Five Years of Organic Strawberry Research at GCREC

... @#$%&!

Thank you GCREC nematology and farm staff, FSGA and Certis, Marrone, BioSafe for funding, Vance Whitaker lab for providing transplants, and Florida strawberry growers for their support

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Organic strawberries in US and Florida (USDA/ERS, 2023)

- Consumer demand for organic berries (farm value of $80 million in 2008 to $300 million in 2019)
- CA grows > 75% of US organic strawberries and acreage tripled from 2008 (1,178 acres) to 2019 (4,022 acres, 13% of total acreage)
- In FL acreage has been growing from 14 acres in 2008 to 680 acres in 2019
- Organic prices on average 50-60% higher (more so in winter months)

UF/IFAS GCREC organic field in Balm established in 2019-20 – mostly used for strawberry nematode research

- **Organic nematicide testing**
- **Strawberry variety screening**
- ASD / solarization experiments
- Transplant heat treatment
- **Cover crops**

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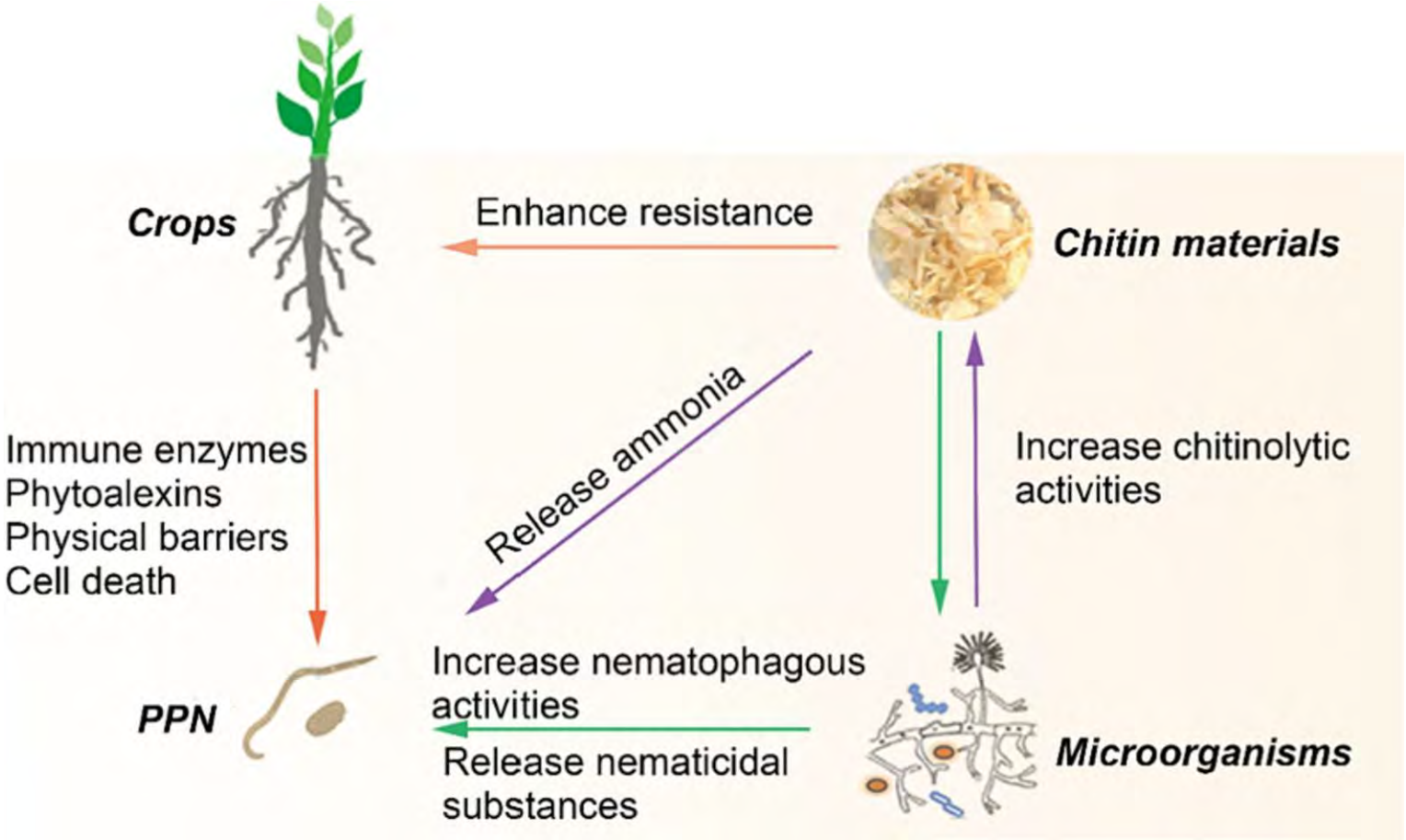
Organic nematicide/product evaluations

- Plant-based products
  - Dazitol (mustard + capsaicin oil)
  - TerraMG / BioFence (mustard meal)
  - Ecozin / AzaGuard (azadirachtin)
  - ProMax (thyme oil), Nemakill (essential oil mix),
- Bacterial-based products
  - Majestene (*Burkholderia* extract)
  - Minuet (*Bacillus subtilis*)
  - TerraGrow (*Bacillus* spp. mix)
- Fungal-based products
  - MeloCon and NemaClean (*Purpureocillium lilicanus* spores)
- Other
  - CrabLife (crab meal and flakes)
  - Kyte Gold (*Bacillus chitinosporus* + crab/lobster meal)

Possible mechanisms of chitin (e.g. crabmeal) on soil nematode control



https://doi.org/10.1016/j.carbpol.2023.120592

Strawberry yield with organic nematicides (4 seasons; * = GCREC organic field)

Product	Rate/A	Application time	2019-20*	2020-21*	2021-22	2022-23	2021-22 (sting)
Dazitol	6.25 + 1.5 gal	At plant + 3 wap	2.0	1.8	2.9	**6.6**	**33**
TerraMG	20 gal	2 wbp	-	-	4.8	**7.9**	**12**
Ecozin	22.5 oz	At plant + 3 wap	2.1	2.0	3.6	**9.6**	**13**
Majestene	2 gal	At plant + 3 wap	2.2	1.9	3.3	**10.6**	**18**
MeloCon	10.25 oz	At plant + 4, 8 wap	1.9	1.8	5.0	**5.9**	**17**
ProMax + Fertigold	1 + 0.5 gal	At plant + 9 appsp	1.9	2.3	2.4	**7.9**	**19**
Kyte Gold	2 qt	At plant + 4, 8 wap	1.8	2.4	4.8	**6.1**	**11**
Crab Flake+Powder	1000 lb + 80 lb	4 wbp, 5 + 8 wap	-	-	4.9	**10.7**	**10**
BioFence	4.5 lb	At plant + 3, 6 wap		2.6	-	**-**	**-**
Nemakill	48 oz	At plant + 3, 6 wap	1.9	2.6	-	**-**	**-**
Minuet	24 oz	At plant + 3, 6 wap	-	2.4	-	**-**	**-**
Velum*	6.8 oz	At plant	-	-	3.9	**10.0**	**8**
Kpam*	30 gal	3 wbp	-	-	-	**9.2**	**-**
Control	water		2.1	2.3	5.1	**6.7**	**15**
P value			*0.56*	*0.73*	*0.74*	*0.04*	*0.17*

*- = chemical nematicides (not OMRI); wap: weeks after planting; wbp =weeks before planting

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Strawberry yield with different varieties (GCREC organic field)

Variety	2019-20	2019-20	2020-21	2021-22	2022-23	Conventional (2022-23)
Sensation		3.22	**4.6**	**3.5**	**3.6**	**19.50**
Beauty	2.24	2.95	2.1	1.6	2.4	13.09
Pearl			-	1.6	1.5	12.74
Brilliance	**2.75**	**4.19**	2.5	2.5	2.6	12.67
Radiance			3.2	2.3	**3.2**	**17.47**
Winterstar			2.5	1.8	1.9	15.08
Elyana			1.4	2.2	1.6	12.23
Festival			2.1	-	2.1	12.26
Medallion			-	-	2.0	15.10
Felicity			-	-	**3.9**	13.63
P value	*<0.05*	*<0.05*	*<0.001*	*<0.001*	*<0.001*	*<0.001*

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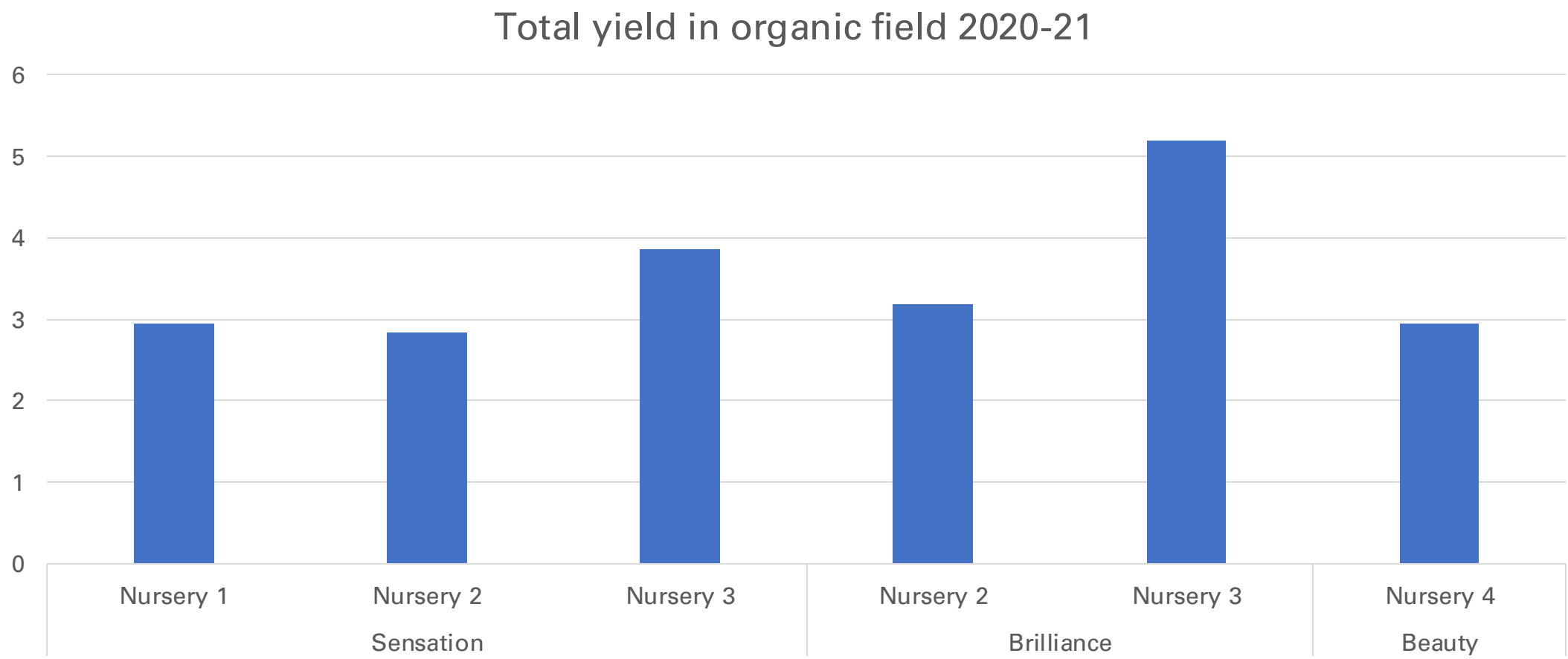
Nursery source can make a difference (GCREC organic field)



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Cover Crops for Nematode Management


Buckwheat


Goat's Rue


Marigold


Mexican Sunflower


Millet


Sunnhemp


Sunflower

Crop	Cultivar	Species
Buckwheat	VNS	*Fagopyrum esculentum*
Goat's Rue	VNS	*Tephrosia virginiana*
Marigold	Nana Champion Flame	*Tagetes patula*
Mexican Sunflower	VNS	*Tithonia diversifolia*
Millet	German Foxtail	*Setaria italica*
Pearl Millet	Wonderleaf	*Pennisetum glaucum*
Radish	VNS	*Raphanus sativus*
Sesame	VNS	*Sesamum indicum*
Sorghum Sudangrass	AS 6201	*Sorghum x drummondii*
Sorghum Sudangrass	AS 6401	*Sorghum x drummondii*
Southern Peas	Iron & Clay	*Vigna unguiculata*
Sugar Beet	BL 47150	*Beta vulgaris*
Sunflower	Peredovic	*Helianthus annuus*
Sunnhemp	VNS	*Crotalaria juncea*


Pearl Millet


Radish


Sugar Beet


Southern Pea


Sorghum Sudangrass


Sesame

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Strawberry nematode reproduction on cover crops

Common Name	Sting Nematode	Northern Root-Knot	Northern Root-Lesion	Plant Biomass
Buckwheat	Good	Moderate	Moderate	Low
Marigold	Good	Poor	Poor	Low
Mexican Sunflower	Good	Poor	Good	Low
Millet	Good	Poor	Poor	Low
Pearl Millet	Good	Poor	Poor	Low
Radish	Good	Moderate	Good	Low
Sesame	Poor	Poor	Moderate	Low
Sorghum Sudangrass	Good	Poor	Moderate	High
Cowpea	Good	Good	Poor	High
Sugar Beet	Poor	Poor	Poor	Low
Sunflower	Good	Poor	Good	Low
Sunnhemp	Poor	Poor	Moderate	High

Sting nematode populations (and cover crop cultivars) are not all the same!

	Reproduction (x-fold increase after 60 d)	
Crop	**Thonotosassa pop.**	**Durant pop.**
Fallow	0.1	0.1
Buckwheat	6.2	0.5
Goat's Rue	0.2	0
Marigold	1.1	0
Mexican Sunflower	7.2	0.2
Millet	16.6	0.4
Pearl Millet	11.3	0.5
Radish	11.3	1.8
Sesame	0.2	0.1
Sorghum Sudangrass (AS6201)	**36.0**	**1.4**
Sorghum Sudangrass (AS6401)	**19.1**	**0.3**
Southern Pea	9.9	1.1
Sugar Beet	0.3	0.1
Sunflower	3.7	0.8
Sunnhemp	**0.1**	**0.01**
Strawberry 'sweet sensation'	**27.5**	**1.3**

Summary:

- Significant difference in sting nematode population
- **Do not plant**:
  - Buckwheat
  - Millet
  - Radish
  - Sorghum-sudan
  - Southern Pea
  - Sunflower
- **Do Plant**:
  - Sesame
  - Sunnhemp

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Cover crop mixtures for sting nematode and weed suppression
(GCREC farm)

	Sting Nematode per 200 mL soil			Wee
Cover Crop Mix	**At Plant**	**Pre-Till**	**Post-Till**	**Purple Nutsedge**
Sunnhemp	3	1 b	3	53 ab
Sunnhemp + Marigold	2	2 b	1	79 ab
Southern Pea	3	5 ab	3	58 ab
Southern Pea + Marigold	6	5 ab	4	17 b
Sunnhemp + Southern Pea	5	4 ab	1	56 ab
Sunnhemp + Southern Pea + Marigold	3	4 ab	5	46 ab
Sorghum Sudan	2	19 a	9	54 ab
Weedy Fallow	3	3 ab	5	122 a
***P*-value**	0.219	0.044	0.397	0.027

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Common strawberry weeds and sting nematodes (greenhouse)

		Nematode Host Status		
Common Name	Genus and Species	Sting Nematode	Northern Root-Knot Nematode	Northern Root-Lesion Nematode
Bermuda Grass	Cynodon dactylon	**Good**	Poor	**Good**
Carolina Geranium	Geranium carolinianum	**Good**	**Good**	**Good**
Carpetweed	Mollugo verticillate	Poor	**Good**	Poor
False Daisey	Eclipta prostrata	**Good**	**Good**	**Good**
Purple Nutsedge	Cyperus rotundus	**Good**	Poor	Poor
Florida Pusley	Richardia scabra	Poor	Poor	Poor
Ragweed	Ambrosia artemisiifolia	Poor	Poor	Poor
Sandbur	Cenchrus echinatus	Poor	Poor	Poor
Yellow Nutsedge	Cyperus esculentus	**Good**	Poor	**Good**

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What have we learned in last 5 years?

- Growing organic strawberries in Florida is a constant battle
- Limited options compared to conventional counterparts
- No nematode-resistant strawberry cultivars - some cultivars (Sensation/Felicity) better in organic fields
- Post plant nematicides / biostimulants may offer some benefit but are no stand-alone solutions
- Sunn hemp-based cover crop during summer still a good option

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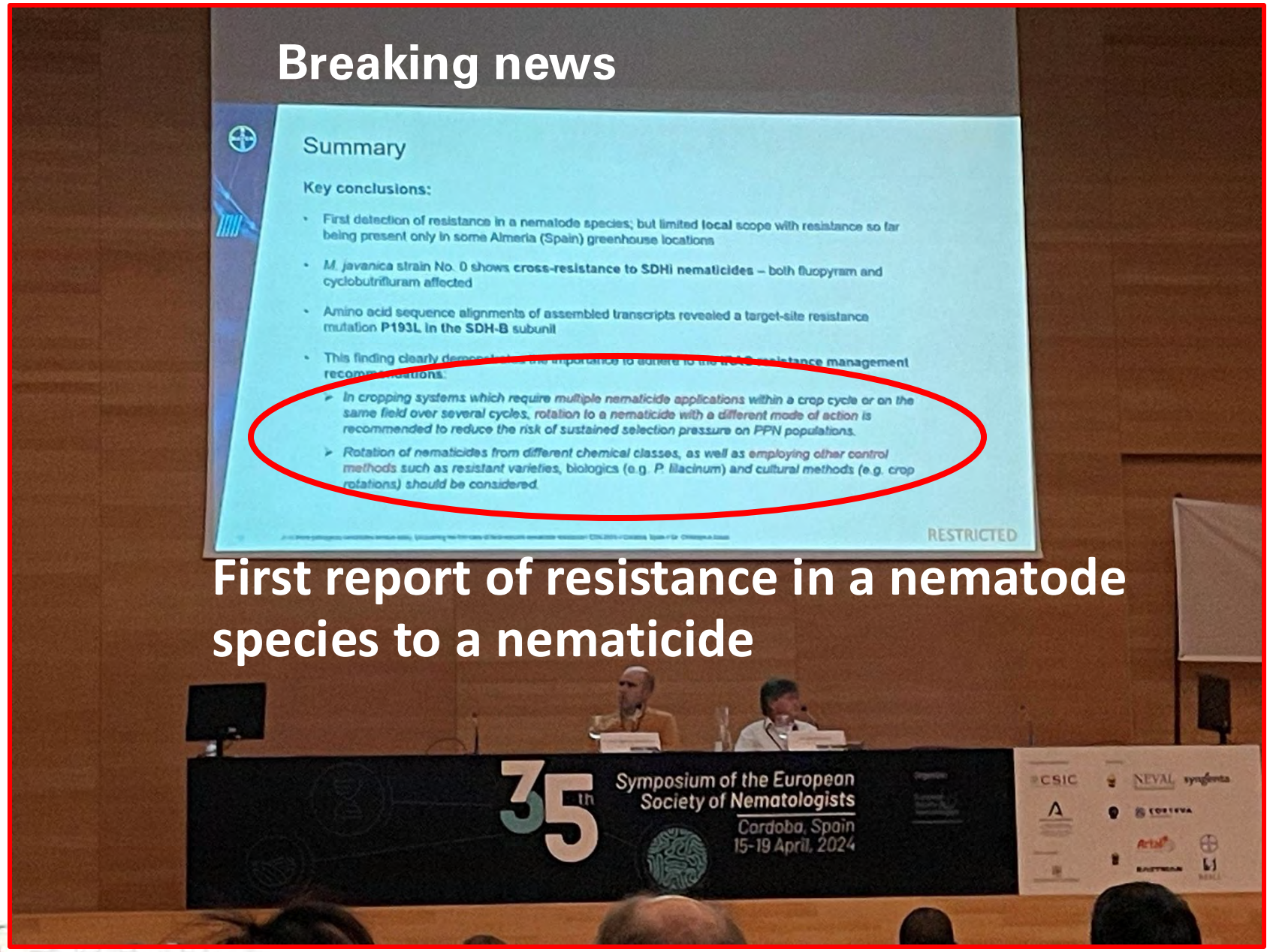

Florida Strawberry Growers Association

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