# Fumigant and Nonfumigant Programs for Florida Strawberries – Effects on Soilborne Pests and Diseases and Soil Health

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## Summary

**Plant-parasitic nematodes present a significant barrier to strawberry production in Florida. This report summarizes this year's results of a continuation of a 15+ year-long large-plot demo trial evaluating fumigants and more recently also nonfumigant approaches for nematode management. This year we also evaluated how the treatments affect overall soil health, in terms of 1) beneficial nematode populations (non-plant-parasitic), 2) soil microbial (bacterial and fungal) diversity, and 3) soil biological suppressiveness of nematodes. Due to the Covid-19 shutdown, the only data available so far are growth and yield data. Nematode, soil microbial and soil suppressiveness data are still pending, and will be reported later.**

**2019-2020 Results so far:**

- **Nutsedge counts were higher for treatments that received no in-bed fumigant (non-fumigant treatments and deep fumigant treatments).**
- **Early yields (December) were highest for treatments having either PicClor80 or Kpam included. Mid-season (January) yields and late-season (February) yields were higher for all treatments that had a fumigant in the bed. Nimitz fb Velum was the best non-fumigated treatment, with yields close to some of the fumigated treatments. Other non-fumigated treatments, as well as deep-fumigated only, had significantly lower yields.**
- **Plant size distribution was closely correlated with yield, confirming it is a very good yield predictor for strawberries.**
- **No yield benefit was noted from deep shank or deep drip applications, which primarily target nematodes, and may indicate that soilborne diseases were the main yield-limiting factors in this trial, not sting nematodes. The good performance of the Nimitz followed by Velum treatment likewise seems to indicate that Velum provides some disease control in strawberries.**

## Methods

**Table 1** – Fumigant and non-fumigant treatments for 2019-20 trial at FSGA farm

| # | Treatment | Method | Rate |
|---|---|---|---|
| 1 | Telone C35 | Shank | 30 gpta |
| 2 | Telone II + Telone C35 | Deep shank + Shank | 12 gpta + 30 gpta |
| 3 | Telone II + Telone C35 + Kpam | Deep shank + shank + drip | 12 gpta + 30 gpta + 62 gpta |
| 4 | PicClor80 | Shank | 320 lb/ta |
| 5 | Telone II + PicClor80 | Deep shank + Shank | 12 gpta + 320 lb/ta |
| 6 | Telone II + PicClor80 + Kpam | Deep shank + Shank + drip | 12 gpta + 320 lb/ta + 62 gpta |
| 7 | Kpam | Drip | 62 gpta |
| 8 | Kpam fb Bio-nematicides* | Drip + drip | 62 gpta |
| 9 | Kpam fb Velum | Drip + drip | 62 gpta + 6.5 oz/a |
| 10 | Kpam fb Nimitz | Drip + drip | 62 gpta + 5 pts/ta |
| 11 | Nimitz fb Velum (no fume program) | Drip + drip | 5 pts/ta + 6.5 oz/a |
| 12 | Nimitz + Velum mix (no fume program) | Drip + drip | 5 pts/ta + 6.5 oz/a |
| 13 | Nimitz + Nimitz fb Bio-nematicides* (no fume prog.) | Deep drip + drip + drip | 5 pts/ta + 5 pts/ta + * |
| 14 | Untreated control | | |
| 15 | Telone II + Nimitz | Deep shank + drip | 12 gpta + 5 pts/ta |
| 16 | Kpam + Nimitz | Deep drip / Drip | 62 gpta + 5pts/ta |

* Bio nematicides were Majestene (2 gal/a), Dazitol (5 gal/a), Nemakill (64 oz/a) and Melocon (2 lbs/a); No fume program included Goal as a pre-plant herbicide and Ridomil as an at-plant fungicide

## Results

Nutsedge counts were higher for treatments that received no in-bed fumigant (non-fumigant treatments and deep fumigant treatments) (Table 2). These treatments only received Goal (Oxyflurofen) as a weed control treatment; canopy convergence was significantly delayed the whole season, particularly again with treatments that received no in-bed fumigant (non-fumigant treatments and deep fumigant treatments + Nimitz) (Table 2).

**Table 2.** Effect of treatments on nutsedge emergence and convergence of strawberry plant canopy

| Trt | % converge Jan 8,2020 | S.E. | | NutSedge 240' row | S.E. |
|---|---|---|---|---|---|
| 1 | 97.380 | 1.630 | | 6.1 | 3.08 |
| 2 | 99.000 | 0.681 | | 1.9 | 0.79 |
| 3 | 99.625 | 0.375 | | 0.3 | 0.16 |
| 4 | 97.780 | 2.220 | | 14.0 | 14.00 |
| 5 | 100.000 | 0.000 | | 2.3 | 1.520 |
| 6 | 100.000 | 0.000 | | 0.1 | 0.13 |
| 7 | 98.130 | 1.870 | | 8.5 | 3.42 |
| 8 | 99.375 | 0.625 | | 5.6 | 2.33 |
| 9 | 98.750 | 0.818 | | 6.4 | 3.44 |
| 10 | 94.880 | 2.360 | | 4.9 | 3.32 |
| 11 | 92.125 | 0.875 | | 52.5 | 9.86 |
| 12 | 88.000 | 2.140 | | 254.4 | 59.40 |
| 13 | 86.750 | 1.220 | | 172.8 | 79.20 |
| 14 | 87.140 | 1.840 | | 237.6 | 76.00 |
| 15 | 84.880 | 1.060 | | 602.0 | 169.00 |
| 16 | 84.630 | 1.180 | | 229.4 | 76.50 |

S.E.= +/- standard error of the mean

Early yields (December) were highest for treatments having either Piclor80 or Kpam included (Trts 4-9, Table 3). Nimitz fb Velum (Trt 11) was the best of the non-fumigated treatments, with similar early fruit yield to some of the fumigated treatments. Treatments with deep fumigation and Nimitz in the bed had similarly low yields than treatments w/o fumigant. Mid season (January) and late season yields (February) were higher for fumigated treatments (Trts 1-10), especially C35 and PicClor80 treatments, and the Kpam fb bionematicides treatment. Nimitz fb Velum was still the best of the non-fumigated treatments, with other non-fumigant treatments and deep-fumigated only (no fumigant in the bed), having significantly lower yields at this time.
Total yields (December thru February) were highest for the treatments having PicClor80 and Kpam fb bionematicides. Other Kpam treatments had similar yields than C35 treatments. Nimitz fb Velum was the best-yielding non-fumigant treatment, only slightly less than Kpam treatments. Other non-fumigated treatments, and treatments with deep fumigant + Nimitz in the bed, had significantly lower total yields (Table 3).

**Table 3.** Effect of 16 fumigant and nonfumigant treatments on Strawberry yield (8 lb flats/acre) for the months of December 2019, January 2020, and February 2020 at the FSGA research farm, Dover, FL.

| Trt | | **Total Flats +/- S.E. per Acre by Month (2019-2020)** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **19-Dec** | **DEC S.E.** | **Relative Dec Yield vs Control** | **20-Jan** | **JAN S.E.** | **Relative Jan Yield vs Control** | **20-Feb** | **FEB S.E.** | **Relative Feb Yield vs Control** | **Total DEC-FEB** | **Total S.E.** | **Relative Tot Yield vs Control** |
| 1 | | 309.1 | 10.5 | 108.99 | 604.1 | 54.3 | **136.55** | 911.8 | 52.2 | **132.12** | 1824.9 | 77.4 | **128.86** |
| 2 | | 310.5 | 13.2 | 109.48 | 594.1 | 24.2 | **134.29** | 954.3 | 40.1 | **138.28** | 1859 | 67.4 | **131.27** |
| 3 | | 299.2 | 18.3 | 105.50 | 598.4 | 26.4 | **135.26** | 914.6 | 57.7 | **132.53** | 1812.2 | 94.8 | **127.97** |
| 4 | | 344.6 | 15.1 | **121.50** | 592.7 | 27.1 | **133.97** | 1094.7 | 63.2 | **158.62** | 2031.9 | 94.2 | **143.48** |
| 5 | | 333.2 | 12.1 | **117.48** | 609.7 | 16.8 | **137.81** | 979.8 | 31.9 | **141.97** | 1922.8 | 31.3 | **135.78** |
| 6 | | 361.58 | 9.37 | **127.49** | 633.8 | 14 | **143.26** | 969.9 | 75.4 | **140.54** | 1965.3 | 93 | **138.78** |
| 7 | | 333.2 | 17.4 | **117.48** | 560.1 | 24.7 | **126.60** | 865 | 29.9 | **125.34** | 1758.3 | 38 | **124.16** |
| 8 | | 350.2 | 21.6 | **123.48** | 578.53 | 9.82 | **130.77** | 977 | 44.7 | **141.57** | 1905.8 | 61.1 | **134.58** |
| 9 | | 332.37 | 8.53 | **117.19** | 578.5 | 51.6 | **130.76** | 878 | 47.4 | **127.22** | 1789 | 105 | **126.33** |
| 10 | | 307.7 | 19.4 | 108.49 | 547.3 | 39.7 | **123.71** | 842.3 | 61.3 | **122.05** | 1697 | 111 | **119.83** |
| 11 | | 338.89 | 9.08 | **119.49** | 516.1 | 10.1 | **116.65** | 799.7 | 13.3 | **115.88** | 1654.8 | 15.1 | **116.85** |
| 12 | | 259.49 | 9.93 | 91.49 | 404.1 | 13.2 | 91.342 | 687.7 | 56.6 | 99.65 | 1351.3 | 64.7 | 95.42 |
| 13 | | 297.8 | 11.5 | 105.00 | 448.1 | 24.4 | 101.28 | 703.3 | 53.7 | 101.91 | 1449.2 | 54.8 | 102.33 |
| 14 | | 283.6 | 19.6 | 100 | 442.4 | 32.3 | 100 | 690.1 | 78.1 | 100 | 1416.1 | 75.4 | 100 |
| 15 | | 268 | 21 | 94.49 | 411.2 | 18.7 | 92.94 | 626.7 | 48.6 | 90.81 | 1305.9 | 57.6 | 92.21 |
| 16 | | 296.36 | 7.81 | 104.49 | 409.8 | 11.7 | 92.63 | 676.4 | 48.6 | 98.01 | 1382.5 | 44.1 | 97.62 |

S.E.= +/- standard error of the mean

No yield benefit was noted from any of the deep soil applications (Telone, Kpam or Nimitz), a treatment that primarily targets nematode control. This may indicate that sting nematode was not the main yield-limiting factor (nematode counts are still pending); probably soilborne diseases were more important in determining yield, which would explain why PicClor80 and Kpam treatments were the best yielding treatments.

Nimitz followed by Velum was the best non-fumigant treatment and had yields similar to many of the fumigated treatments; only by the end of the season (February), this treatment started failing and yields went down.

Possibly adding another Velum application in this program might prolong its efficacy; it looks like Velum provided some disease control in this trial, which needs to be further investigated. If so, Velum could be a valuable product for Florida strawberries, providing both nematode and disease control.

Fruit yield correlated well plant size distribution in January (Table 3). Highest yielding treatments (Trts 1-11) all had > 70% large plants, whereas lower yielding treatments had 60% or less large plants. Also, the best yielding treatments had less than 10% missing plants, with the lower yielding treatments having around 20% missing plants (Table 4). Plant size is apparently a very good predictor of strawberry fruit yield in Florida.

**Table 4.** Effect of 16 fumigant and nonfumigant treatments on the percentage of small (<8"), medium (8 –12"), large (>12") canopy diameter plants, and dead and missing plants per 240 linear feet of row, January 2020.

| Trt | | Percentage of Plant Sizes per 240 linear ft of Row | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Percent Small | Small S.E. | Percent Medium | Medium S.E | Percent Large | Large S.E. | %Dead Missing | Dead S.E. |
| 1 | | 2.129 | 0.546 | 6.510 | 1.150 | 81.51 | 2.78 | 9.850 | 1.550 |
| 2 | | 2.159 | 0.517 | 6.052 | 0.986 | 85.71 | 1.47 | 6.083 | 0.868 |
| 3 | | 2.190 | 0.502 | 6.630 | 0.822 | 82.09 | 2.25 | 9.090 | 1.690 |
| 4 | | 2.487 | 0.373 | 7.570 | 3.000 | 82.05 | 4.35 | 7.890 | 1.550 |
| 5 | | 2.129 | 0.283 | 5.262 | 0.557 | 84.22 | 1.42 | 8.390 | 1.310 |
| 6 | | 2.950 | 0.680 | 4.592 | 0.822 | 82.48 | 2.07 | 9.980 | 1.110 |
| 7 | | 4.470 | 1.280 | 10.640 | 1.700 | 75.03 | 3.67 | 9.850 | 1.190 |
| 8 | | 2.524 | 0.243 | 7.540 | 1.060 | 82.48 | 1.89 | 7.450 | 1.090 |
| 9 | | 3.320 | 1.130 | 6.660 | 1.250 | 82.24 | 3.95 | 7.790 | 1.680 |
| 10 | | 4.650 | 1.230 | 11.440 | 2.640 | 74.30 | 4.81 | 9.610 | 1.920 |
| 11 | | 2.038 | 0.312 | 14.290 | 1.600 | 73.84 | 1.70 | 9.824 | 0.795 |
| 12 | | 4.866 | 0.855 | 18.160 | 3.810 | 56.27 | 4.14 | 20.710 | 1.120 |
| 13 | | 4.015 | 0.625 | 16.420 | 1.860 | 61.22 | 2.74 | 18.340 | 1.940 |
| 14 | | 3.094 | 0.274 | 18.210 | 2.120 | 61.70 | 1.55 | 17.000 | 1.090 |
| 15 | | 4.592 | 0.898 | 17.210 | 1.390 | 57.39 | 3.10 | 20.800 | 1.660 |
| 16 | | 3.254 | 0.453 | 16.940 | 2.550 | 58.49 | 3.62 | 21.320 | 2.390 |
| S.E.= +/- standard error of the mean | | | | | | | | | |

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