South Dakota Vegetable Grower Experiences with Soil Tarping and Solarization during the 2024 Field Season

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Introduction

Occultation and solarization are weed management techniques being explored by vegetable growers across the Midwest and the wider United States (Kubalek, 2022; Rylander, 2020; Birthisel, 2018). Occultation is the use of opaque tarps to block light from reaching weed seeds and seedlings, therefore preventing germination and growth for most weed species. This provides a weed-free growing area at tarp removal without extensive use of tillage or herbicides. Solarization is the use of clear greenhouse plastic, trapping moisture and heat via solar energy and causing a microclimate of elevated moisture and temperature beneath the plastic (Voye, 2023). In high temperature climates, conditions can become so extreme beneath the plastic that weed seeds and seedlings in the soil die. In cooler climates, temperatures can become warm enough to germinate weed seeds and enhance weed growth earlier in the season than is common, exhausting the weed seed bank. In this case, a grower will need to terminate weeds before planting into the area.

On-farm research trials in South Dakota aimed to understand how a grower can realistically use tarps for reducing weed competition in their specific system as well as to increase grower's knowledge of this tool. This research was an extension of on-campus research in Brookings, SD studying the effects of tarp material and time on weed pressure and crop growth (Voye, 2024; Voye, 2025).

Materials and Methods

Growers at two farms participated in this soil tarping study for the 2024 field season: Rick and Michelle Grosek at Bear Butte Gardens in Sturgis, SD, and Peggy Martin and Bud Manke at Cedar Creek Gardens in Midland, SD. Both growers were provided with two twenty by fifty feet opaque silage tarps with one side black and one side white to experiment with occultation and one twenty by fifty feet sheet of clear greenhouse plastic (UV resistant six mil) to explore solarization. These tarps were purchased from Farm Plastic Supply. Each grower was asked to use the tarps however best fit their operation.

Methods for Bear Butte Gardens

Bear Butte Gardens laid tarps on May 10 and removed them on June 24. Photos were taken of weeds present in the area before tarp application to be later identified (Table 1). Tarps were secured by pallets laid down the middle of the tarp and bucket loads of compost spread around the edges (Figure 1). Onset HOBO temperature and moisture sensors were installed four inches deep in the soil beneath tarps May 23 until tarp removal. Weed biomass was collected when tarps were removed. This was done by randomly throwing two twenty-five by twenty-five-centimeter square quadrats into each tarped plot, clipping weeds at soil level, and placing in paper bags to be dried and weighed. Eight soil cores were taken in a "W" pattern within each treatment plot zero to six inches deep and six to twelve inches deep the day of tarp removal. Soil samples were analyzed

for microbial activity using Permanganate Oxidizable Carbon (POXC), where higher values of POXC equate to higher active carbon available to soil microbes. Photos and observations on weed growth were taken after tarp removal and into the field season.

Table 1. Weeds Identified at Bear Butte Gardens

Perennial Weeds	Scientific Name
Bindweed	*Convolvulus sp.*
Broadleaf plantain	*Plantago major*
Clover	*Trifolium sp.*
Common mallow	*Malva neglecta*
Curly dock	*Rumex crispus*
Dandilion	*Taraxacum offinale*
Annual Weeds	**Scientific Name**
Amaranth	*Amaranthus sp.*
Common lambsquarter	*Chenopodium album L.*
Crabgrass	*Digitaria sanguinalis*
Foxtail	*Seteria sp.*
Purselane	*Portulaca oleracea*

Figure 1. Bear Butte Gardens tarps secured with wooden pallets and compost burying edges on May 10, 2024.

Methods for Cedar Creek Gardens

Cedar Creek Gardens laid tarps June 10 and removed them August 10, covering the soil for two months. Tarps were secured with cinder blocks around the edges and metal fencing down the middle (Figure 2). Onset HOBO temperature and moisture sensors were installed four inches deep in the soil beneath tarps before tarp application on June 10 and collected data until tarp removal. Eight soil cores taken in a “W” pattern within each treatment plot zero to six inches deep and six to twelve inches deep were collected before tarp application and at tarp removal to be analyzed for POXC. Photos and observations were taken on weed growth after tarp removal.

Figure 2. Cedar Creek Gardens tarps secured with cinder blocks and metal fencing pieces.

Grower Observations and Results

Observations and Results for Bear Butte Gardens

At tarp removal, Bear Butte Gardens observed differences among tarp treatments (Figures 3, 4, and 5). Low weed growth was seen beneath black and white tarp treatments, with a large amount of chlorotic and necrotic creeping jenny. Patches of algae were discovered beneath clear tarps (Figure 6). Where pallets had been placed to secure clear tarps, they noted more prevalent weeds. Michelle Grosek noted the clear tarps reduced weeds better than she had anticipated at tarp removal, however, later in the season on August 29, more variety of weeds came up in this treatment plot (Figure 7) compared to the black and white tarp plots (Figures 8 and 9). Weeds identified later in the season are noted in Table 1. Onset HOBO temperature and moisture sensors showed the clear tarp to have higher soil moisture than the black and control tarps during tarp application (Figure 10). The sensor in the white tarp treatment plot malfunctioned, so a full dataset for moisture and temperature was not collected for that treatment. The temperature was highest for the clear tarp followed by the black and control treatments (Figure 11). Weed biomass collected at tarp removal showed highest dry biomass weights for the control

area with no tarp, followed by the clear tarp treatment, white tarp treatment, and black tarp treatment (Figure 12). Soil samples collected at tarp removal revealed POXC to be higher in the clear tarp and white tarp treatments than the control and black tarp treatments at the six-inch depth. Clear tarp, white tarp, and control were close in POXC values, with the black tarp treatment lower at the six- to twelve-inch depth (Figure 13).

Figure 3. Bear Butte Gardens clear tarp treatment at tarp removal on June 24, 2024.

Figure 4. Bear Butte Gardens black tarp treatment at tarp removal on June 24, 2024.

Figure 5. Bear Butte Gardens white tarp treatment at tarp removal on June 24, 2024.

Figure 6. Purslane and algae noted in Bear Butte Gardens clear tarped area at tarp removal on June 24, 2024.

Figure 7. Bear Butte Gardens weeds seen in clear tarped area on August 29, 2024.

Figure 8. Bear Butte Gardens weeds seen in black tarped area on August 29, 2024.

Figure 9. Bear Butte Gardens weeds seen in white tarped area on August 29, 2024.

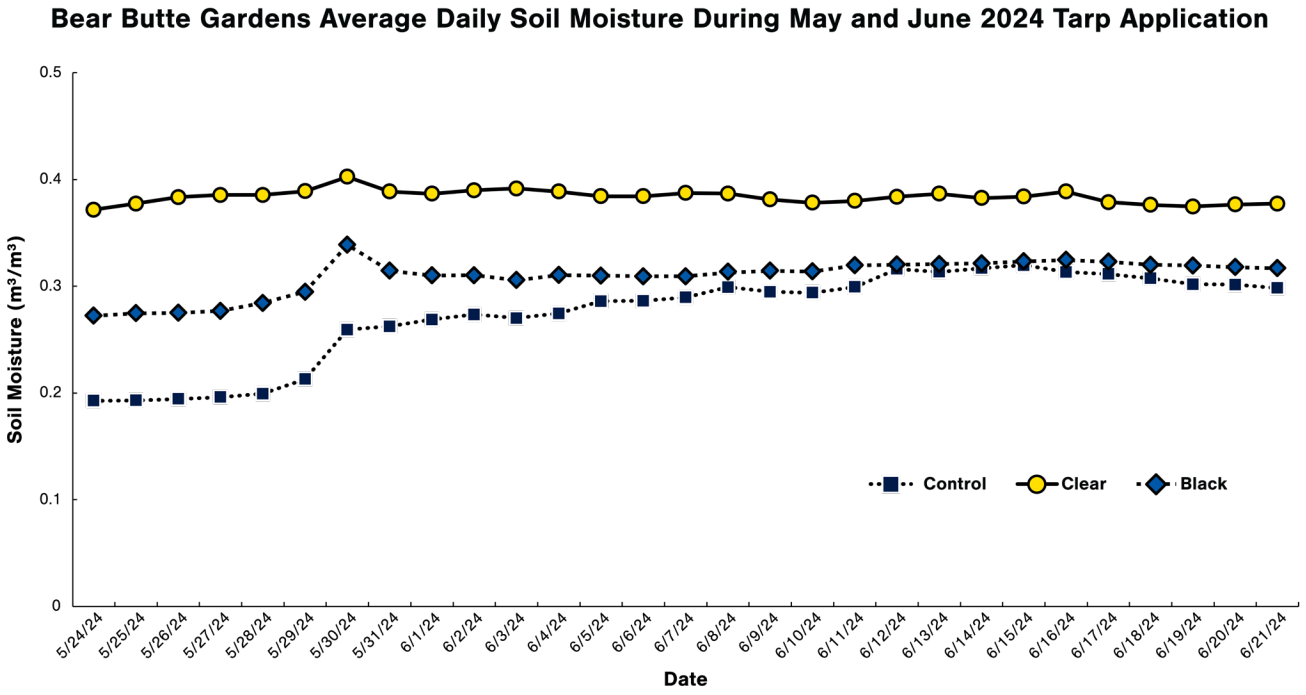

Figure 10. Bear Butte Gardens average daily soil moisture for one replicate of each tarp treatment during 2024 May and June tarp application. Onset HOBO moisture and temperature sensors were placed four inches deep in soil beneath each tarp. White tarp treatment moisture is not included due to sensor malfunction.

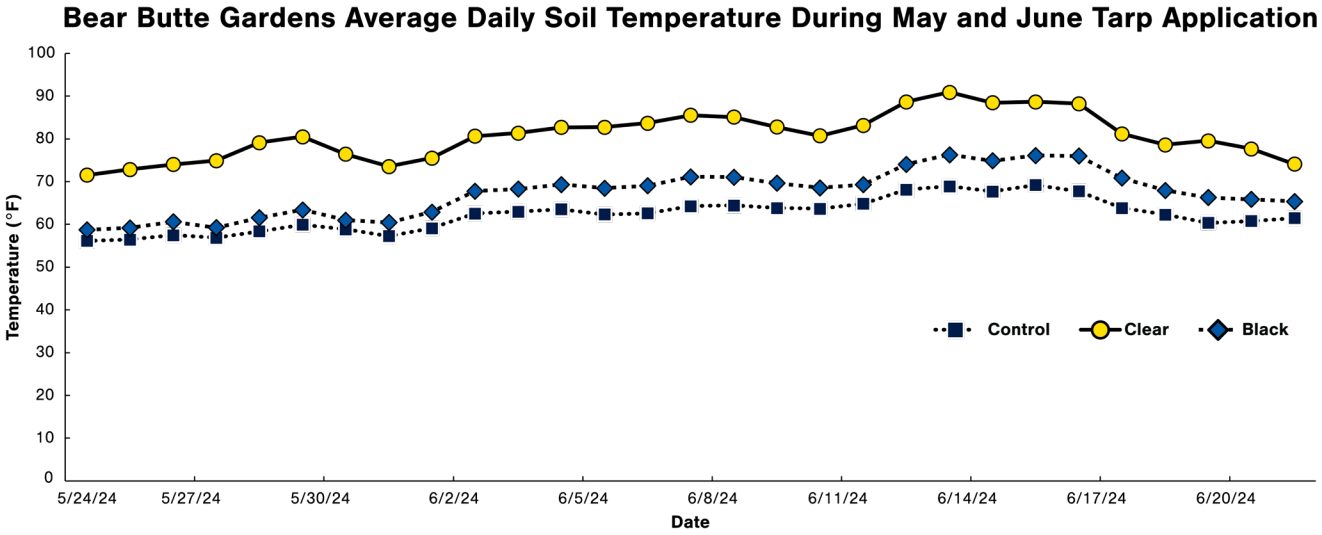

Figure 11. Bear Butte Gardens average daily soil temperature for one replicate of each tarp treatment during May through June tarp application. Onset HOBO moisture and temperature sensors were placed four inches deep in soil beneath each tarp. White tarp temperature is not included due to sensor malfunction.

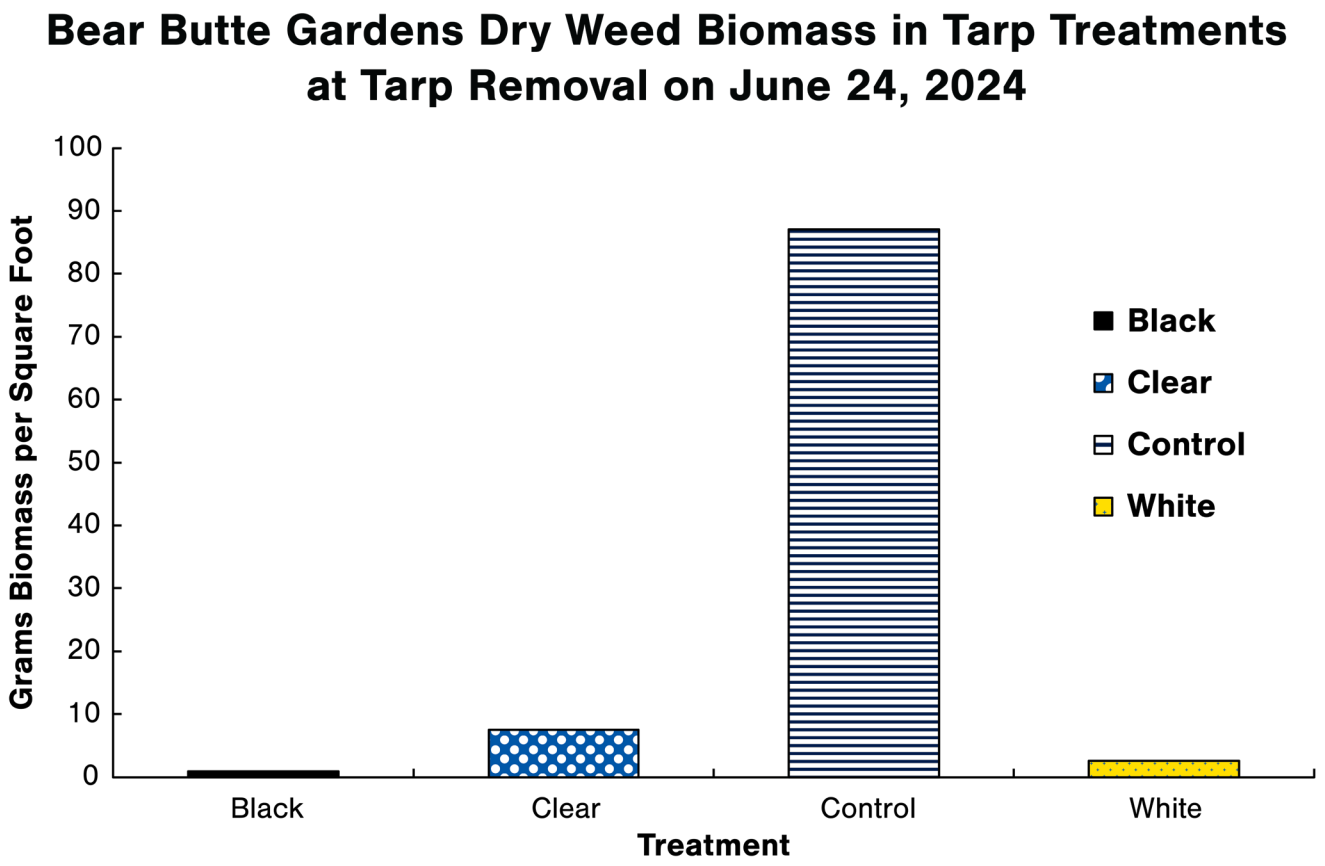

Figure 12. Bear Butte Gardens weed biomass for one replicate of each tarp treatment at tarp removal on June 24, 2024. Two 25 by 25 centimeter-square PVC quadrats were thrown randomly into each treatment plot. Within the quadrat area, weeds were clipped at soil level and placed in a paper bag to dry before weighing.

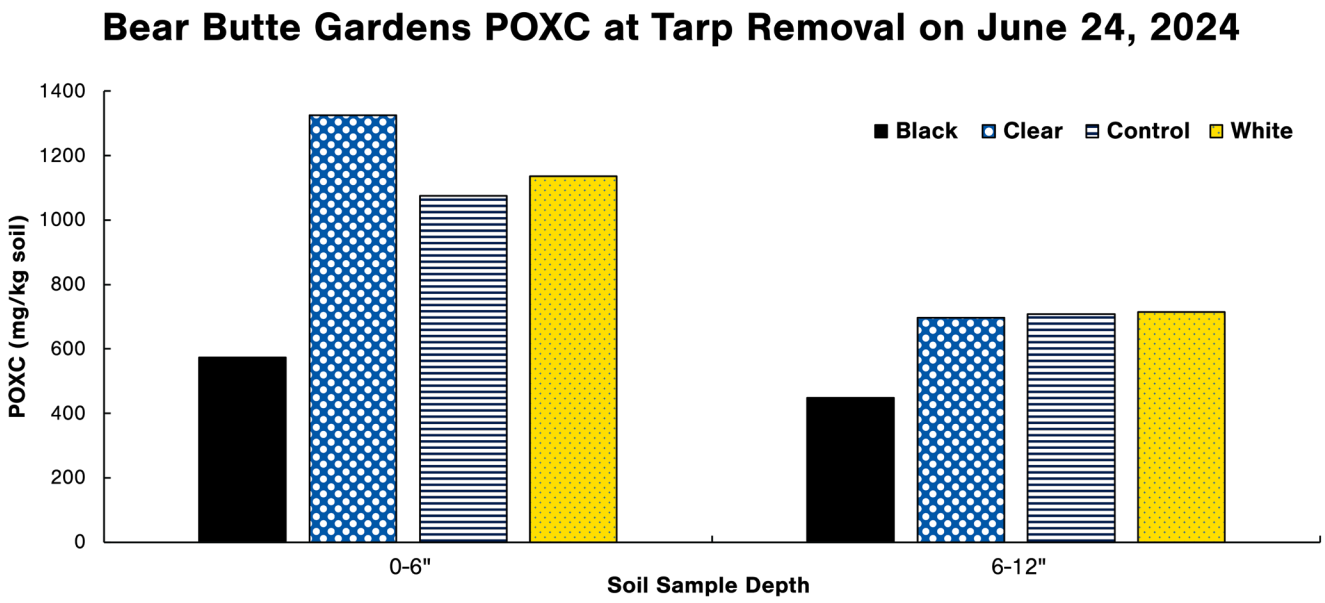

Figure 13. Bear Butte Gardens POXC in tarp treatments soil collected at tarp removal on June 24, 2024. Higher POXC corresponds with higher levels of active carbon available for microbes in soil.

Observations and Results for Cedar Creek Gardens

Cedar Creek Gardens noted that the soil was wet beneath tarps at tarp removal, more so than the surrounding areas. However, once the tarps were removed, the soil dried and became too hard to plant into. The ground was tilled to loosen soil. Bud Manke noted that there were more weeds under the clear tarp than the black tarp at removal (Figure 14). Onset HOBO temperature and moisture sensors showed higher moisture beneath the black tarp, followed by the clear, white, and control treatments (Figure 15). Moisture values for the white tarp treatment fluctuated around the clear tarp treatment. Similar to the results from Bear Butte Gardens, Cedar Creek Gardens' soil temperature was highest beneath clear, followed by black, white, and control treatments. Soil temperature values beneath the white tarp treatment fluctuated around the control (Figure 16). Samples collected before tarp application showed varying values in each of the plots (Figure 17). After tarp removal, POXC values were highest for the black tarp treatment at the six-inch depth followed by white, clear, and control. POXC levels were highest again in the black tarp treatment for the twelve-inch depth followed by the control, clear, then white. Since these values are collected from only one replicate, we cannot say these differing POXC values were due to tarp treatment.

Figure 14. Cedar Creek Gardens tarped area at tarp removal on August 10, 2024. The clear tarp treatment is closest to the camera, then the white-tarp treatment followed by black-tarp treatment.

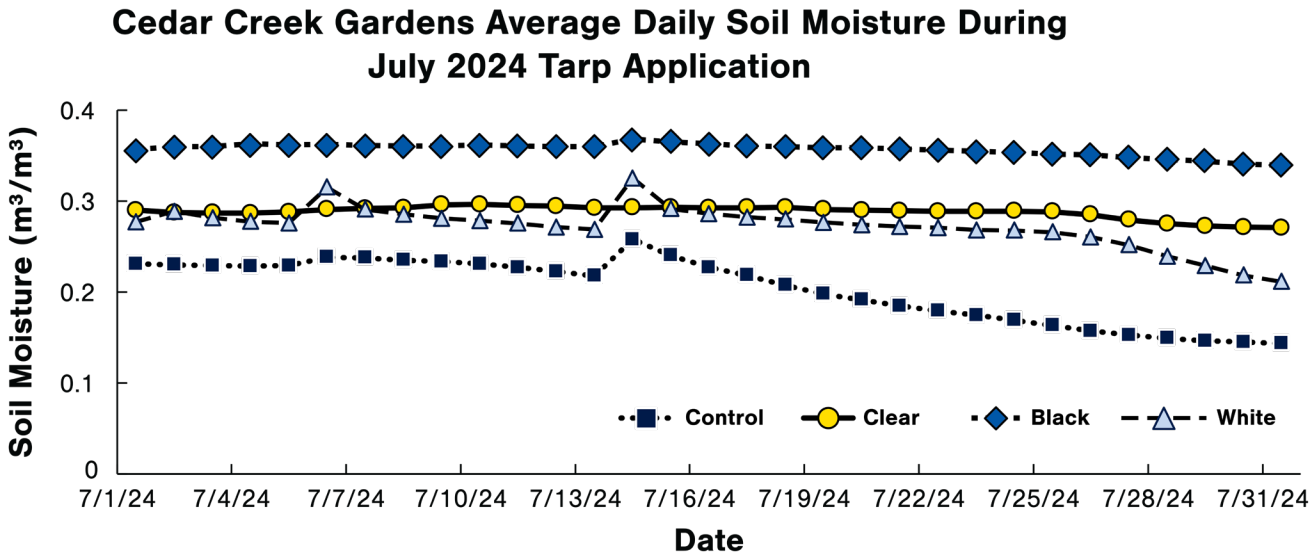

Figure 15. Cedar Creek Gardens average daily soil moisture for one replicate of each tarp treatment during July 2024 tarp application. Onset HOBO moisture and temperature sensors were placed four inches deep in soil beneath each tarp.

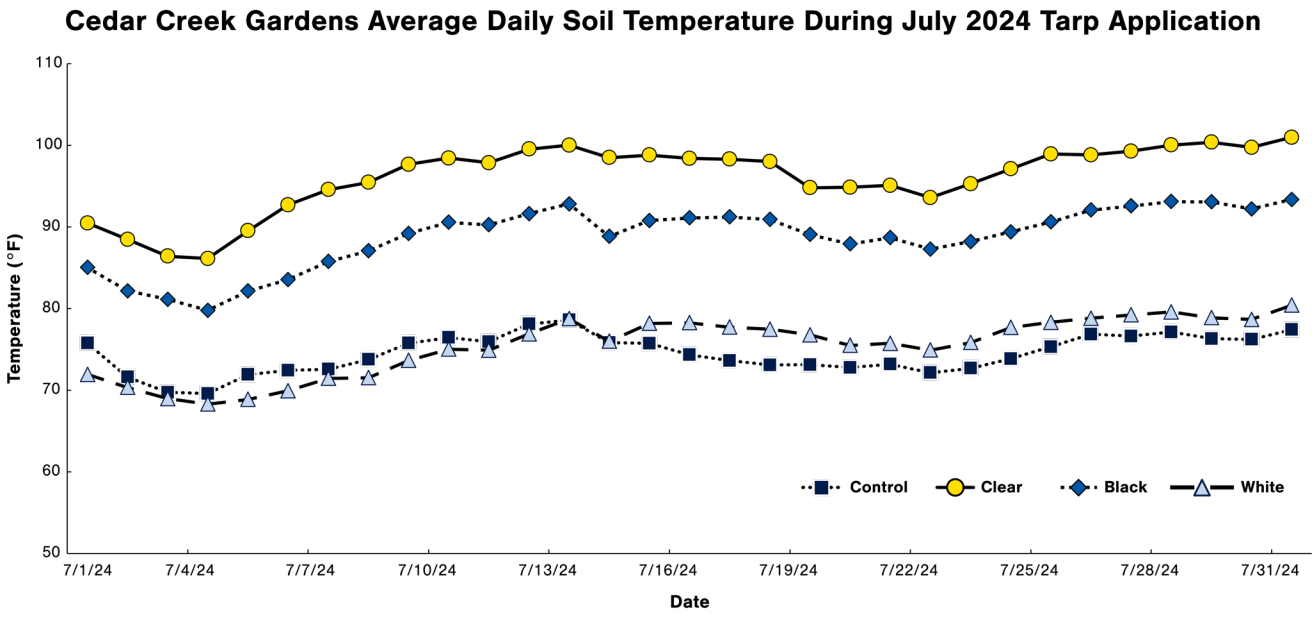

Figure 16. Cedar Creek Gardens average daily soil temperature for one replicate of each tarp treatment during July 2024 tarp application. Onset HOBO moisture and temperature sensors were placed four inches deep in soil beneath each tarp.

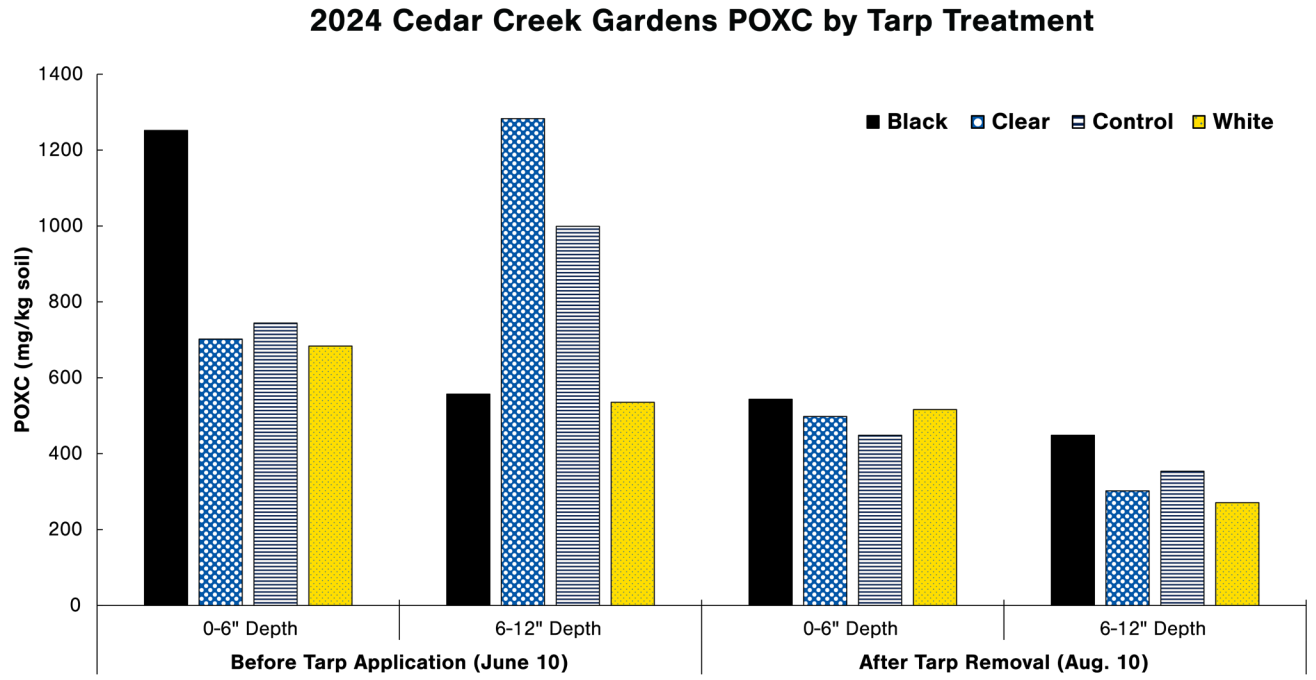

Figure 17. Cedar Creek Gardens POXC in tarp treatment soil before tarp application June 10 and after removal on August 10, 2024. Higher POXC corresponds with higher levels of active carbon available for microbes in soil.

Conclusions and Future Research

Growers were interested in the efficacy of tarping to reduce labor, and how the labor saved via tarping compares with the costs and labor of other mechanisms to reduce weeds. Both growers acknowledged a learning curve experienced in the first couple years of tarping and expressed interest to continue experimenting with it. An idea for future tarping use that was discussed is “succession tarping”: using clear plastic to germinate weed seeds earlier in the season and using black tarps to snuff out the weed growth encouraged by the clear tarp. Final thoughts from growers on tarping were generally positive. Bud Manke from Cedar Creek Gardens said he would use occultation with the black silage tarp again, as he observed it to reduce weeds the best. Michelle Grosek from Bear Butte Gardens would like to try all three tarping materials again in the 2025 growing season and would like to cut down the size of her tarps to a more manageable size.

Figure 18. Logo for Bear Butte Gardens located in Sturgis, South Dakoka, owned and operated by Michelle and Rick Grosek.

Figure 19. Logo for Cedar Creek Gardens, LLC located in Midland, South Dakota, owned and operated by Peggy Martin and Bud Manke.

While both growers had mixed experiences on the effectiveness of tarping in their area, they gained knowledge through participation in the research and are interested in experimenting with soil tarping further. Soil tarping can have varying effects on not only weed growth, but also soil temperature, moisture, and microbial activity depending on grower location, time of year, and duration of tarp application.

References and Resources

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