UConn Co-Op Legacy Fellows Portrait

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Analyzing the Effect of Drift from Conventional to Organic Farmland

Summer 2017

PROJECT SUMMARY

During the summer I conducted a 12-week study at two local, student run, organic farms: the Spring Valley Student Farm (SVSF) and EcoGarden. On the conventionally operated UConn farmland (corn and grass fields) located adjacent to SVSF and EcoGarden, synthetic herbicides and fertilizers are used to promote crop yield. At the SVSF and EcoGarden, no man-made herbicides or fertilizers are spread in order to keep their crops organic, but if a significant amount of drift occurs from the adjacent conventional farmland, then can the farms really be labeled as organic? The project objective was to quantify the airborne drift in order to answer that question.

WHAT IS DRIFT AND WHY SHOULD I CARE?

Airborne drift occurs when particles get moved from their original location to another through wind patterns. It is estimated that up to 40% of all herbicides applied to crops end up being volatilized (i.e. enter the gas state) and move away from their application site. There are two main ways to think of drift: dry deposition and wet deposition. Dry deposition occurs when the particle simply drifts in the air over to where it lands and settles. Wet deposition occurs when a rain event grabs the particle out of the air and bring it to the ground (it gets "washed out" of the atmosphere). Figures 1 and 2 show the general trends for herbicide drift (much of the act is the same for fertilizers).

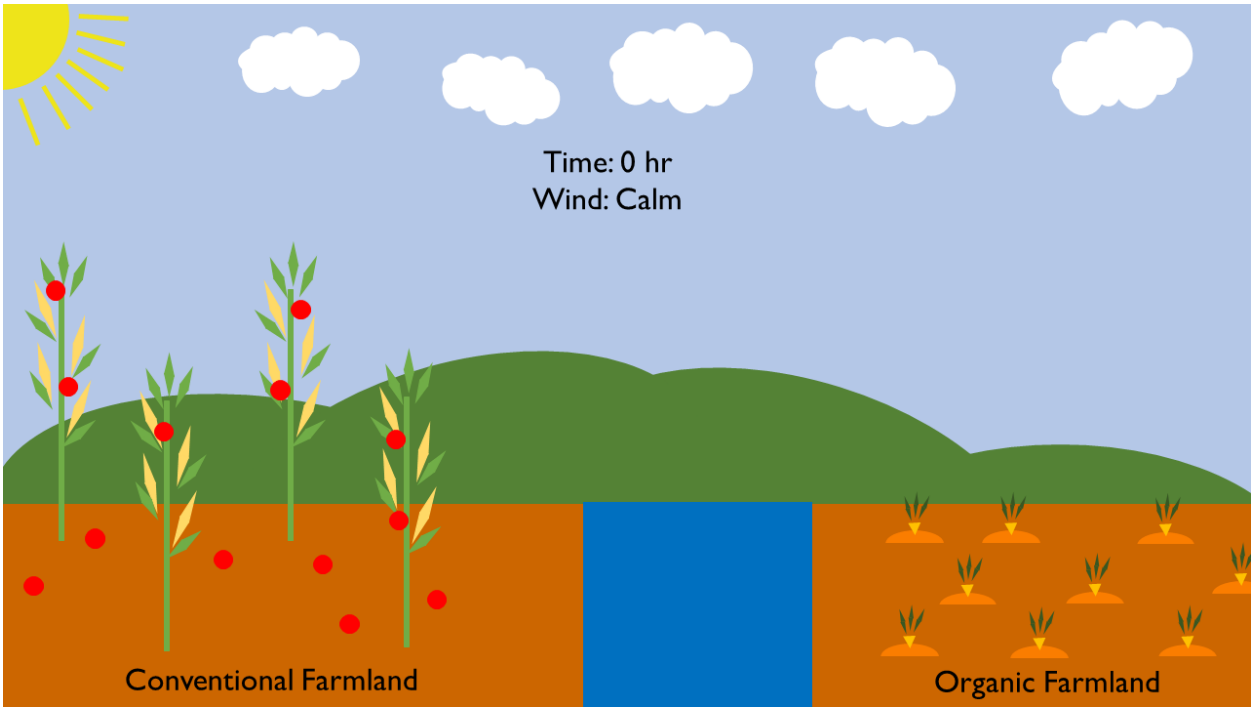

Figure 1. Exaggerated look at herbicide drift. In this scenario there is conventional farmland on the left using a special type of herbicide resistant corn. On the right there is an organic farm growing carrots. They are separated by a river which they both might use for irrigation purposes. The red dots on the left indicate herbicide droplets that have been applied to the corn. Most of them stay nearby the application area as they were just applied and the wind is calm.

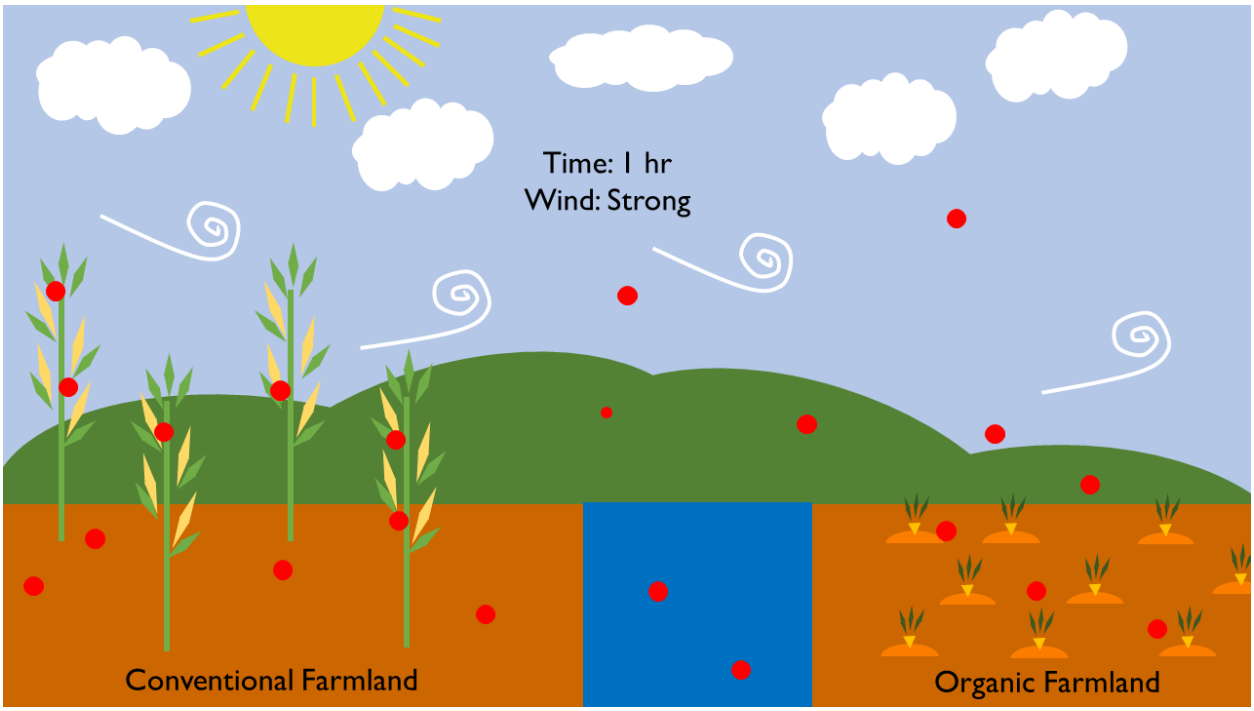

Figure 2. After 1 hour (arbitrarily chosen) we can see that some of the herbicides have gotten blown away by a strong wind. Some of the herbicides get picked up by the air and are taken far away while others land nearby in the river and on the carrots. If enough gets transported over, the organic carrots could suffer as they are not herbicide resistant like the corn is. The drift can make its way into the groundwater supply by entering the river and contaminate nearby wells and irrigation methods.

When nearby farms spray herbicides, there is always a risk that there could be drift onto the organic crops nearby. This can undermine the organic farm's practice if they don't have a way to mitigate the problem. If as a consumer you purchase organically grown produce you expect it to be free of synthetic chemicals and it is ultimately up to the organic farmer, not their neighbor using the herbicides, to make sure it is clean. Being able to quantify drift levels can empower organic farmers to know if their crops are meeting standards and to identify issues with neighboring conventional farms.

THE SPRING VALLEY STUDENT FARM AND ECOGARDEN

The SVSF is a UConn operated organic farm run by students on UConn granted land and is managed by Julia Cartabiano. The SVSF is a located at 86 Spring Manor Rd, Storrs, CT and is supported by numerous departments such as Department of Dining Services, Residential Life, First Year Programs and Learning Communities, CAHNR, UConn Facilities and others. Students live on the farm year round (even during the summer) and are required to spend a certain amount of time out in the fields working each week. They grow produce for Dining Services, provide informational sessions on organic farming, participate in collaborations with local communities to get kids excited about farming, serve as a living laboratory for numerous agriculture related student projects, and much more.

The SVSF land breakdown is given in the appendix as Figure 1. Their primary crop area (outlined in yellow) is no more than 30 feet from grass fields operated by the University of

Connecticut Farm Services department. The corn field (outlined in red) is also operated by Farm Services. The secondary planting area (outlined in light green) is known as the Edible Forest Garden where they primarily grow berries and herbs. A view of the Edible Forest Garden can be seen in the appendix as Figure 3. There is a train track (outlined in purple) that runs between the SVSF and Farm Services land. There is a tree barrier that runs along the tracks as well.

EcoGarden is a UConn undergraduate student organization that shows members how to farm using organic methods. Julia Cartabiano is also the advisor of EcoGarden. They have a plot of land (also known as the EcoGarden) inside of the Mansfield Community Garden off of Route 195 near campus. A land breakdown is given as Figure 2 in the appendix.

EcoGarden has Farm Services operated corn fields directly adjacent to its borders. The corn fields are much closer than those at the SVSF and there is no tree buffer between them.

PROJECT METHODOLOGY:

To capture dry deposition, two pump monitors were installed at the SVSF to collect air samples. One of them can be seen as Figure 4 in the appendix. Each monitor had two filters, one designed to collect herbicides and the other to collect particulate nitrogen (which serves as a proxy for fertilizer drift). No pump monitors were set up at EcoGarden as there was no power source for them there. To capture wet deposition rainfall monitors were set up at the SVSF and EcoGarden (1 each). Figure 5 in the appendix shows the rainfall monitor at EcoGarden. A weather station was installed at the SVSF to track parameters such as temperature, instantaneous rainfall rate, humidity, wind speed, and wind direction. See Figure 6 in the appendix.

Several particulate matter monitoring enclosures were set up to help track general trends in particle movement in the air. While they wouldn't be able to differentiate chemical species, they provided a sense for when there were times of greater drift. Figure 7 in the appendix shows the general setup of these particulate matter monitoring enclosures.

Air filters and rainfall vials were collected on a weekly basis and brought to the Center for Environmental Science and Engineering (CESE) for chemical analysis. The pump monitors and rainfall monitors were also borrowed from CESE.

PRELIMINARY PROJECT RESULTS:

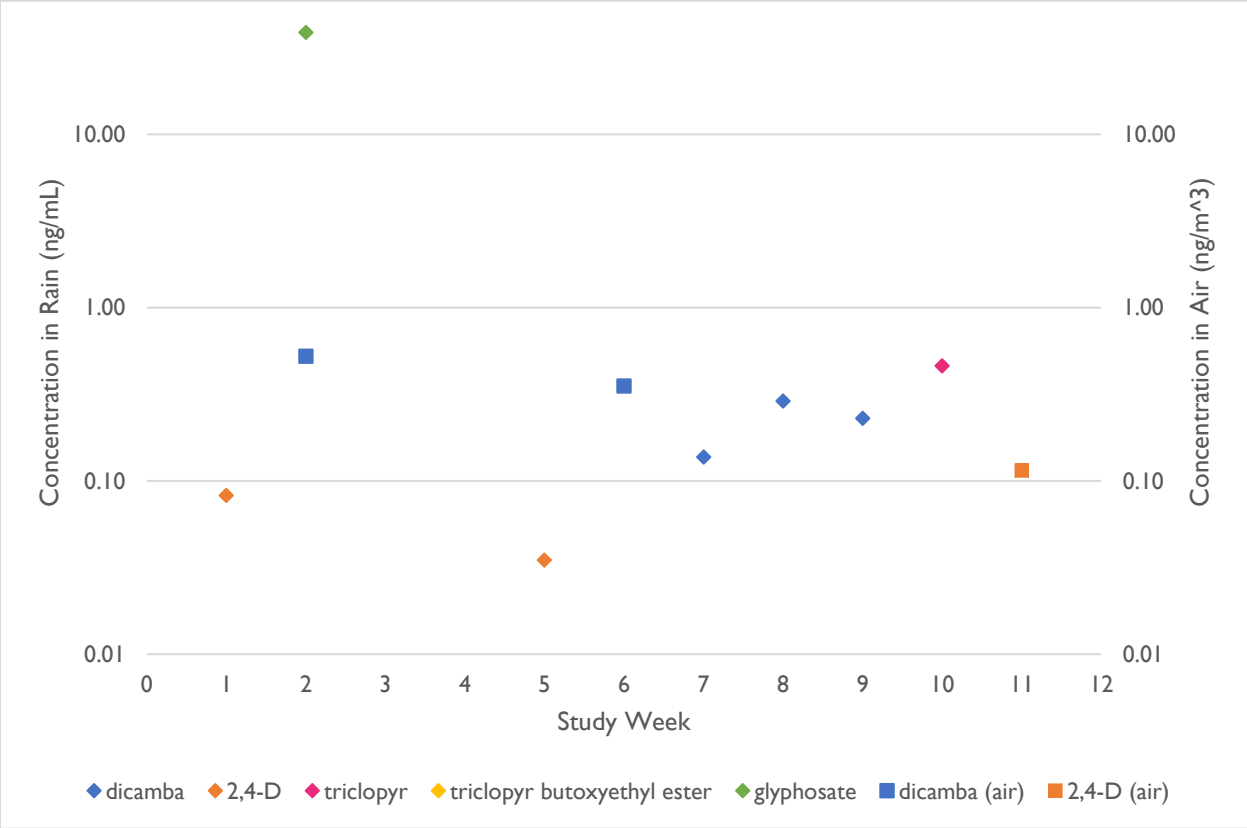

Figure 3. Herbicide concentrations reported at SVSF and EcoGarden. Air filter hits (represented as squares) were recorded at the SVSF while all water hits (represented as diamonds) were recorded at EcoGarden except for the 2,4-D hit during week 1. Week 1 corresponds to 05/16/17 to 05/23/17 and week 11 corresponds to 07/25/17 to 08/01/17.

In Figure 3 above we see the results of the study for herbicides. For the most part concentrations were below 1ng/mL in rainfall (except for glyphosate during week 2) and 1ng/m^3 in the air. These levels are relatively negligent and pose no issue for SVSF or EcoGarden. It is interesting that most rainfall hits were recorded at EcoGarden rather than the SVSF. It is suspected the closer proximity and lack of a tree barrier aided the transport of herbicides.

During the course of the summer UConn Farm Services only sprayed herbicides one time at each location. They sprayed at the SVSF on 06/29/17 and at EcoGarden on 06/30/17. This equates to the middle of study week seven. They brought in an outside company, Crop Production Services (CPS), to do their spraying for them rather than using their own rig for this summer. A picture of the application device CPS is shown as Figure 8 in the appendix.

When CPS sprayed, they used their own blend of herbicides that mainly consisted of glyphosate and dicamba. The hits of dicamba in the water during study weeks 7-9 indicate that some amount of drift from the event was possible. The herbicide hits before week 6 are interesting in that there was no major spray event from Farm Services during that time. Part of this semester will be working on figuring out why we got readings during the earlier study weeks.

Currently I do not have the fertilizer data completed and will be working on that during the course of the semester.

INITIAL CONCLUSIONS:

While I don't have all of the results finalized yet, there are a few conclusions that can be made:

- From the results of my study the SVSF and EcoGarden have very little to worry about in terms of drift.
    - This also means that students eating their produce at Chuck and Augie's or the dining halls don't need to be concerned either.
- More rainfall hits of herbicides at EcoGarden indicate that the lack of a tree buffer there puts them at greater risk to drift in the future.
- Other drift sources need to be evaluated to explain some readings (potentially from summer construction clearing land or from removing weeds along railroad)

NEXT STEPS:

There are several additional steps of analysis that need to be carried out before fully understanding the study results. First, once the fertilizer data comes in we will be able to compare drift levels with those from the herbicides and figure out there might be a concern. I also need to look into the particulate matter readings in order to see if they can serve as proxies to drift. Weather parameters need to be analyzed to a greater extent to determine if drift was affected (from initial analysis it seems only wind speed, wind direction, and humidity play a role).

I will be presenting my research to several groups in and around campus. On October 25th I will be presenting a poster at Fall Frontiers and on October 30th I will be presenting a poster at the American Institute of Chemical Engineers (AIChE) Student Conference. I have met with the members of the Spring Valley Student Farm to go over preliminary project results and will continue to do so whenever I make new conclusions. During the fall semester I plan to present to EcoHusky, an environmentally focused student group on campus that I am a member of. I have met with UConn's Farm Services manager to discuss the results as well.

PROJECT REFLECTION:

I have always thought that I wanted to go to graduate school but after completing this project I finally know that graduate school is the place I belong. Taking on a summer long independent research project gave me a look at what my life might be like in grad school and I enjoyed every bit of it. Being in charge of my own project, I got to explore aspects of the project that most interested me which made the work exciting and engaging. I could have spent my summer working for a company or doing rudimentary lab work as a part of an REU but I got to go out into the field and conduct an investigation on a topic that directly effects members of my community. This project has strengthened my desire to become a professor to perform independent research on environmental issues. I will be applying to graduate school later this semester for chemical and environmental engineering programs.

Even though I am a chemical engineer and not an environmental engineer I have always been more interested in environmental applications of chemical engineering than anything else. While my chemical engineering studies helped to prepare me for this project, I have learned so much about other disciplines such as agriculture, sustainability, and environmental science directly from the project. While interacting with fellow students at the SVSF I learned the basics of farming and what issues really matter to them. I knew most of the theoretical background to the project going in but I was at a loss for how to operate equipment and properly collect samples while in the field for an environmental study. This project helped fill out the skills I was missing as a researcher in a primarily theoretical lab.

Personally, I feel like drift is a topic that will continue to be a problem for the foreseeable future. Just this summer there was such widespread concern in Arkansas over the drift of dicamba that the state had to take action. Being able to quickly and cheaply assess if drift is occurring will be a need of farmers in the future. Drift doesn't just affect organic farmers but also farmers that don't use herbicide resistant crops. My research doesn't offer any solutions to the problem but perhaps in the future I will be able to apply the knowledge I gained towards making a positive impact for farmers across the country.

ACKNOWLEDGEMENTS:

There were a lot of people that made my project possible. First, I would like to thank my research advisor, Dr. Kristina Wagstrom, for all the advice and support I received. From creating the project idea to actually carrying it out she was there to help me succeed. I would like to thank the UConn IDEA Grant Coordinator and UConn Co-Op Legacy Fellows Coordinator, Melissa Berkey, for her efforts in not only managing my project but encouraging me to pursue avenues to share my research. Before Melissa Berkey took over as the Co-Op Legacy Fellows Coordinator Caroline McGuire helped shape the path of what it meant to be a fellow. Christopher Perkins from the Center for Environmental Science and Engineering played a key role in helping me secure the equipment I needed for my project and provided general knowledge on conducting an environmental study that was invaluable.

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APPENDIX

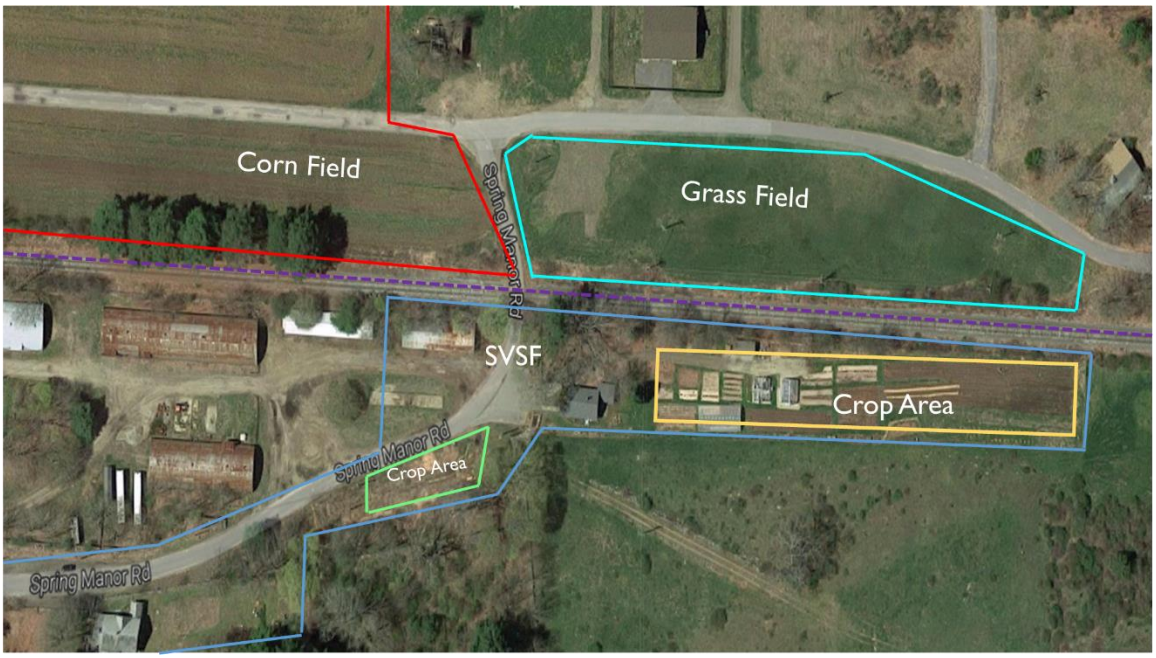

Figure 1. Land breakdown at the SVSF.

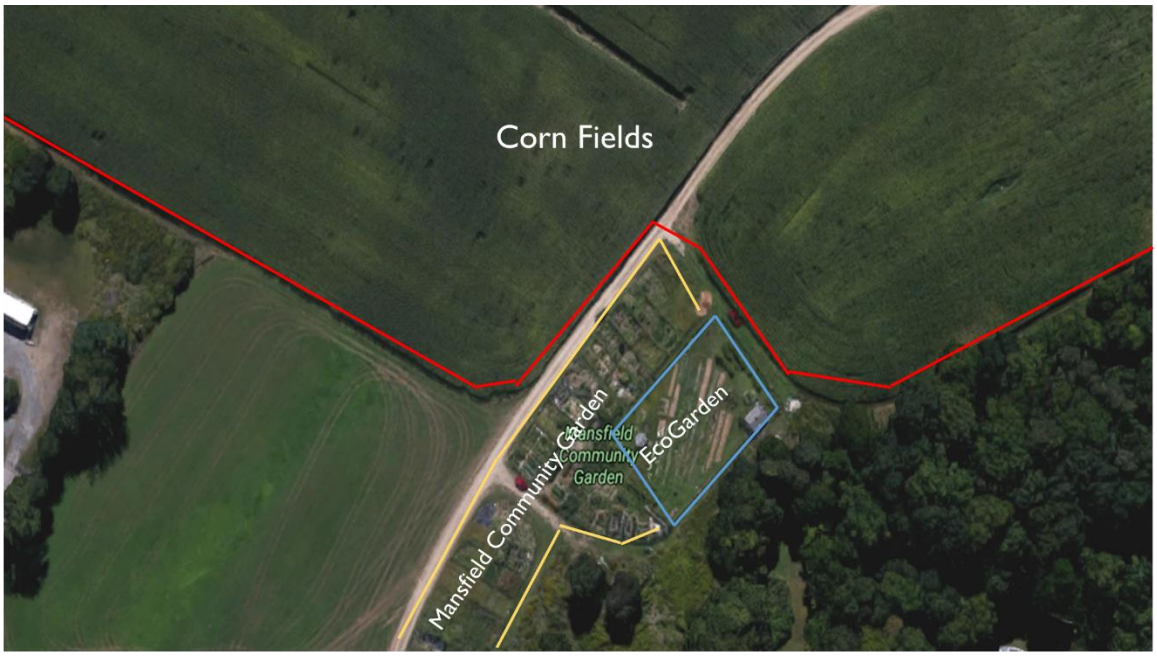

Figure 2. Land breakdown at the EcoGarden.

Figure 3. View of the Edible Forest Garden at the SVSF in May where one of the rain water monitors was placed.

Figure 4. One of the pump monitors used at the SVSF.

Figure 5. Rainfall monitor and particulate matter monitor at EcoGarden.

Figure 6. Weather station placement at the SVSF.

Figure 7. Particulate matter monitoring enclosure at the SVSF. A cinder block was used to secure it in place.

Figure 8. A view of the spray rig CPS brought for herbicides. For reference the tires are roughly 6 feet tall.