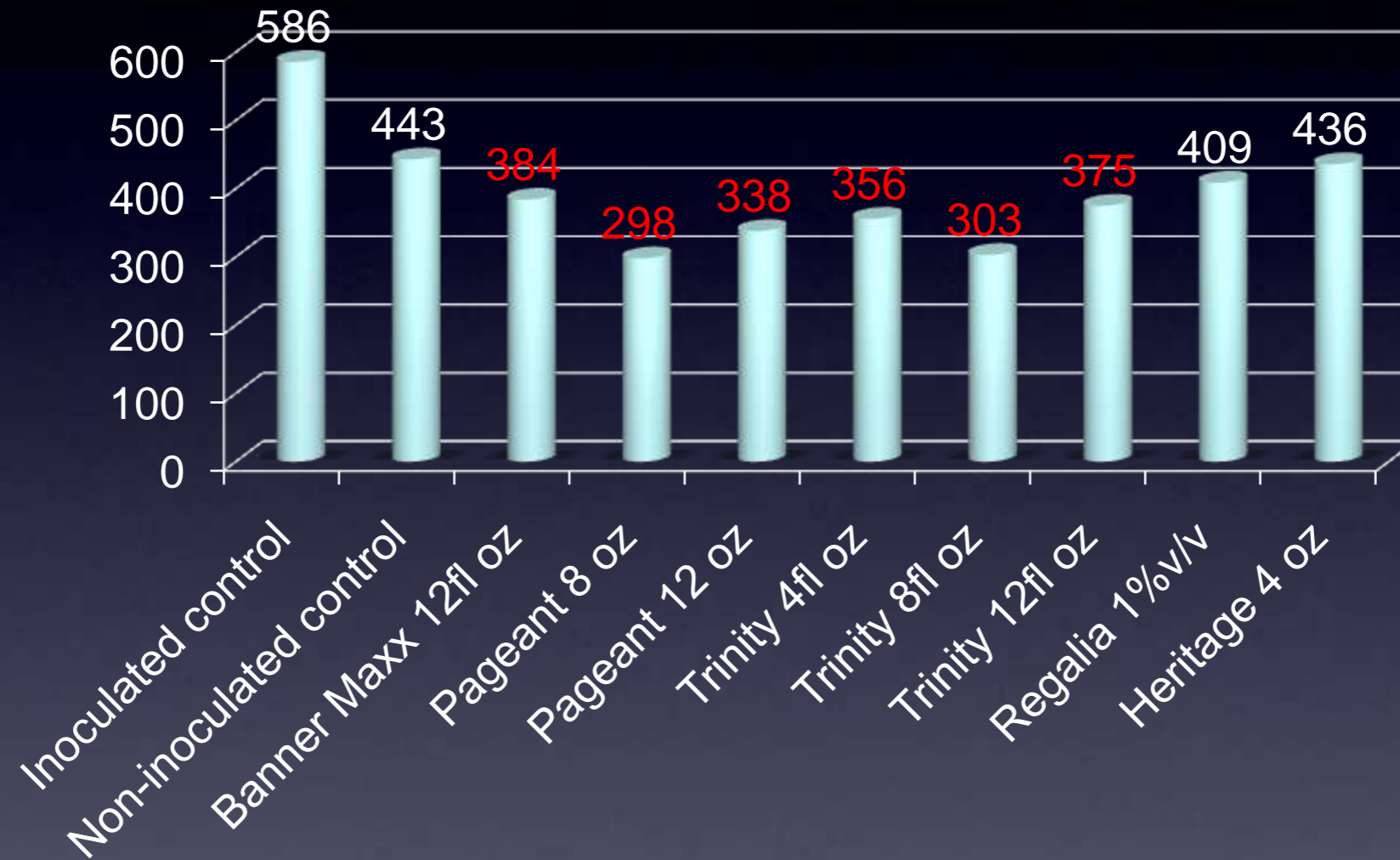
Disease levels for 10 treatments to control *myrothecium* leaf spot on dieffenbachia. Disease measures were # symptomatic leaves (final), % severity (final), and AUDPC for both variables.

Treatment	Rate/100 gal; 14 day	# symptomatic leaves (final)	% severity (final)	AUDPC (# symptomatic leaves)	AUDPC (% severity)
1-Banner Maxx	12.0 fl oz	17.00±1.78 <u>ab</u>	6.75±5.00 <u>ab</u>	384.4±25.1 b	137.3±20.7 <u>ab</u>
2-Pageant 38 WG	8.0 oz	12.25±2.39 b	4.75±4.20 b	297.8±39.4 b	99.9±16.2 b
3-Pageant 38 WG	12.0 oz	13.00±2.27 b	7.50±6.56 <u>ab</u>	338.3±33.5 b	141.5± 26.2 <u>ab</u>
4-Trinity 2SC	4.0 fl oz	11.25±3.07 b	3.75±2.22 b	355.9±34.4 b	69.5±4.7 b
5-Trinity 2SC	8.0 fl oz	11.25±1.75 b	4.50±2.50 b	303.4±17.2 b	94.7±6.2 b
6-Trinity 2SC	12.0 fl oz	12.75±1.93 b	5.25±3.37 b	375.0±22.6 b	119.4±6.2 <u>ab</u>
7-Regalia SC	1%v/v	16.50±4.37 <u>ab</u>	5.50±5.10 b	409.1±36.0 <u>ab</u>	103.3±20.1 <u>ab</u>
8-Heritage	4.0 oz	15.75±2.69 <u>ab</u>	6.75±5.16 <u>ab</u>	435.8±38.8 <u>ab</u>	139.2±24.2 <u>ab</u>
9-inoculated control	---	24.00±4.64 a	10.00±5.00 a	568.1±41.3 a	177.9±4.3 a
10-uninoculated control	---	15.5±0.65 b	5.75±4.25 b	443.6±24.8 <u>ab</u>	126.1±19.5 <u>ab</u>

Column means indicated with the same letters are not significantly different ($P \leq 0.05$) based on Student Newman Keuls test

Myrothecium leaf spot

AUDPC- # diseased leaves















Rust

-management-

Plant disease free material

Space plants to allow for good air circulation

Avoid wetting the foliage

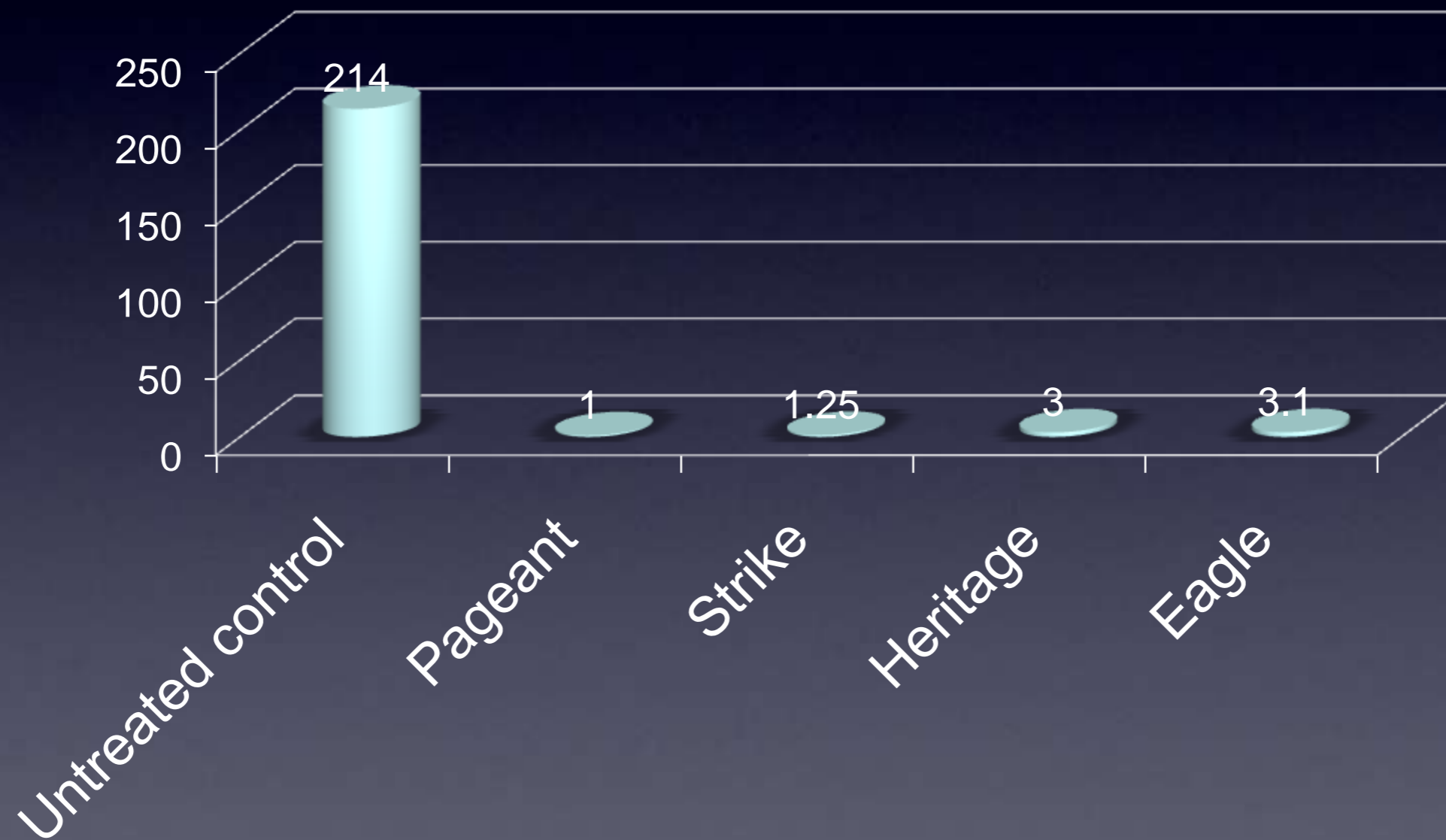
Fungicides that have good efficacy

Disease levels for 4 treatments to control canna lily rust. Disease measures were number of symptomatic leaves, final percent severity (y_{max}), and AUDPC of each variable. Values within each column with the same letter do not differ significantly based on means separation using Fisher's LSD. All treatments were foliar applications. Marketability is the number of marketable plants out of the four experimental units for the given treatment.

Product	Rate/100 gal; 14 day interval	number of symptomatic leaves	AUDPC of symptomatic leaves	y_{max} (%)	AUDPC of y_{max}	Marketability
1- Untreated control	---	17.50±3.23 a	214.13±28.45 a	2.00±0.78 b	14.27±4.27 a	0
2- Pageant 38 WG	12 oz	1.00±1.00 c	8.88±8.88 b	0 c	0.43±0.37 b	4
3- Strike 50 WDG	2 oz	1.25±1.14 c	8.75±8.17 b	0.06±0.19 c	0.87±0.99 b	4
4- Heritage + Capsil	3 oz 6 fl oz	3.00±1.58 bc	10.50±5.53 b	0.01±0.01 c	0.03±0.03 b	4
5- Eagle 20 EW	6 fl oz	3.10±1.69 bc	11.38±5.74 b	0.11±0.29 c	0.33±0.84 b	3
	LSD	8.39	134.79	1.89	17.52	---
	P=	0.0022	0.0105	0.0555	0.0120	---

Canna lily rust

AUDPC- # of symptomatic leaves



Downy mildew

Leaf abscission may be severe

Under humid cool conditions the fungus appears on the lower leaf surface

Purplish to black areas appear on the stems and peduncles

Similar spots and dead tips develop on the calyxes, and infected twigs may be killed

More severe than powdery mildew

Foliar symptoms may resemble burns from pesticide toxicity















Management

-cultural practices-

Avoidance of diseased plants

Aggressive management in production

Separate seed grown and vegetative plants

Limit moisture on the leaves

Provide good horizontal air movement
(proper plant spacing)

Management

-chemical control-

Use products that are labeled

Preventative approach is best!

Good coverage of contact fungicides

Proper rotation of fungicide chemistry

Group Code	Fungicide Class or Family	Common Name	Example trade names	Risk of Resistance	Use(s)
4	phenylamide (PA)	mefenoxam	Subdue Maxx, GR	High	L,N,G
11	quinone outside inhibitor (QOI) strobilurins	kresoxim-methy	Cygnus	High	G
		fluoxastrobin	Disarm O		N,G
		azoxystrobin	Heritage		L,N,G
		trifloxystrobin	Compass		L,N,G
		pyraclostrobin	Insignia, Pageant		L,N,G
14	aromatic hydrocarbons (AH)	etridiazole	Terrazole	Low to Medium	N,G
19	polyoxin	polyoxin D	Affirm WDG, Endorse	Medium	L,N,G
21	quinone inside inhibitor (QIL)	cyazofamid	Seway	Medium	L,N,G
28	carbamates	propamocarb hydrochloride	Banol	Low to medium	N,G
33	phosphonates	fosetyl-Al or phosphous acid	Aliette Phostrol	Low	L,N,G
40	carboxylic acid amides(CAA)	dimethomorph	Stature DM, SC	Low to Medium	N,G
43	benzamides	fluopicolide	Adorn	Not Known	L,N,G
44	microbial	<i>bacillus subtilis</i>	Cease, Rhapsody	Not Known	L,N,G
45	quinone x inhibitor	ametoctradin	Orvego	Medium to High	N,G
M1	inorganic	coppers	Badge, Champ, COC	Low	L,N,G
M3	dithiocarbamates	mancozeb	Dithane, Fore, Protect	Low	L,N,G

List of resistant pathogens (oomycetes) isolated from ornamentals

Num	FRAC Group Code	Fungicide Class/Family	Pathogen	Disease	Crop	Reference	Remarks
1	4	PhenylAmides (PA)	<i>Phytophthora citricola</i>	Dieback	Azalea	Ferrin & Kabashima 1991	field / laboratory
2	4	PhenylAmides (PA)	<i>Phytophthora nicotianae</i>	Root rot	Ornamentals	Hu et al. 2008	field
3	4	PhenylAmides (PA)	<i>Phytophthora palmivora</i>	Root rot	Ornamentals	Lucas et al. 1990	laboratory induction
4	4	PhenylAmides (PA)	<i>Phytophthora parasitica</i>	Blight	Periwinkle	Ferrin & Kabashima 1991	field / laboratory
5	4	PhenylAmides (PA)	<i>Phytophthora sp.</i>	Root rot	African violet	Romano & Edgington 1985	field
6	4	PhenylAmides (PA)	<i>Plasmopara halstedii</i>	Downy mildew	Sunflower	Albourie et al. 1998	field
7	4	PhenylAmides (PA)	<i>Plasmopara obducens</i>	Downy mildew	Impatiens (Busy lizzy)	FRAC 2011	FRAG UK 2011
8	4	PhenylAmides (PA)	<i>Pythium aphanidermatum</i>	Damping off	Turf	Sanders et al. 1990	in-vitro mutation / field
9	4	PhenylAmides (PA)	<i>Pythium aphanidermatum</i>	Damping off	Ornamentals	Moorman et al. 2002	field
10	4	PhenylAmides (PA)	<i>Pythium cylindrosporium</i>	Damping off	Ornamentals	Moorman et al. 2002	field
11	4	PhenylAmides (PA)	<i>Pythium dissotocum</i>	Root rot	Ornamentals	Moorman et al. 2002	field
12	4	PhenylAmides (PA)	<i>Pythium heterothallicum</i>	Damping off	Ornamentals	Moorman et al. 2002	field
13	4	PhenylAmides (PA)	<i>Pythium irregulare</i>	Damping off	Ornamentals	Moorman et al. 2002	field
14	4	PhenylAmides (PA)	<i>Pythium splendens</i>	Damping off	Ornamentals	Moorman et al. 2002	field
15	4	PhenylAmides (PA)	<i>Pythium ultimum</i>	Damping off	Ornamentals	Moorman et al. 2002	field
16	11	quinone outside inhibitors (QOI) strobilirins	<i>Pythium aphanidermatum</i>	Damping off	Turf	Olaya et al. 2003	laboratory/nursery
17	28	carbamates	<i>Pythium spp.</i>	Damping off	Geraniums	Moorman et al. 2002, Moorman & Kim 2004	Greenhouse
18			<i>P. aphanidermatum</i>				
19			<i>P. cylindrosporium</i>				
20			<i>P. dissotocum</i>				
21			<i>P. heterothallicum</i> group F				
22			<i>P. irregulare</i>				
23			<i>P. splendens</i>				
24	<i>P. ultimum</i>						
25	33	phosphonates	<i>Pythium aphanidermatum</i>	Not specified	Not specified	Sanders et al. 1990	in-vitro mutation

Host: 4" potted Impatiens variety S.E. Xp Coral

Pathogen: *Plasmopara obducens*

Fungicide applications on 14-day schedule 2/10, 2/24 & 3/9

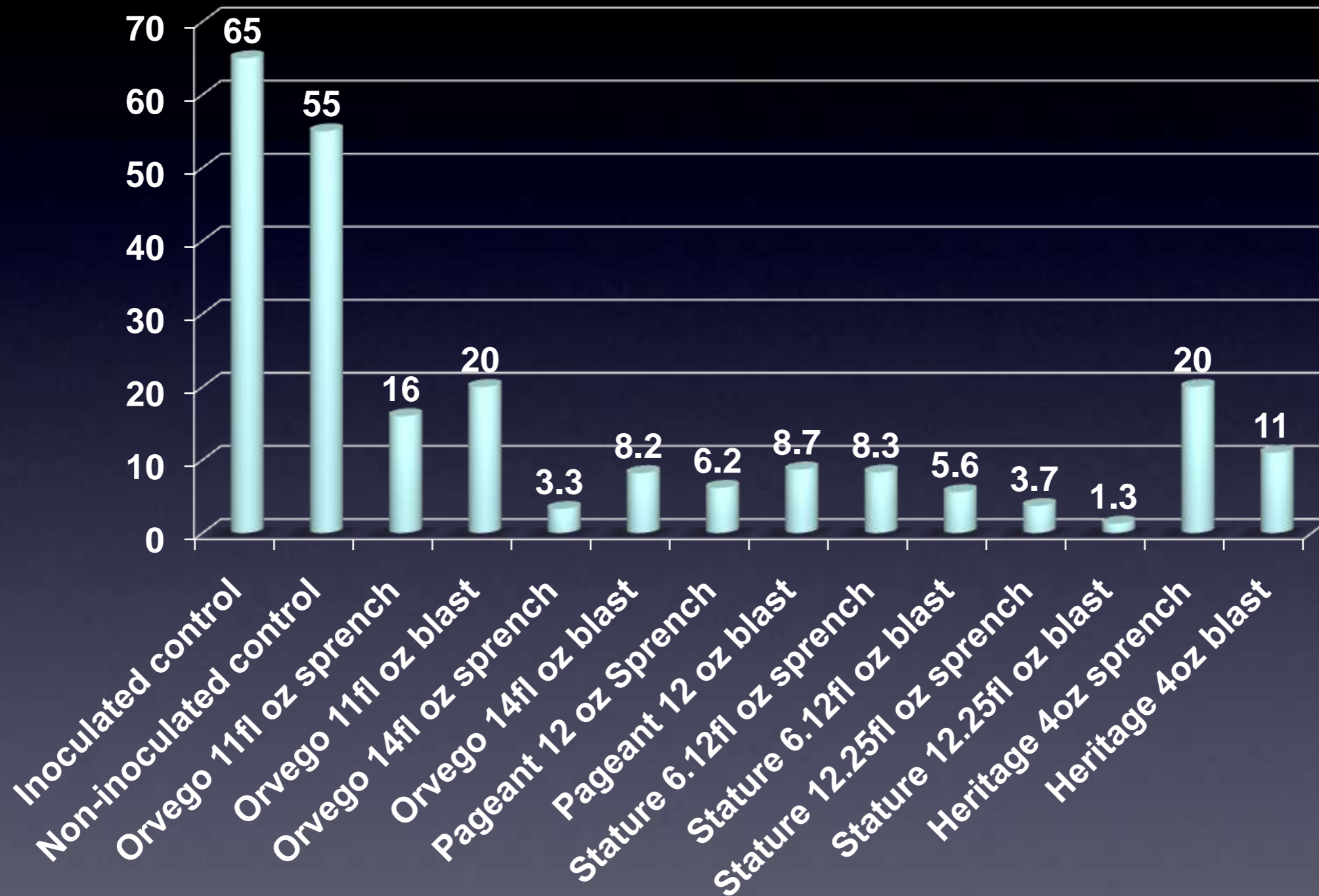
14 treatments & 10 replications arranged in a RCBD

Disease levels for 14 treatments to control downy mildew of impatiens. Disease measures were incidence

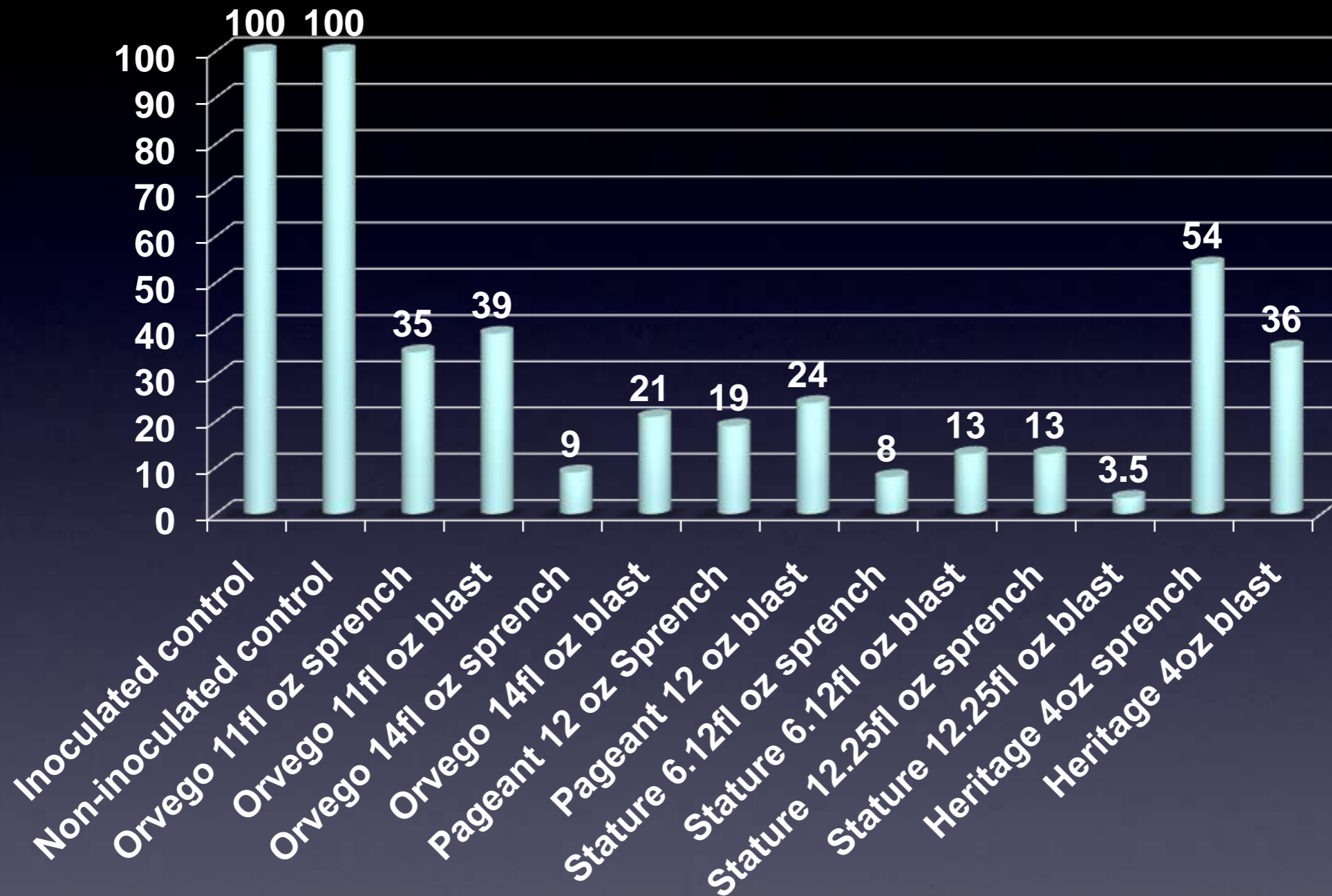
(# of symptomatic leaves) and severity (% of canopy affected).

Treatment	Active ingredient	Rate/100 gal	Application method
Non-inoculated control	---	---	---
Inoculated control	---	---	---
Orvego	ametoctradin + dimethomorph	11 fl oz	Sprench
Orvego	ametoctradin + dimethomorph	14 fl oz	Sprench
Orvego	ametoctradin + dimethomorph	11 fl oz	Airblast
Orvego	ametoctradin + dimethomorph	14 fl oz	Airblast
Pageant	pyraclostrobin + boscalid	12 fl oz	Sprench
Pageant	pyraclostrobin + boscalid	12 fl oz	Airblast
Stature SC	dimethomorph	6.12 fl oz	Sprench
Stature SC	dimethomorph	12.25 fl oz	Sprench
Stature SC	dimethomorph	6.12 fl oz	Airblast
Stature SC	dimethomorph	12.25 fl oz	Airblast
Heritage	azoxystrobin	4 oz	Sprench
Heritage	azoxystrobin	4 oz	Airblast

Disease incidence



Disease severity



Minimize crowded
plantings



Minimize overhead
irrigation





Monitor watering





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RESEARCH PROGRAM

Bacterial blight of Ficus Caused by Xanthomonas



Brief Narrative of Ongoing Project:

We are currently conducting research to:

- 1) determine if *Xanthomonas* isolates from *Ficus elastica* are different from those previously reported to cause disease on other *Ficus* species;
- 2) conduct host range trials to see if other (i.e. *Strelitzia* spp., *Ficus* spp., *Cordyline* sp., *Anthurium* sp., *Syngonium* sp., and *Dieffenbachia*) popular foliage plants are susceptible;
- 3) evaluate the impact of temperature and light on disease; and 4) conduct bactericide efficacy trials.

Improved disease diagnosis: Molecular techniques for the detection and identification of plant pathogens in host tissue



Brief Narrative of Ongoing Project:

Our current research on molecular diagnostics is funded by the USDA