

2023 On-Farm Experiences Growing Cucurbits in Newly Established Clover Living Mulch in Eastern South Dakota



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Introduction

In the Great Plains region of the United States, perennial clover living mulch is being explored for the potential benefits of reducing tillage, suppressing weeds, and supplementing soil nutrients. Research on the use of perennial living mulch in vegetable systems has been limited in the Great Plains, and farmers have expressed interest in trialing this system to improve soil health and reduce erosion by wind and rain. However, the use of a living mulch can cause a reduction in yield since the clover can compete for light, water, and nutrients with the cash crop (Bruce, 2022). Two vegetable farms, Haroldson Farms (HF) in Bruce, SD and Blue Sky Vegetable Co. (BSF) in Worthing, SD, have participated in the on-farm trials since 2023.

Research Objectives

On-farm research was conducted over the summer months of 2023 at two farms in Bruce and Worthing, SD. The objective of this study was to determine the impact of two established clover species on weed suppression, crop growth, and yield of squash.

Materials and methods

Research Treatments

The clover cultivars used for living mulch were 'Domino' white clover (WC) (*Trifolium repens*), and 'Dynamite' red clover (RC) (*Trifolium pratense*). The third treatment was bare ground (BG) control. Cash crops were planted into

plastic that had been laid beforehand to control in-row weed competition.

Clover Establishment

HF tilled all plots prior to planting the clover and oat nurse crop on April 16, 2023. Clover was planted by hand broadcasting and oats were drilled. (Figure 1) The seed beds were then raked. Lack of early season rain caused a poor establishment of the clover crop, so clover and oat were reseeded on June 15, 2023. The bare ground treatment was tilled once during the season to manage weeds. Black plastic mulch was laid by hand on June 4, 2023. Three mowing and weeding events took place to knock down weeds in hope of allowing clover to establish and to prevent weeds from going to seed. (Figure 2)



Figure 1. Rows tilled through the three clover treatments before laying plastic at Haroldson Farms. Photo Courtesy: Kyle Haroldson.



Figure 2. Rows of squash plants growing in the plastic mulch at Haroldson Farms. Photo Courtesy: Kyle Haroldson.

BSF tilled all plots prior to planting clover and oat nurse crop which was planted May 26, 2023. Living mulch seed was planted using a drill. Clover established well the first weeks after planting. Black plastic mulch was laid using a Rain-Flo plastic mulch layer (Figure 3). Three weeding events took place to limit weed competition. One mowing event was used to prevent weeds from producing seeds and to allow more light to reach clover.



Figure 3. Rain-Flo plastic mulch layer. Photo Courtesy: Kjersten Oudman.

Clover Growth and Weed Suppression Assessment

Oat, Clover, and weed biomass was assessed three times throughout the season. A 25 by 25 cm square PVC quadrat was randomly tossed three times in the BG, KC, and RC treatments. Three random oat, clover, and weed plants were measured from the base to the leaf tip. Oat, clover, and weed plants were then cut as close to the ground as possible and separated by plant type into labeled paper bags. The paper bags were then put in a dryer for at least 48 hours at 140 degrees Fahrenheit (60 degrees Celsius) before determining biomass dry weight to the nearest 0.1g.

Cash Crop

Several Cucurbit varieties were chosen by the two farms which they normally grow for market. Some of the cultivars that were grown on the farms were butternut, acorn, spaghetti, cantaloupe, and delicata. Cash crop was planted at HF June 5, and at BSF June 2 into black plastic mulch.

Results

Clover and weed Biomass

HF had no measurable oat or clover plants across all three sampling events (Table 1). Weeds were prevalent during the season and reached an average height of nine inches. Weed biomass was lower in the BG treatments at an average of 2,500 pounds per acre while the clover treatments had an average 5,427 pounds of weed biomass per acre.

Table 1. Oat, clover, and weed biomass collected by sampling date during the 2023 growing season at Haroldson Farms. BG = Bare Ground, WC = White Clover, RC = Red Clover.

| Collection Date and Treatment | Oat Height (inches) | Clover Height (inches) | Weed Height (inches) | Oat Weight (lbs/acre) | Clover Weight (lbs/acre) | Weed Weight (lbs/acre) |
|-------------------------------|---------------------|------------------------|----------------------|-----------------------|--------------------------|------------------------|
| June 6 | | | | | | |
| BG | 0 | 0 | 4 | 0 | 0 | 76 |
| WC | 0 | 0 | 6 | 0 | 0 | 4777 |
| RC | 0 | 0 | 6 | 0 | 0 | 3327 |
| August 9 | | | | | | |
| BG | 0 | 0 | 5 | 0 | 0 | 5937 |
| WC | 0 | 0 | 9 | 0 | 0 | 6621 |
| RC | 0 | 0 | 10 | 0 | 0 | 8047 |
| September 6 | | | | | | |
| BG | 0 | 0 | 9 | 0 | 0 | 1488 |
| WC | 0 | 0 | 13 | 0 | 0 | 3960 |
| RC | 0 | 0 | 19 | 0 | 0 | 5828 |

BSF had oat and clover plants established at the first sampling. The average oat biomass was 154 pounds per acre and average clover biomass was 31 pounds per acre during the first sample date and then had no measurable oat or clover plants later in the season (Table 2). Weed biomass was low during the first sample date and then had a large increase in the second and third sample dates.

Table 2. Oat, clover, and weed biomass collected by sampling date during the 2023 growing season at Blue Sky Farms. BG = Bare Ground, WC = White Clover, RC = Red Clover.

| Collection Date and Treatment | Oat Height (inches) | Clover Height (inches) | Weed Height (inches) | Oat Weight (lbs/acre) | Clover Weight (lbs/acre) | Weed Weight (lbs/acre) |
|-------------------------------|---------------------|------------------------|----------------------|-----------------------|--------------------------|------------------------|
| June 6 | | | | | | |
| BG | 0.0 | 0.0 | 6.3 | 0 | 0 | 333 |
| WC | 4.4 | 0.4 | 1.8 | 204 | 24 | 119 |
| RC | 4.0 | 1.4 | 1.4 | 105 | 38 | 333 |
| August 9 | | | | | | |
| BG | 0.0 | 0.0 | 23.9 | 0 | 0 | 12341 |
| WC | 0.0 | 0.0 | 20.0 | 0 | 0 | 3361 |
| RC | 0.0 | 0.0 | 22.5 | 0 | 0 | 13558 |
| September 13 | | | | | | |
| BG | 0.0 | 0.0 | 32.2 | 0 | 0 | 5824 |
| WC | 0.0 | 0.0 | 22.7 | 0 | 0 | 4374 |
| RC | 0.0 | 0.0 | 26.1 | 0 | 0 | 4136 |

Harvest

HF had 9.2 pound per plant (acorn, buttercup, butternut, Spaghetti, and cantaloupe) harvested as marketable from the BG treatment and 7.2 pounds per plant harvested as marketable from the RC treatment (Table 3). 1.4 pound per plant was harvested as unmarketable from the BG treatment and 1.1 pound per plant was harvested as unmarketable from the RC treatment. Some variation can be seen in the weight per plant when comparing treatments within varieties (Table 4).

Table 3. Total marketable and unmarketable weight per plant harvested at Haroldson Farms.

| Clover Treatment | Total Marketable weight per Plant | Total Unmarketable weight per Plant |
|------------------|-----------------------------------|-------------------------------------|
| BG | 9.2 | 1.4 |
| RC | 7.2 | 1.1 |
| WC | 8.5 | 1.3 |

Table 4. Marketable and unmarketable weight per plant harvested of squash variety by clover treatment at Haroldson Farms.

| Clover Treatment | Squash Variety | Marketable weight per Plant | Unmarketable weight per Plant |
|------------------|----------------|-----------------------------|-------------------------------|
| BG | Acorn | 2.6 | 0.1 |
| RC | Acorn | 1.8 | 0.1 |
| WC | Acorn | 1.6 | 0.1 |
| BG | Buttercup | 1.3 | 0.3 |
| RC | Buttercup | 0.9 | 0.2 |
| WC | Buttercup | 1.2 | 0.3 |
| BG | Butternut | 2.3 | 0.1 |
| RC | Butternut | 2.1 | 0.1 |
| WC | Butternut | 2.4 | 0.1 |
| BG | Spaghetti | 1.3 | 0.2 |
| RC | Spaghetti | 1.1 | 0.2 |
| WC | Spaghetti | 1.9 | 0.3 |
| BG | Cantaloupe | 1.7 | 0.6 |
| RC | Cantaloupe | 1.3 | 0.4 |
| WC | Cantaloupe | 1.4 | 0.5 |

BSF had 213 marketable squash harvested in total in the BG treatment and 185 marketable squash in the RC treatment (Table 5). 211 pounds were the total marketable weight of squash harvested in BG and 200.4 was the total marketable weight of squash harvested in RC. 51 was the total unmarketable count in WC and 26 were the total marketable weight of squash harvested in RC. 30.5 pounds of unmarketable squash were harvested from WC and 10.0 pounds of unmarketable squash were harvested from RC (Figures 4 and 5). When comparing treatments some variation can be seen in the weight per plant within varieties (Table 6).

Table 5. Total marketable and unmarketable count and weight of harvested squash by clover treatment at Blue Sky Vegetable Co.

| Clover Treatment | Total Marketable Count | Total Marketable weight per Plant | Total Unmarketable count | Total Unmarketable weight |
|------------------|------------------------|-----------------------------------|--------------------------|---------------------------|
| BG | 213 | 211.0 | 36 | 29.0 |
| RC | 185 | 174.3 | 26 | 10.0 |
| WC | 204 | 200.4 | 51 | 30.5 |

Table 6. Marketable and unmarketable count and weight of harvested squash variety by clover treatment at Blue Sky Vegetable Co.

| Clover Treatment | Squash Variety | Total Marketable Count | Total Marketable weight per Plant | Total Unmarketable count | Total Unmarketable weight |
|------------------|----------------|------------------------|-----------------------------------|--------------------------|---------------------------|
| BG | Butternut | 140 | 131.6 | 20 | 15.8 |
| RC | Butternut | 114 | 102.6 | 12 | 2.8 |
| WC | Butternut | 132 | 123.8 | 16 | 6.7 |
| BG | Spaghetti | 33 | 42.6 | 12 | 10.9 |
| RC | Spaghetti | 20 | 25.6 | 10 | 5.4 |
| WC | Spaghetti | 25 | 34.1 | 26 | 18.9 |
| BG | Acorn | 40 | 36.8 | 4 | 2.4 |
| RC | Acorn | 51 | 46.2 | 4 | 1.8 |
| WC | Acorn | 47 | 42.5 | 9 | 4.9 |



Figure 4. Wagon load of spaghetti, acorn, delicata, bonbon, and butternut squash harvested at Blue Sky Vegetable Co. Photo Courtesy: Kjersten Oudman.



Figure 5. Wagon load of spaghetti, delicata, Hubbard, and orange squash harvested at Blue Sky Vegetable Co. Photo Courtesy: Kjersten Oudman.

Farmer Observation

HF owner Kyle Haroldson said that an irrigation system was needed to successfully establish clover at the beginning of the season, especially with the lack of moisture received in 2023. He would recommend laying the plastic mulch first and then using a seeder, such as a Jang seeder, to plant the clover rather than by hand broadcasting. Squash yield was reduced and did not vine out as much compared to squash Kyle grew using landscape fabric in a separate area of his farm. Clover trials needed more water during hot afternoons than the squash grown using landscape fabric. Kyle plans to use a different material and recommends not to use a heat-sensitive cash crop.

BSF owners Dirk and Kjersten had success planting the clover and oat seed at the beginning of the summer, but the weeds eventually became too much and overwhelmed the clover preventing establishment. Dirk and Kjersten agreed that the method of using a drill for the clover worked well but weed control was difficult because of the squash vines. Some color variation on the leaves of squash was noticed between the cash crop in the RC and KC versus the BG but it's not clear if it was from nutrient competition or water stress. At harvest Kjersten noted that spaghetti squash was smaller and there was less acorn squash in the KC and RC treatments than BG (Figure 6 and 7). Dirk and Kjersten plan to replant in a new area of freshly broken sod in the hopes to beat some of the weed pressure and have greater success establishing the clover in 2024.



Figure 6. Three different sized butternut squash harvested at Blue Sky Vegetable Co. Photo Courtesy: Kjersten Oudman.



Figure 7. Two different sized spaghetti squash harvested at Blue Sky Vegetable Co. Photo Courtesy: Kjersten Oudman.

Conclusion

Clover living mulch can be a useful tool once established but can be difficult to get to a point where it is self-sufficient. The first months of care require ample water and TLC that can be difficult to provide when other projects are taking place on the farm. Early establishment may be the key to success to beat the weeds and allow clover to grow its long tap root which will make it less susceptible to drought stress and weed competition. Lessons from the first year of this study will be used to inform our discussion in the coming years.

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