

Integrated Nematode Management for Organic Strawberry Production in Florida

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Summary

(1) nursery transplants: plant parasitic nematodes were detected in 19 % of sampled transplants; (2) cultivars: Felicity, Sensation and Radiance had highest yields under organic management (3) organic nematicides/soil amendments: limited effect was noted on nematodes and fruit yield in field trials at GCREC and in organic grower fields.

Background

Several of the organic strawberry fields in Florida have seen significant problems with sting nematodes in the past years, and in some fields also root knot and stubby root nematodes have been found to cause visible damage. Sting nematode is one of the main problems for organic strawberry production in Florida. Without fumigants, options for nematode management are limited, which is why an integrated approach targeting all aspects of strawberry production is especially important. This includes (1) monitoring nursery transplants, (2) evaluating organic nematicides/amendments, (3) comparing cultivars, (4) evaluating cover crops and (5) looking into other off-season practices, including fallowing and biological soil disinfestation practices.

Methods

- (1) **Monitoring transplants:** transplants were collected from grower coolers during October 2022; each sample consisted of roots from 20-30 plants which were cut into small pieces and extracted at the GCREC nematode lab. For the 2022-23 season 31 samples were collected from six nurseries and nine cultivars.
- (2) **Cultivar comparisons:** cv's Florida 127, Beauty, Pearl, Brilliance, Radiance, Winterstar, Elyana, Festival, Medallion, Felicity were planted at the GCREC organic certified field in plastic beds and grown under organic conditions (fish fertilizer via drip, sprays with OMRI products; field has low nematode pressure). A soil amendment ('wormpower', a liquid extract of earthworm frass) was also evaluated in this experiment.

- (3) Nematicide OMRI evaluations: OMRI nematicides were evaluated at the GCREC in a conventionally managed field at GCREC with historic sting, root knot and lesion nematodes present; treatments were the same as the previous season, except that a Kpam treatment was included (Table 3.1). Products were all applied via the drip irrigation system. This experiment was done in our non-organic field and was managed conventionally with weekly fungicide and insecticide sprays.
- (4) Organic nematode management programs were evaluated by monitoring nematode populations in four organic grower fields by installing valves in at least six rows (~ 350 ft long) and sampling soil for nematodes in these rows, as well as adjacent rows with no valves. In one farm, we applied a nematicide treatment program (Majestene alternating with Melocon, 2 applications each, to individual rows to supplement the grower's program).

Results

- (1) **Monitoring transplants:** transplants have been monitored for presence of nematodes since 2018 (Table 1). Non plant parasitic bacterial and fungal-feeding nematodes are mostly found, but also plant-parasitic nematodes (PPN) occur, mostly lesion and stunt, and occasionally root knot nematodes. In most cases, PPN are found on Canadian transplants, but last year we also found some on California plants.
- (2) **Cultivar comparisons:** weeds were a major problem in the organic field, as well as chili thrips and diseases. The poorest crop stands were noted for cv. Brilliance and Winterstar. The cultivars Felicity, Sensation and Radiance looked better in terms of yield. Brilliance, Beauty, Medallion and Festival were intermediate and cvs. Pearl, Winterstar and Elyana had the lowest yield (Table 2).
- (3) **Nematicide evaluations at GCREC:**

Strawberry yields in this trial were low due to disease and weed pressure, with Velum, Crablife, Majestene and Terra MG having the highest yields (Table 3). Lesion nematode was the main PPN in the trial, with highest populations at mid-season in the control and Ecozin+ treatments; all other treatments had lower lesion nematode counts (Table 3).

A soil amendment called '**wormpower**' was tested in the organic field as part of the cultivar trial but had no effect on crop stand and yield (Table 2). No sting nematodes, and very few root knot nematodes were present in the field. Wormpower did increase the number of free-living (non-plant parasitic) nematodes.

On farm testing in organic fields: two of the farms had severe sting nematode infestation (Fig. 1, our experiment was in the infested part in one farm, but outside of it in the other farm). The other two fields had no obvious sting nematode damage. In one of the farms with measurable sting nematodes, the grower's program had no effect (Table 4). In the other three farms, no sting nematodes, and very few other PPN (root-knot and stubby root nematodes) were found. Mostly free-living nematodes (bacterial and fungal feeding types) were found, which were not clearly impacted by the grower's/our program (Table 4).

Takeaways

- Strawberry transplants can come with lesion, stunt (and root knot) nematodes; root knot and lesion can potentially cause damage to FL strawberries.
- Sensation, Felicity and Radiance produced the highest yields in the organic field.
- OMRI nematicides/amendments reduced lesion nematodes at mid-season; effect on yield was variable.
- No effect on (sting) nematode of organic management programs was observed on four farms.

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Table 1 Plant-parasitic nematodes detected in strawberry transplants collected from 2018 to 2022.

Season	State	Nurseries sampled	Shipments sampled	<i>P. penetrans</i> (lesion)	<i>M. hapla</i> (root knot)	<i>Tylenchorhynchus</i> (stunt)
2018/2019	North Carolina	2	14	0	0	1 (2)
	California	5	17	0	0	0
	Idaho	1	1	0	0	0
	Nova Scotia	3	18	9 (1-57) ^a	0	6 (1-9)
	Ontario	2	2	0	0	0
	Quebec	1	2	1 (1)	0	1 (1)
Subtotal	6	14	54	10	0	8
2019/2020	North Carolina	2	7	0	0	0
	California	3	17	0	0	0
	Idaho	1	1	0	0	0
	Nova Scotia	4	11	0	1 (13)	0
	Ontario	1	2	0	0	0
	Florida	1	1	0	0	0
	Quebec	2	9	2 (1-62)	0	0
Subtotal	7	15	48	2	1	0
2020/2021	North Carolina	2	4	0	0	0
	California	2	17	0	0	0
	Idaho	0	0	0	0	0
	Nova Scotia	3	14	7 (1-11)	1 (2) ^b	2 (1-3)
	Ontario	1	1	0	1 (100)	0
	Quebec	2	4	1 (1)	0	0
Subtotal	6	10	40	8	2	2
2021/2022	North Carolina	1	1	0	0	0
	California	4	17	0	0	0
	Idaho	1	2	0	0	0
	Nova Scotia	3	10	4 (1-11)	0	0
	Ontario	2	4	3 (1-3)	0	1 (1)
	Quebec	2	7	2 (1-3)	0	0
Subtotal	6	13	41	9	0	1
2022-23	California	3	18	3	0	3
	Idaho	1	1	0	0	0
	Canada	3	11	2	0	1
	Florida	1	1	0	0	0
Subtotal	8	8	31	5	0	4
Total	7	26	214	34	3	15

^aNumbers in parentheses indicate the range of nematodes found per 10 grams of root tissue.

Table 2. Yield (kg/plant) of ten strawberry cultivars + effect of ‘Wormpower’ in an organic field

	Cultivar	Early yield (Jan)	Mid-yield (Feb)	Late yield (Mar)	Total yield
Sub-plot	Sensation	0.014	0.054	0.091	0.160
	Beauty	0.006	0.045	0.037	0.088
	Pearl	0.006	0.028	0.019	0.052
	Brilliance	0.024	0.088	0.040	0.152
	Radiance	0.016	0.075	0.055	0.145
	Winterstar	0.008	0.054	0.030	0.093
	Elyana	0.006	0.026	0.031	0.064
	Festival	0.016	0.022	0.066	0.103
	Medallion	0.023	0.055	0.023	0.100
	Felicity	0.013	0.067	0.074	0.155
Main plot	Wormpower	0.012	0.048	0.048	0.108
	Control	0.014	0.055	0.045	0.114
<i>p</i> -value	Cultivar	<0.0001	<0.0001	<0.0001	<0.0001
	Product	0.59	0.21	0.83	0.69
	Cultivar*Product	0.001	0.002	0.06	0.08

P value > 0.10 indicates no significant difference between treatment

Table 3 – Effect of OMRI nematicides/products as compared with Kpam and Velum in a conventionally managed field at GCREC (2022-23 season)

Trt	Bio-nematicides	Rate/A	Application timing
1	Dazitol	6.25 + 1.5 gal	At plant + 3 wap
2	Terra MG	20 gal	10 days pre-plant
3	Ecozin+	22.5 oz	At plant + 3 wap + 6 wap
4	Majestene	2 gal	At plant + 3 wap + 6 wap
5	Melocon LC	10.25 fl oz	At plant + 4 wap + 8 wap + 12 wap
6	ProMax + Fertigold	1 gal + 0.5 gal	At plant, 1+2 wap, 4+5 wap, 8+9 wap, 12+13 wap
7	Kyte Gold	2 qt	At plant + 4 wap + 8 wap
8	CrabLife powder	80 lbs (3x)	1wbp + 5 wap + 8 wap
9	Velum	6.8 oz + 6.8 oz	At plant + 4 wap
10	Kpam	30 gal/acre	3 weeks before planting
11	Control		

wbp = weeks before planting; wap: weeks after planting

Dazitol (mustard oil and capsaicin); Terra MG (mustard meal); Ecozin+ (azadirachtin); Majestene (Burkholderia dead bacteria); Melocon LC (Purpureocillium lilicanus, live fungus); Promax + Fertigold (Thyme oil); Kyte Gold (Bacillus chitinosporus and shrimp meal); Crablife (crab meal); Velum (fluopyram); Kpam (metam potassium)

Products	Early season (Dec)	Mid-season (Jan)	Late-season (Feb-March)	Total yield	Lesion January	Lesion April
Dazitol	0.026	0.079	0.256 a	0.361	1	0
Terra MG	0.035	0.085	0.369	0.489	0	0
Ecozin +	0.024	0.078	0.326	0.428	21	0
Majestene	0.031	0.106	0.364	0.501	0	0
Melocon	0.033	0.066	0.199	0.298	1	0
Promax/Ferti	0.028	0.098	0.204	0.330	0	0
Kyte Gold	0.032	0.067	0.231	0.331	2	0
CrabLife	0.035	0.082	0.373	0.490	0	1
Velum	0.035	0.091	0.375	0.501	1	3
Kpam	0.034	0.073	0.282	0.389	3	0
Control	0.025	0.68	0.222	0.316	13	2
<i>P value</i>	0.74	0.03	0.01	0.02	0.005	-

P value > 0.10 indicates no significant difference between treatment; lesion = *Pratylenchus penetrans*, the northern lesion nematode

Table 4 Nematode counts from four organic farms comparing OMRI nematicide programs

A. Free-living nematode soil population/200 cc soil in 2022-2023 (AY farm)			
Treatment	Oct 24, 2022	Dec 2, 2022	Jan 13, 2023
Grower program	475	318	805
Untreated control	486	345	859

*Few plant-parasitic nematodes (root-knot and stubby nematodes) were observed in this field.

B1. Sting nematode soil population/200 cc soil in 2022-2023 (JM farm)					
Treatment	Oct 25, 2022	Nov 7, 2022	Dec 8, 2022	Jan 6, 2023	Feb 03, 2023
Grower program	0	3	18	2	12
Untreated control	1	2	14	3	14

B2. Free-living nematode soil population/200 cc soil in 2022-2023 (JM farm)					
Treatment	Oct 25, 2022	Nov 7, 2022	Dec 8, 2022	Jan 6, 2023	Feb 03, 2023
Grower program	481	266	377	82	1123
Untreated control	469	290	261	84	1020

*Few plant-parasitic nematodes (root-knot and stubby nematodes) were observed in this field.

C. Free-living nematode soil population/200 cc soil in 2022-2023 (SA farm; not grower program, treatments were applied by Desaeger team in individual rows)					
Treatment	Nov 9, 2022	Dec 8, 2022	Jan 6, 2023	Feb 03, 2023	Mar 03, 2023
Majestene + Melocon	800	327	1041	714	1137
UTC	679	368	703	824	1004

*Few plant-parasitic nematodes (root-knot, stunt, and stubby nematodes) were observed in this field.

D. Free-living nematode soil population/200 cc soil recorded in the organic strawberry field in 2022-2023 (HC farm)				
Treatment	Nov 23, 2022	January 27, 2023	February 24, 2023	March 24, 2023
Grower program	1153	1702	1036	142
Untreated control	768	1434	1166	261

*Very few plant-parasitic nematodes (root-knot, root lesion, stunt, and stubby nematodes) were observed in this field.

Fig. 1. Sting nematode infestation in two organic strawberry fields, showing stunted plants and short stubby roots (2022-23 season)

