Report on small-scale cover crop study at boston colleges brighton campus

Environment, Plants

Considering the effects of cover crop and intercropping on garden settings

1. Introduction

1. 1 Background

Sustainable agricultural production systems, otherwise known as agroecosystems, employ a variety of techniques to maintain environmental quality. Cover crops are one strategy used by growers to preserve and enhance soil resources because of their impacts on soil-nutrient dynamics (such as nitrogen and carbon fixation)and microbiological functions (Steenworth and Belina, 2008). Cover crops such as cereal grass, hairy vetch, and oilseed radish, manage problems in an agroecosystem such as soil quality, erosion and fertility, water quality, pests and weeds because they tend to be less resource intensive than other crops and instead contribute to the regeneration and healthy functioning of the ecosystem. Yet, there are also instances where mixing cover crops together will not enhance an agroecosystem (Smith, Atwood, Warren, 2014). Farmers and gardens will choose certain cover crops depending on their needs, whether they have environmental or economic concerns, to assure cost-effective techniques that maintain both a healthy ecosystem and provide for their economic needs.

Intercropping is the practice of growing multiple plant species in close proximity; for example intercropping lettuce between rows of brussel sprout. The goal is to increase yield on a given piece of land by utilizing resources that otherwise would not be used. In addition to increase yield per unit area, it also acts as an insurance in the event that crops fail in an abnormal year, it

reduces runoff in the upper layers of the soil profile and controls weeds. Crops that are large enough may be able to provide shade to shade tolerant plants and thus supports the other crops. It can result in higher economic gain as intercropping with important cash crops can be highly profitable. Despite its many advantages such as increasing yield, transferring nitrogen from one crop to another, and reductions in nitrate leaching losses, intercropping also has some disadvantages. Its results can be uncertain; just as some studies find increases in crop yields due to intercropping, other studies show little or inconsistent benefits. In some cases, if incorrect crops are chosen to be intercropped together or their life cycles are asynchronous, then the crops could compete against each other for water and nutrient leading to negative yields. Intercropping can also result in the increase of fertilizer use or irrigation water in the event that one of the crops varies in their response to the other crops. In all cases, growing conditions and/or climate influences intercrop yields and sometimes intercropping can make a system even more vulnerable to changes or stresses in the environment (Toward Sustainable Agricultural Systems in the 21st Century, 2010). Lastly, it can be difficult to harvest the crops when they are arranged in an intercropping formation.

1. 2 Objectives of study

The objective of the study was to analyze growth, germination, and general effectiveness of three cover crops, hairy vetch, cereal rye, and oilseed radish, on the soil of a very small garden at Boston College. Additionally, we monitored weed suppression as an indicator of the cover crop’s effectiveness. The hypotheses were:

- H0: The cover crops would have no effect in either a polycultural or monocultural garden setting (null hypothesis).

- H1: The cover crops would have a positive effect on browning of plants in a polycultural setting but not a monocultural setting.

- H2: The cover crops would have a positive effect on browning of plants in a moncultural setting but not a polycultural setting.

- H3: The cover crops would have a positive effect on browning of plants in both a monocultural and polycultural garden setting.

1. 3 Justification of hypothesis

I am taking the optimistic approach that the cover crops will have a positive effect on weed suppression and brownness of plants regardless of the setting. Although crops in general are more effective in a polycultural setting, we may see that in such a small garden setting that the makeup of plants (monoculture vs. polyculture) will make little difference. Moreover, research by Smith, Atwood, and Warren (2014) demonstrates that species-rich mixtures of five annual species did not improve or enhance an agroecosystem in New Hampshire. Thus, it is entirely possible that we could see either increases in biomass in monoculture or polyculture settings.

2. Methods

2. 1 Site description

The study took place at a small garden at Boston College’s Brighton Campus in Boston, Massachusetts, 42°20'32. 0280" N, -71°09'43. 2252" E. Boston is considered to be situation at a cool temperate forest biome experiences an annual high temperature of 58. 7 degrees fahrenheit and an annual low temperature of 44. 1 degrees fahrenheit with an average temperature of 51

degrees fahrenheit. It experiences about 2615 hours of annual sunshine and 44 inches of snowfall annually (http://www. usclimatedata. com/climate/ boston/massachusetts/united-states/usma0046). The garden used is very small and has a mix of fresh, healthy organic soil.

2. 2 Experimental design

The experiment was set up with multiple serrated plots that were planted by six different groups of students. Each group planted variations of seed layouts of the three cover crops. In total, 23 plots were analyzed in the experiment.

2. 3 Variety of cover crops

The garden hosts a variety of cover crop species but for this study we consider the cover crops: hairy vetch, cereal rye, and oilseed radish. These crops were chosen for a variety of reasons such as their ability to manage weeds, low cost, winter tolerance, and nitrogen fixation. All three of these cover crops are especially useful cover crops as they not only suppress weed through physical or competition-based suppression but also through allelopathy – a natural process where the cover crop plants are able to inhibit seed germination of other plants through secondary compounds (“ In Organic Cover Crops, More Seeds Means Fewer Weeds,” 2010).

Vicia villosa (hairy vetch) is a legume native to Europe and Asia in the Fabaceae family with several subspecies. Organic growers in the United States commonly use hairy vetch as a winter cover crop. It is also popular in no-till farming. Advantages to hairy vetch are that it is winter hardy and a nitrogen (atmospheric) fixing plant that has shown to fix almost 200 pounds per acre. Its disadvantages include its hard-shelled seed that can be difficult

to shatter. This can lead to difficulties in wheat production, as it will remain as a weed after the harvest season. Hairy vetch is a companion plant to tomatoes and thus provides an alternative to rotating crops. For the tomato, it acts as an instant mulch preserving moisture and preventing sprouting weeds (Hill, Ngouajio, Nair 2006).

Secale cereale (cereal rye) is an annual cool season cereal grain in the family Poaceae. Its benefits include the ability to scavenge excess Nitrogen, erosion prevention, weed and pest suppression and the addition of organic matter. It is often planted with legumes, such as hairy vetch, grasses and other cereal grains. Although cereal rye is widely adapted and will germinate at temperatures as low as 34 degrees Fahrenheit, it often performs best in cool, temperate zones. Additionally, cereal rye also outperforms all other cover crops on poorly prepared land, sandy or acidic soil, and infertile soil. One downfall of cereal rye is that it will not dramatically improve soil conditions with growth of one single standard despite its extensive root system that provides fast weed suppression (Wander et al. 1994)

Raphanus sativus (oilseed radish) is a mustard that was originally developed for oil production that is part of the Brassicaceae family. Oilseed radish is a productive cover crop namely because of its thick, very long taproot that reaches deep into the soil profile. This taproot not only draws up nutrients and scavenge nitrate that has leached below the rooting zone for neighboring crops but also loosens and aerates the soil. Other benefits include its fast growth, especially during cool weather that provides quick ground cover against eroding soil and smothering weeds. It can also be used as livestock forage and may have an allelochemical effect – an interference

in plant development/growth – caused by allelochemicals (secondary compounds from the plants) to the rhizosphere that controls soil-borne insects, weeds, nematodes and other pests (Wander et al. 1994).

2. 4 Data collection

Over the course of the semester, we took a number of measurements for each crop treatment type (bare, cereal rye, cereal rye/hairy vetch, hairy vetch, or oilseed radish). For each of these five cover crop treatment types, four plots with weed replicates were established. Each plot was observed for abundance (number of weeds), which was then converted to a point system to compare weed density, percent GC (vegetation cover?), and plant height (inches). These data were collected by students in the class.

2. 5 Data analysis

3. Results

3. 1 General

After making calculations for dry biomass, I estimate the biomass of cereal rye as 0. 8 (using the middle high value for 60% which is also the low value of 70% GC), 1. 55 for hairy vetch (using the middle value of 60%), and 0. 8 for oilseed radish (middle value for both 60% and 70% GC). The average of the three crops was 1. 05 or 1000 pounds per acre.

3. 2 Biomass accumulation

In order to compare the total biomass of each of the cover crop treatment type, we compared number of points at the beginning of the experiment to the total number of points for each treatment type at the end of the experiment. Using the methodology previously explained, we found the average points for each treatment type and took into consider the standard

deviation of this average point system. The results are shown in Figure 1.

Figure 1. Before and after point totals for five different cover crop types. Standard deviations are plotted as error bars.

Increases in biomass accumulation are seen across all cover crop types (Figure 1). Oilseed radish and cereal rye were the most successful monocultures to generate more biomass with the least variation (12. 4 and 5. 2, respectively). The polyculture (cereal rye/hairy vetch/oilseed radish) was also very successful in generating more biomass; however, the standard deviation is very high in both the before (1) and after (2). Overall, it appears that monocultures may be more effective in increase biomass in small garden.

4. Discussion

4. 1 Interpretation of results

The null hypothesis that the cover crops would have no affect on the garden is not seen to be the case. Rather, increases in biomass was seen in all cover crop treatment both in polycultural and monocultural garden settings. Although the differences between polyculture versus monoculture treatments are slight, we can make the argument that cover crops perform better, in terms of biomass accumulation, in monocultural settings. This is seen by the greater increase in cereal rye, hairy vetch, and oilseed radish biomass than the combinations of these three cover crops.

Potential errors in the data collection include differences in counting or measuring techniques between the students, lack of monitoring for differences in climate between the plots, and inconsistent visits by the students. Also, the experiment’s short length (in terms of time) could inhibit

the most accurate results. Since there were six teams working on the project, the measurement of the variables could have easily fluctuated in terms of precision between different methods utilized by the group. In the future, less teams should do the analysis or if it is necessary to include this many teams, then the precise methodology must be firmly and clearly articulated and followed.

The implications of these results are that monocultural garden settings may be more effective for cover crops. If only one type of cover crop is to be chosen, then oilseed radish may want to be used over the cereal rye or hairy vetch. However, this results seems counter intuitive and thus the experiment should be repeated again to determine accuracy. The experiment could also be replicated on a larger scale in order to mimic a more realistic situation. Overall, we can conclude that cover crops are indeed an effective form of increasing soil health and decreasing soil erosion; however, we can't say that intercropping is effective with as much certainty. Because of the large gains in biomass accumulation of single crops (monocultural settings) and lower variation between plots (small standard deviation), we could conclude that oilseed radish is the single most effective cover crop, especially when planted by itself. Planting hairy vetch or cereal rye, but not mixing the two, also showed to be an effective strategy.

5. References

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