SOIL SOLARIZATION OPTIMIZATION
For
ROOT-KNOT NEMATODE CONTROL:
SYNOPSIS

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Background

In the Spring of 2022, there were signs of Root-Knot Nematode (RKN) damage to tomato plants grown in *Discovery Garden raised Beds Nos. 22 and 23. The plants exhibited sudden wilting and had large galls within the root structure – typical symptoms of RKN damage to tomato plants. Soil solarization is a standard method used to treat RKN in raised bed garden soils. The attendant GCMGAs Glenn Diket and Lisa Belcher for Bed Nos. 22 and 23 enlisted Gene Speller for assistance in the installation of necessary materials for soil solarization in the Summer of 2022.

Soil solarization works by using plastic covers to trap the sun's energy and heat the underlying soil. Current guidelines call for a clear plastic cover to allow sunlight to pass through and heat the dark soil underneath. The plastic cover also traps much of the outgoing radiant heat from the soil (the so called "Greenhouse Effect".) In order to be effective in controlling RKN infested soils, the soil must be heated to RKN kill temperature/time thresholds. See attached chart (Fig. 1) for RKN kill temp thresholds on Page 3. The deeper the soil, the more difficult it is to heat the soil and achieve the RKN kill temp/time thresholds.

In 2015, RKN symptoms were observed in pepper plants grown in Bed 40, a 12-inch deep raised bed. Extensive RKN infestation was confirmed by microscopic examination of a soil sample analyzed by the Texas A&M Plant Disease and Diagnostic Laboratory. Bed 40 was solarized in July and August of 2015 using two layers of clear plastic. An RKN kill threshold of 110-F for several hours was achieved at a depth of 10-inches below surface. Higher temperatures were measured at depths closer to the surface (i.e. upwards of 120 to 140-F from 3 to 5-inches below the surface). That was good enough to hold the RKN at bay for a couple of years. Summary data for the 2015 reference (Fig. 2 and 3) study are provided on Page 3.

In the process of solarizing Beds 22 and 23, it was decided to make a comparative study on different solarization methods. Both beds presented a challenge because each bed was 18-inches deep, compared to standard raised beds at 10 to 12-inches deep. The study was conducted In July and August of 2022. Equipment was assembled and operated by Gene Speller and fellow GCMGA David Eskins. The soil temperature was continuously recorded via weather station sensors at 12 and 18-inches below the surface for each bed. Each bed was equipped with soaker hoses and irrigated prior to covering with plastic. For the first two weeks of July (Stage 1), Bed 22 was initially covered with a single layer of 6-mil black plastic on the sides and top. Bed 23 was initially covered with a single layer of 6-mil clear plastic (est. ~ 85% to 90% light transmission) on the sides and top. For the remainder of the study (Stage 2: mid-July through August) Bed 22 was also equipped with a polycarbonate clear top layer. Bed 23 was also equipped with a second layer of 6-mil clear plastic. The second layers for each bed were approximately 4 to 6-inches above the first layer. The idea behind a using a second layer is to provide additional heat trapping capacity of the miniature greenhouse.

* Discovery Garden is the Galveston County AgriLife Extension demonstration garden, located in Carbide Park, 4102 Main Street, La Marque, TX

Findings

(1) A single layer of black plastic performs as well or better than clear plastic. As much as a 5 to 7-degree increase in temperature was achieved with black versus clear plastic.

(2) A second layer of clear plastic sheeting increases soil temps in the upper layers (surface to 12-inches deep) of a raised bed by 10 to 15-degrees greater than a single layer.

(3) The double layer of clear plastic on Bed 23 achieved an RKN kill temperature at 12-inches below the surface (104-F for > 46 hrs.) However, these layers did not achieve an RKN kill temperature at 18-inches below the surface. The highest temperature at 18-inches below soil surface for Bed 22 was 99-F, which is below the lowest known RKN kill temperature.

(4) The combination of a black plastic first layer and clear plastic polycarbonate top on Bed 22 achieved the RKN kill threshold temperatures at 12-inches below the surface (110- F for > 3 hrs.) and at 18-inches below the surface (104-F for > 46 hrs.). It is surmised that the clear polycarbonate has a greater sunlight transmission factor than does clear low-density polyethylene (LDPE).

Supporting data and pictures (Fig. 4, 5, 5 and 7) for the 2022 study are included in Page 4.

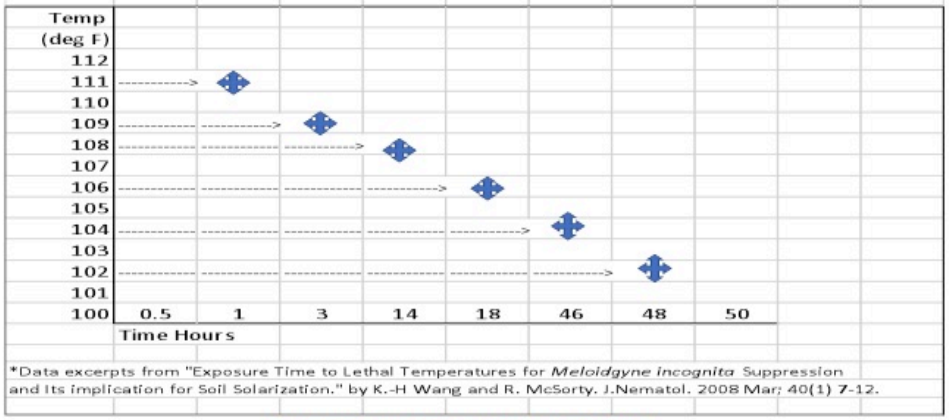
One of the benefits of using a polycarbonate cover is that it can be stored and reused, whereas the polyethylene sheeting is only good for one season because of wear and tear and breakdown from ultraviolet radiation in sunlight. There is also more of an issue with polyethylene covering during rainstorms from it being blown off and water puddling if not installed properly. The cost of a polycarbonate cover is approximately $\$2.88/ft^2$, compared with LDPE sheeting at approximately $\$0.10/ft^2$.

It should be noted that soil solarization by itself is not a cure-all for RKN infestation. A more effective integrated pest management (IPM) program for RKN control would also include: (1) crop rotation with non-target vegetables (i.e. cruciferous vegetables); (2) using an organic composted soil rather than a sandy soil; (3) preventing cross contamination by cleaning tools before and after use; and (4) using nematode resistant plants. Other control methods include the planting of Elbon Rye (aka Cereal Rye, an RKN trap crop) and resting or fallowing the area for one or more seasons.

"Soil Solarization Optimization"
Summer 2022

Time and Temperature Chart
for
Root-Knot Nematode Kill Threshold*

Temp (deg F.)	Time (Hours)
111	1
109	3
108	14
106	18
104	46
102	48



*Data excerpts from "Exposure Time to Lethal Temperatures for *Meloidgyne incognita* Suppression and Its implication for Soil Solarization." by K.-H Wang and R. McSorty. J.Nematol. 2008 Mar; 40(1) 7-12.

Figure 1: Time and Temperature Chart For RKN Kill Thresholds

"Soil Solarization Optimization" (Summer 2022)

Figure 2 : Raised Bed 40 with 2 layers of clear plastic July/August 2015

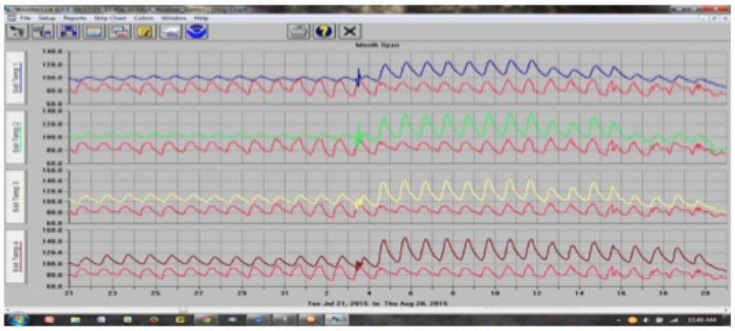


Figure 3: Ambient Air and Soil Temps for Bed 40 in July and August 2015.

Legend: Outside (ambient) Air Temp = ----------
Bed 40 Soil Temp No. 1 at 10" = ----------
Bed 40 Soil Temp No. 2 at 5" = ----------
Bed 40 Soil Temp No. 3 at 3" = ----------

"Soil Solarization Optimization" (Summer 2022)

Figure 4: Raised Bed 22 (left) in one layer of black plastic and
Raised Bed 23 (right) in first layer of clear Plastic and 2nd layer on top (07/19/22)

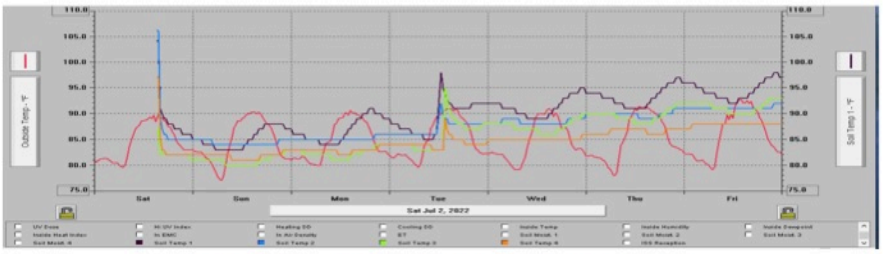


Figure 5: Ambient Air and Soil Temps for Week Starting
July 2, 2022.

Legend: Outside (ambient) Air Temp = ----------
Soil Temp No. 1 in Bed 22 at 12" = ----------
Soil Temp No. 2 in Bed 22 at 18" = ----------
Soil Temp No. 3 in Bed 23 at 12" = ----------
Soil Temp No. 4 in Bed 23 at 18" = ----------

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"Soil Solarization Optimization"(Summer 2022)

Figure 6: Raised Bed 22 (left) in one layer of black plastic and clear polycarbonate top
Raised Bed 23 (right)in first layer of clear Plastic and 2nd layer on top (07/19/22)

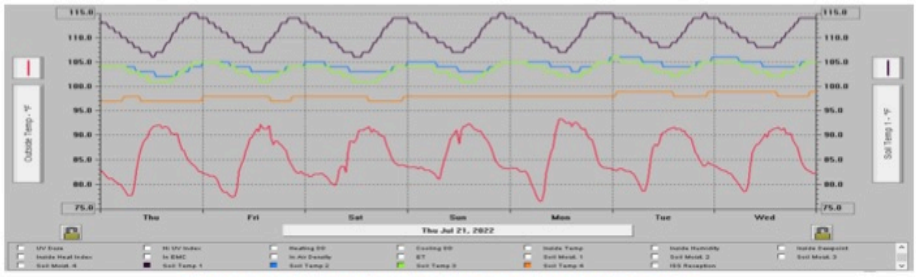

Figure 7: Ambient Air and Soil Temps for Week Starting
July 21, 2022.

Legend: Outside (ambient) Air Temp = ----------
Soil Temp No. 1 in Bed 22 at 12" = ----------
Soil Temp No. 2 in Bed 22 at 18" = ----------
Soil Temp No. 3 in Bed 23 at 12" = ----------
Soil Temp No. 4 in Bed 23 at 18" = ----------