



**Paul C. and Edna H. Warner Endowment Fund for Sustainable Agriculture  
Interdisciplinary Grant Program for On-Farm Research**

**Report Form**

**Project Title:** Cost-effectiveness of caterpillar tunnels for mitigating impacts of heat on production of leafy greens in central Ohio

**Summary**

At our urban farm in Columbus, we aimed to compare average yields of summer lettuce mix from 3 methods: (1) caterpillar tunnels covered with shade cloth, (2) outside plantings that were uncovered or (3) outside plantings covered with wire hoops and shade cloth.

We found that, compared to outside plantings, the mass of caterpillar tunnel yields were about one standard deviation lower, due at least in part to increased pest pressure from whiteflies and cutworms in the tunnels.

Our findings suggest that caterpillar tunnels with shade cloth do not reliably improve summer greens production, though we think this question warrants further investigation.

**What was done?**

Our long-term goal with our 2020-2022 Warner grants has been to evaluate cost-effective ways of mitigating the impact of heat stress on small-scale production of salad greens in central Ohio. In 2020, we tested whether we could improve the yields of summer lettuce using either shade cloth, micro-sprinkler interval watering (spreading out the same amount of watering over the day), or their combination. We found that combining shade cloth and interval watering led to faster growth in several varieties of full-sized heads of lettuce, and to a two-fold increase in the yields for lettuce mix and Salanova/Eazyleaf lettuce. In 2021, we continued and expanded upon our past work with these crop cooling methods by holding the interval watering treatment constant, and comparing the effect of three shade cloth treatments (40% black, 40% white, and no shade cloth) on spinach and lettuce mix.

In 2022, we compared lettuce mix grown (1) inside tunnels covered with 50% black shade cloth with lettuce mix grown outdoors under two shade treatments, (2) uncovered or (3) covered with hoops and 40% black shade cloth. Our 2022 lettuce mix plantings were all seeded using a Jang JP-1 seeder with six rows to the 30" wide bed, and watered on intervals spread over four periods throughout the day. To measure the standardized effect size of treatments, we fit a linear mixed effect model with treatment as a fixed effect, bed as a random effect (block), and mass per foot of bed as the response variable, and extracted 95% confidence intervals for the fixed effects using the lmer package in R.



## What were the results?

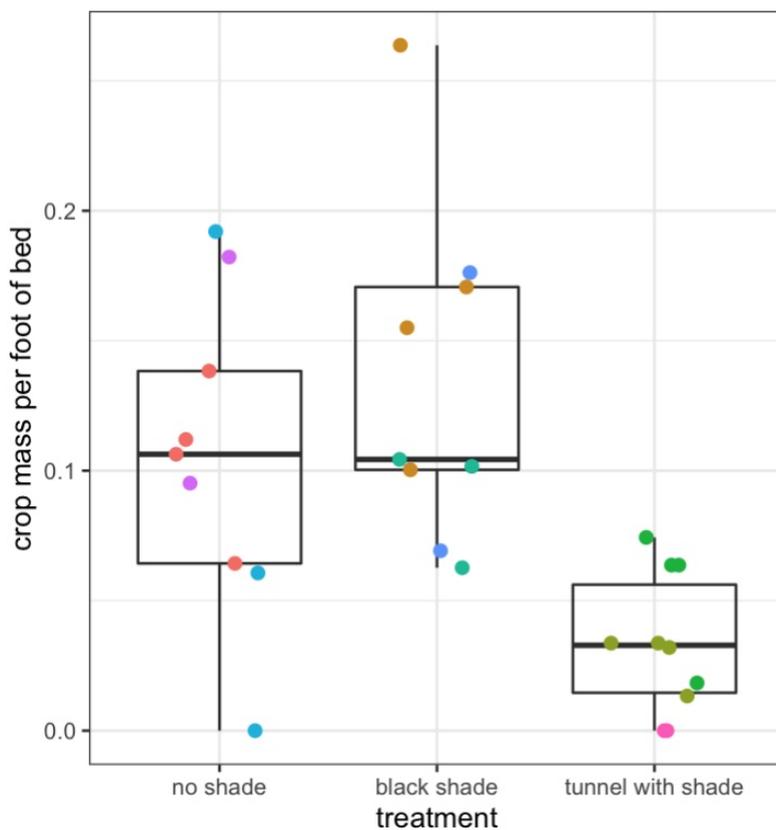
### OUTCOME

In our trials, the tunnels with shade had a 1.1 standard deviations lower yield per foot of bed than the no-shade treatment (Fig 1.).(95% confidence interval (CI): -1.8 to -0.39 standard deviations lower yield). We did not detect a clear difference in yield between outdoor plantings with and without shade cloth (95% CI: -0.29 to +1.1 standard deviations).

### CONCLUSION

The reduction in yield from caterpillar tunnels suggests that shade cloth-covered caterpillar tunnels are **not** a reliably better choice for growing summer greens successfully in central Ohio. Although caterpillar tunnels are still a good investment for improving yields of other crops, like summer tomatoes and winter greens, they are not worth the investment if the goal is to grow summer greens.

We observed increased pest pressure on lettuce in the tunnels which could be driving the difference. In one of our trial tunnels, our yields were reduced by whiteflies. In the other, cutworms decimated the lettuce crop before it grew to a harvestable size. We believe pest pressure might be higher in tunnels because pests may overwinter more successfully and possibly extend their breeding season. The summer tunnel environment, even with shade cloth, might also increase heat stress on heat-sensitive crops, making the crops more susceptible to pest pressure. We would love to see these experiments replicated at other sites, especially since our trials



included just two tunnels, and growers in other parts of the country report success growing summer greens in tunnels.

This year's data also corroborates previous years' data in suggesting that using shade cloth outdoors improves lettuce yields over the no shade treatment. Combining all three years of data with the outdoor shade versus no shade treatments will improve the accuracy of estimates of the effect of shade cloth. This meta-analysis is pending. We will use this result to do a cost-benefit analysis on using shade cloth outdoors.

**Figure 1. Average mass of lettuce yields are lower in tunnels with shade.** Dots show total daily yield of lettuce. Different colors show different beds. Boxes and whiskers show median (thick line within box), the 25th - 75th percentile (box), and range of yields.



### **How have the results contributed or will they contribute to sustainable agriculture?**

Most produce vendors sell lettuce mix during the spring and fall, so the market is relatively saturated, but we're usually the only vendor at our farmers market offering it during the hottest summer months. We're excited to help other growers become more profitable by copying the methods we've found to work best to grow successful summer lettuce. In 2021, we presented our findings virtually to growers at the OEFFA conference to an enthusiastic response. On September 14, 2022 we held a field day for local growers to share our findings and current best practices for growing summer lettuce. The field day was well attended by about 30 growers, and we received this nice feedback:

*First off, I want to say a heartfelt thank you for making the effort to conduct that research and spending some of your evening time to meet us and share the preliminary results. Summer lettuce is a very challenging but very important crop for me and I really struggled trying to make it work this year, but the tips about using shade cloth and direct-sowing (even in summer!) really helped me gain some ideas for how to grow it successfully in the future. That could mean a lot for my business and my life, so thank you for doing the work.*

This year we also aim to submit our findings to a peer-reviewed scientific journal, and to Growing For Market Magazine, a widely-read trade publication for small-scale growers, to extend the reach of our work.