Broccolini Performance in Three Established Clover Living Mulches in Eastern South Dakota

Connor Ruen, M.S. Graduate Research Assistant SDSU Agronomy, Horticulture and Plant Science Department
Kristine Lang, Assistant Professor & SDSU Extension Consumer Horticulture Specialist
Thandiwe Nleya, Professor

May 2024

Special thanks to Robin Buterbaugh for peer-review of this report.

Introduction

Vegetables farmers often rely on intensive tillage to control weeds that compete with their cash crops between the rows. Intensive tillage has adverse effects on soil health and increases the chances of soil erosion. To reduce tillage, farmers sometimes use plastic mulch, but single use plastic mulches are hard to recycle. The use of a living mulch cover crops to suppress weeds is an alternative that can reduce plastic waste. A perennial legume living mulch, such as clover, will fix nitrogen in the soil while holding on to leachable nutrients and prevent wind and water erosion. However, the use of a living mulch can cause a reduction in yield since the clover can compete with the cash crop for light, water, and nutrients (Bruce, 2022). Brassica species are commonly grown in South Dakota vegetable systems. However, temperature spikes when nearing harvest can cause broccoli to bolt and become unmarketable.

Broccolini

Broccolini *(Brassica oleracea)* may be able to fill the demand for broccoli and allow farmers to diversify their cash crops. Broccolini is a lesser-known vegetable crop that has gained popularity in recent years. Broccolini is a cross between European broccoli, which is what most people in the United States think of as broccoli, and Chinese broccoli, also known as gai lan or Chinese kale. Broccolini goes by names such as mini broccoli, sprouting broccoli, aspabroc, baby broccoli, and tender stem broccoli. Many of these names give insight to why broccolini has become popular. Broccolini has a long tender stem that does not need to be trimmed and has a mild and sweet flavor in comparison to broccoli, which makes it ideal for cooking and reduces preparation work (Miles, 2024). An advantage of broccolini is the ability to continuously harvest throughout the season. Unlike European broccoli, broccolini is grown for its' side shoots rather than the apical floret. This allows producers to grow the plants for longer periods of time and have more opportunities to profit and harvest in contrast to one harvest in the case of European broccoli.

Research Objective

Field research was conducted over the summer months of 2023 at the Specialty Crop Research Field in Brookings, South Dakota. The objective of this study was to determine the impact of three established clover species on weed suppression, crop growth, and broccolini yield.

Material and methods

Research Treatments and Plot Design

The clover cultivars used for living mulch were 'Domino' white clover (WC) *(Trifolium repens)*, 'Aberlasting' white x kura clover (KC) *(T. repens x ambiguum)*, and 'Dynamite' red clover (RC) *(Trifolium pratense)*. The fourth treatment was a bare ground (BG) control. The clovers were established in 2022 (Barnes, 2023). The

clover living mulch whole plot was replicated within four blocks. Within the whole clover plot, there were four randomized soil management treatments: tilled (T), no-tilled (NT), tilled with fabric (TF), no-tilled with fabric (NTF). These four management options were chosen to determine how soil health and broccolini performance is affected by in-row management strategies. The black woven fabric was 3 feet by 12 feet with holes that had been burned prior to installation with a butane can torch (Barnes, 2023).

Clover Management and Soil Preparation Prior to Planting

Clover plots were mowed on May 17, June 12, July 11, July 26, August 1, August 24, and August 30 (Fig. 1). T and TF subplots were tilled with two passes with a BCS walk-behind tiller (30 inches wide) to a depth of 4 inches at the beginning of the season before fabric was installed in the plots. Stirrup hoes (Johnny Seeds) were used in T and TF subplots throughout the season to control weeds with dates corresponding with mowing events. NT and NTF were hand weeded to remove all plants other than clover and cash crop on dates corresponding with mowing events.

Figure 1. Clover pathways after being mowed with sunsetting in the background.

Broccolini Planting

Broccolini was seeded in 50-cell trays on June 30 in a greenhouse at the SDSU campus and placed in a misting room for one week to improve germination. Once germinated, broccolini was placed on a greenhouse bench and fertigated at 250 parts per million (ppm) 10-4-3 fertilizer on July 18 and July 26. Broccolini transplants were moved to a holding area on July 26 to harden off before being planted.

Broccolini was transplanted into the field on August 9. Each clover x soil management x broccolini cultivar sub-sub plot included five plants that were planted in 18-inch staggered double rows with 12-inch in-row spacing. Once planted, broccolini was watered using a garden hose with breaker nozzle to settle the soil while drip irrigation was also run for approximately two hours. All broccolini rows were covered with ProtekNet pulled over five feet tall nine-gauge galvanized wire secured with sandbag to prevent damage from deer and insects. Broccolini was fertilized using Nature's Source 10-4-3 at 250 ppm through a Dosatron fertilizer injector on August 17, August 26, and September 3.

Drip tape irrigation was installed prior to planting and used throughout the season for watering and fertigation. The drip tape had an emitter spacing of 8 inches and a flow rate of 0.20 gallons per hour at 8 PSI. Two lines of drip tap ran the entire length of the four subplots and were spaced approximately 16 inches apart on each bed.

Broccolini description

'Melody' has large, rounded leaves with a small green floret and side shoots that closely resembles Chinese broccoli (Fig. 2). 'BC1611' has long wavy leaves with a green floret that resembles small European broccoli heads and long slender side shoots (Fig. 3). 'Burgundy' has long wavy leaves with large dark purple apical floret head and long slender side shoots. 'Bonarda' has long smooth leaves with a light purple to pink floret. 'Bonarda' is a variety of broccolini that requires vernalization of 50 degrees Fahrenheit to stimulate bud formation, so no harvest data was collected for this variety.

Figure 2. Apical and lateral shoots of 'Melody' (left), 'BC1611' (center), and 'Burgundy' (right).

Figure 3. Broccolini plants before harvesting. 'Melody' (left), 'BC1611' (center), 'Burgundy' (right).

Clover Growth and Weed Suppression Assessment and Management

Clover biomass was assessed seven times in the whole plot and five times in the in-row management. A 25 by 25 cm square PVC quadrat was randomly tossed three times in the whole plot and two times in the in-row management subplots to determine plant height and biomass of clover and weeds. If clover plants were found in the T and TF managements, it was considered a weed since no plants other than cash crop should be growing after tillage events. Three random clover plants and weeds were measured from the base to the leaf tip to determine plant height (Fig. 4). Weeds and clover plants were then cut as close to the ground as possible and placed in separate 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. After biomass collection in the field, subplots are weeded by hand in the NT and NTF plots and mechanical with stirrup hoes in T and TF plots. The whole plots were mowed at four inches after every biomass collection and weed whipped as needed.

Figure 4. Tap root of red clover.

Infiltration

Water infiltration was assessed from July 13 to 24. A 10-inch diameter PVC infiltration ring was placed on a level area of the plot. The PVC ring was pounded into the ground using a rubber mallet and piece of wood until it was roughly two inches into the soil to prevent leaks. The depth of the ring is necessary to prevent lateral flow of water and ensure an accurate measurement of infiltration. Plastic was placed in the bottom of the ring to prevent water from stirring up soil. Water was poured into the ring to a marking inside the ring. The plastic was removed once the water line was to the mark and a timer was started. After one minute, water from a 1000 mL graduated cylinder was used to bring the water line back to the mark (Fig. 5). The remaining water was then subtracted from the starting amount to get the infiltration rate per minute. This process of adding water every minute continued until infiltration rate did not fluctuate more than 20 mL per minute for three minutes.

Figure 5. Water infiltration ring and two 1000 mL graduated cylinders that are used to refill it every minute.

Broccolini Plant Health Metrics

Broccolini plant height was measured from the soil level to the apical meristem before the first harvest on September 26. Before the last harvest, on October 23, plant height was measured again from the soil level to the highest meristem since the apical meristem is typically the apical floret which had been harvested at that point. Broccolini plant canopy width was measured from the widest leaf tip to leaf tip before the first harvest on September 30 at the widest leaf tip to leaf tip and before the last harvest on October 23 using the same method. The chlorophyll content in the leaf was measured on the newest fully mature leaf using a SPAD 502 Plus Chlorophyll Meter. Five readings were taken on one leaf from three plants per variety per plot. Cash crop biomass was taken on October 25 after the last harvest. Three plants per variety per plot were cut at the base of the stem and dried for six days at 140 degrees Fahrenheit and weighed to the nearest 0.5 grams.

Broccolini Harvest and Data Collection

Broccolini was harvested five times: September 26, October 3, October 10, October 18, and October 24. Apical shoots were cut with harvest knives 2-3 nodes below the floret bunch and lateral shoots were cut at the leaf axis or above woody plant shoots. Because of the lack of United States Department of Agriculture (USDA) standards for marketability of broccolini, standards for European broccoli heads were modified and used (Broccoli for Processing Grades and Standards). A marketable floret, equivalent to a U.S. 1, does not have any sepals that have begun to split or open to reveal the petals within and can have a puffy appearance. Having a puffy appearance is considered nonmarketable according to USDA standards for European broccoli. An open floret is a floret with one or more buds that have opened to reveal the petal or completely blossomed, but the internodes of the floret have not begun to elongate (Fig. 6). An open floret is equivalent to U.S. 2 since it is still edible. A non-marketable floret is any floret bolted (which is defined as open flower buds with elongated internodes and wood stem texture) biological damage from insects or animals, frost damage, or disease damage.

Figure 6. Examples of marketable shoot (left), open floret (center left), bolted (center right), and frost damage (right).

Results

Whole Plot Clover and Weed Biomass

Clover height measurements in July (Table 1) showed that RC was much taller than WC and KC (Table 1).

Weed height and biomass were greater in the BG treatment compared to all clover. The three clover plots had 81-97% less weed biomass present. Clover height in October was not different between RC and WC, but KC was shorter (Table 2). The average weed height had decreased in all clover treatments (Table 2). WC biomass was 1890 lbs/acs which was greater than biomass of KC and RC. Weed biomass was more than 20% lower in RC and KC, while WC had no measurable weed biomass. The weed biomass showed a large increase in the BG plots during the July 11 and July 31 collection dates where there was no competition and while three clovers kept weed biomass below 300 lbs/ac (Fig. 7).

Table 1. Clover and weed whole plot height and biomass accumulation collected from alleyways between broccolini rows on July 11, 2023 at the specialty Crop Research Field, Brookings, SD. BG= Bare ground, KC= Kura Clover, WC= White Clover, RC= Red Clover. Values followed by the same letter within a column are not different from each other based on Fisher's protected least significant difference test (α = 0.05).

Clover Treatment	Plant Height (in)		Plant Biomass (lbs/acre)	
	Clover	Weed	Clover	Weed
BG	0.0 C	9.9 A	0 B	2334 A
KC	3.7 B	1.3 B	2396 A	66 B
RC	11.6 A	2.6 B	2425 A	252 B
WC	4.6 B	2.7 B	2631 A	240 B
p-values	<0.0001	0.0009	<0.0001	0.0001

Table 2. Clover and weed whole plot height and biomass accumulation collected from alleyways between broccolini rows on October 26, 2023 at the specialty Crop Research Field, Brookings, SD. BG= Bare ground, KC= Kura Clover, WC= White Clover, RC= Red Clover. Values followed by the same letter within a column are not different from each other based on Fisher's protected least significant difference test (α = 0.05).

Clover Treatment	Plant Height (in)		Plant Biomass (lbs/acre)	
	Clover	Weed	Clover	Weed
BG	0.0 C	2.2 A	0 C	389 A
KC	3.2 B	0.0 C	1488 B	0 B
RC	4.9 A	1.0 B	1345 B	62 B
WC	4.3 A	0.0 C	1890 A	0 B
p-values	<0.0001	0.0019	<0.0001	0.0228

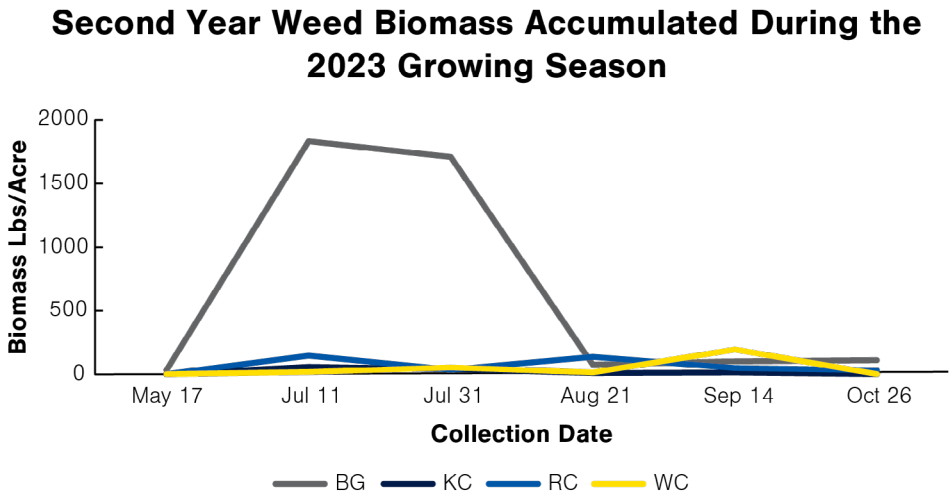

Figure 7. Broccolini whole plot weed biomass collected per sampling during the 2023 growing season. KC = Kura Clover, WC = White Clover, RC = Red Clover.

In-Row Plot Clover and Weed Biomass

In-row clover biomass in the July sampling event was only measured in NT and NTF treatments, with NT having four times as much clover biomass than NTF (Table 3). In-row weed biomass was reduced by 94-98% in the July sampling event in the NT compared to T in the clover treatments while there was no difference in the bare ground treatment between in-row managements. In-row clover biomass in KC and WC had more clover biomass in NT than the NTF during the October sampling event (Table 4). There was no difference between all in-row managements in the weed biomass during the October sampling event.

Table 3. Clover and weed in-row plot height and biomass accumulation collected from alleyways between broccolini rows on July 25, 2023 at the specialty Crop Research Field, Brookings, SD. TF= Tilled Fabric, T= Tilled no Fabric, NTF= No-till Fabric, NT= No-till No Fabric. Values followed by the same letter within a column are not different from each other based on Fisher's protected least significant difference test (α = 0.05).

Treatment	Plant Height (in)		Plant biomass (lbs/acre)	
	Clover	Weed	Clover	Weed
BG				
T	0.0	4.2	0	1159
TF	0.0	4.5	0	1484
NT	0.0	5.1	0	1338
NTF	0.0	4.7	0	1667
p-values	N/A	0.7719	N/A	0.1669
RC				
T	0.0 B	6.0 A	0 B	1358 A
TF	0.0 B	5.3 A	0 B	1191 A
NT	6.1 A	1.1 B	1369 A	29 B
NTF	3.0 B	5.6 A	107 B	976 A
p-values	0.0009	0.0006	0.0002	0.0003
KC				
T	0.0 B	5.5 A	0 B	1051 A
TF	0.0 B	4.8 A	0 B	1078 A
NT	3.5 A	0.9 B	1198 A	67 B
NTF	0.7 B	3.4 A	0 B	1040 A
p-values	<0.0001	0.0002	<0.0001	0.0003
WC				
T	0.0 B	4.8	0 B	1190 A
TF	0.0 B	4.5	0 B	1153 A
NT	3.5 A	1.8	1198 A	73 B
NTF	1.5 B	5.0	292 B	1336 A
p-values	0.0008	0.0558	0.0006	<0.0001

Table 4. Clover and weed in-row plot height and biomass accumulation collected from alleyways between broccolini rows on October 26, 2023 at the specialty Crop Research Field, Brookings, SD. TF= Tilled Fabric, T= Tilled no Fabric, NTF= No-till Fabric, NT= No-till No Fabric. Values followed by the same letter within a column are not different from each other based on Fisher's protected least significant difference test (α = 0.05).

Treatment	Plant Height (in)		Plant biomass (lbs/acre)	
	Clover	Weed	Clover	Weed
BG				
T	0.0	3.3 A	0	235
TF	0.0	0.4 B	0	4
NT	0.0	3.7 A	0	134
NTF	0.0	0.7 B	0	39
p-values	N/A	0.0006	N/A	0.2641
RC				
T	0.0 B	2.1 A	0	62
TF	0.0 B	0.0 B	0	0
NT	9.8 A	0.0 B	1405	2
NTF	7.0 A	0.0 B	906	4
p-values	0.0046	0.0094	0.187	0.2003
KC				
T	0.0 B	2.0	0 B	64
TF	0.0 B	0.8	0 B	5
NT	6.5 A	1.0	1487 A	23
NTF	4.4 A	0.4	103 B	14
p-values	0.0004	0.1868	0.0003	0.4989
WC				
T	0.0 B	2	0 B	50
TF	0.0 B	0	0 B	5
NT	8.0 A	0	1747 A	64
NTF	6.7 A	0	399 B	7
p-values	0.0209	0.1389	0.0017	0.5620

Harvest

There were interactions between broccolini by clover by management which is why harvest data was analyzed within each broccolini variety. There were no differences in number of marketable shoots per plant of 'Melody' from any combination of clover by management in KC, RC, and WC clover in the NTF, T, and TF treatments except for NT plots within RC, KC, and RC had significantly less shoots (Fig. 8). There were no differences in the number of marketable 'Melody' shoots in the bare ground whole plot. There were no differences in marketable weight per plant of 'Melody' in BG, RC, and WC treatments. However, the marketable weight per plant of 'Melody' was harvested from KC in NTF, T, and TF compared to NT (Fig. 9). There were no differences in the number of marketable shoots per plant of 'BC1611' in BG and RC in all treatments (Fig. 10). There were more marketable shoots of 'BC1611' within KC and WC in NTF, T, and TF compared to NT. There were no differences in the number of marketable weight per plant of 'BC1611' in BG, RC, and WC in all treatments (Fig. 11). There were no differences in the number of marketable shoots per plant of 'Burgundy' in all treatments (Fig. 12). There were no differences in marketable weight per plant of 'Burgundy' in BG, RC, and WC (Fig. 13). Within KC, there were more marketable shoots in NTF, T, and TF compared to NT.

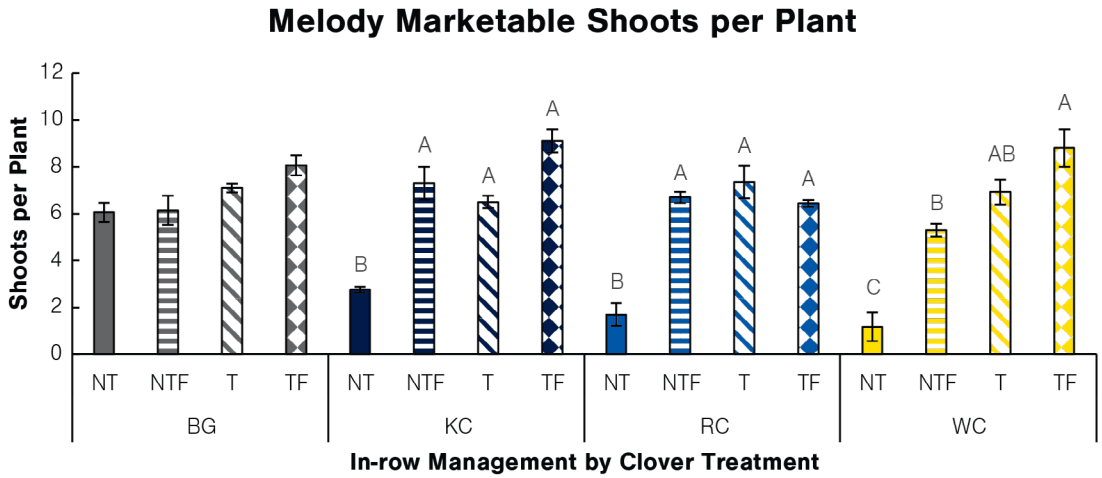

Figure 8. Marketable shoot yield responds per plant of 'Melody' broccolini from in-row management and clover treatments. BG= Bare ground, KC= Kura Clover, WC= White Clover, RC= Red Clover. TF= Tilled Fabric, T= Tilled no Fabric, NTF= No-till Fabric, NT= No-till No Fabric. Clover cultivar and management treatment used affected. Mean separations are affected within each clover treatment, RC (p = 0.0072), WC (p = 0.0014), KC (p = 0.0043) and BG (p = 0.3697). Values followed by the same letter within a column are not different from each other based on Fisher's protected least significant difference test (α = 0.05).

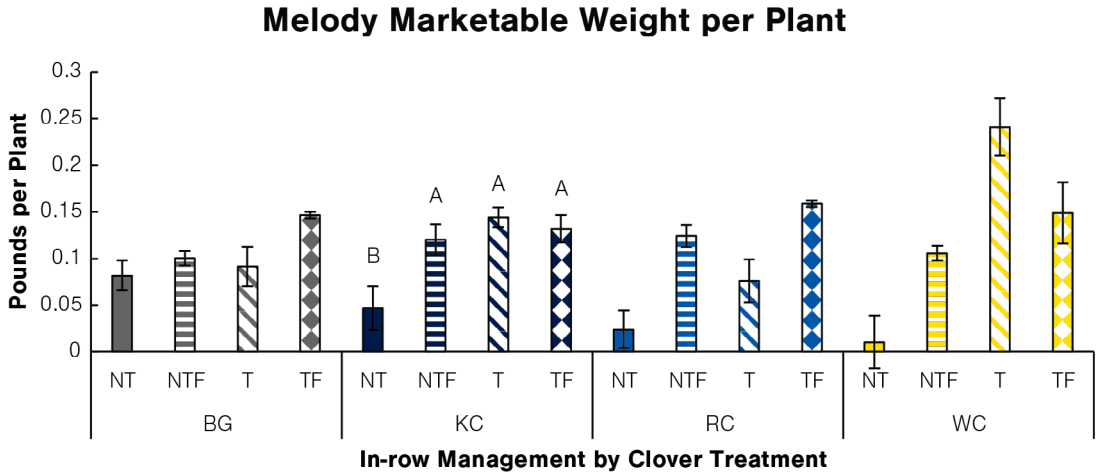

Figure 9. Marketable weight yield responds per plant of 'Melody' broccolini from in-row management and clover treatments. BG= Bare ground, KC= Kura Clover, WC= White Clover, RC= Red Clover. TF= Tilled Fabric, T= Tilled no Fabric, NTF= No-till Fabric, NT= No-till No Fabric. Clover cultivar and management treatment used affected. Mean separations are affected within each clover treatment, RC (p = 0.1572), WC (p = 0.0601), KC (p = 0.0003) and BG (p = 0.8804). Values followed by the same letter within a column are not different from each other based on Fisher's protected least significant difference test (α = 0.05).

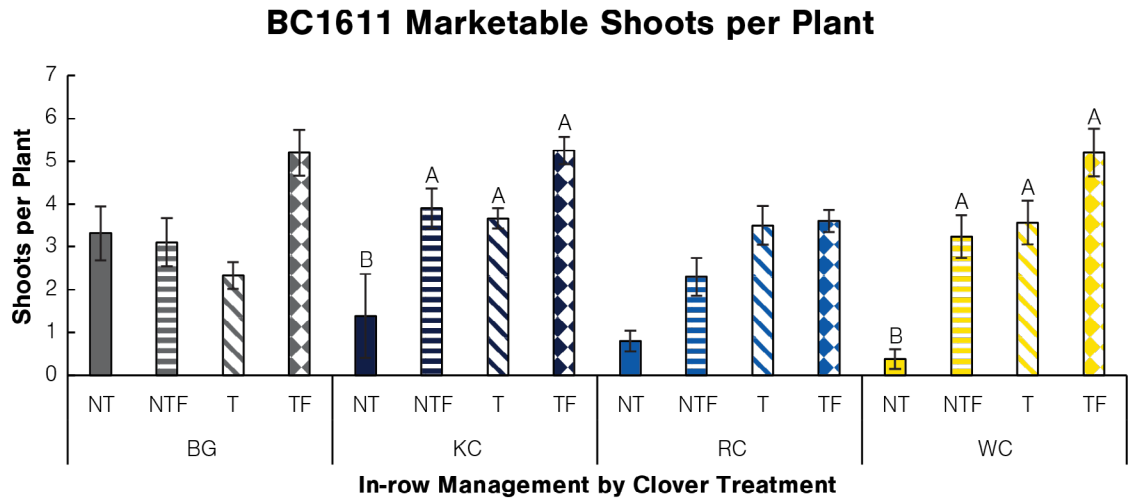

Figure 10. Marketable shoot yield responds per plant of 'BC1611' broccolini from in-row management and clover treatments. BG= Bare ground, KC= Kura Clover, WC= White Clover, RC= Red Clover. TF= Tilled Fabric, T= Tilled no Fabric, NTF= No-till Fabric, NT= No-till No Fabric. Clover cultivar and management treatment used affected. Mean separations are affected within each clover treatment, RC (p = 0.0830), WC (p = 0.0083), KC (p = 0.0086) and BG (p = 0.3909). Values followed by the same letter within a column are not different from each other based on Fisher's protected least significant difference test (α = 0.05).

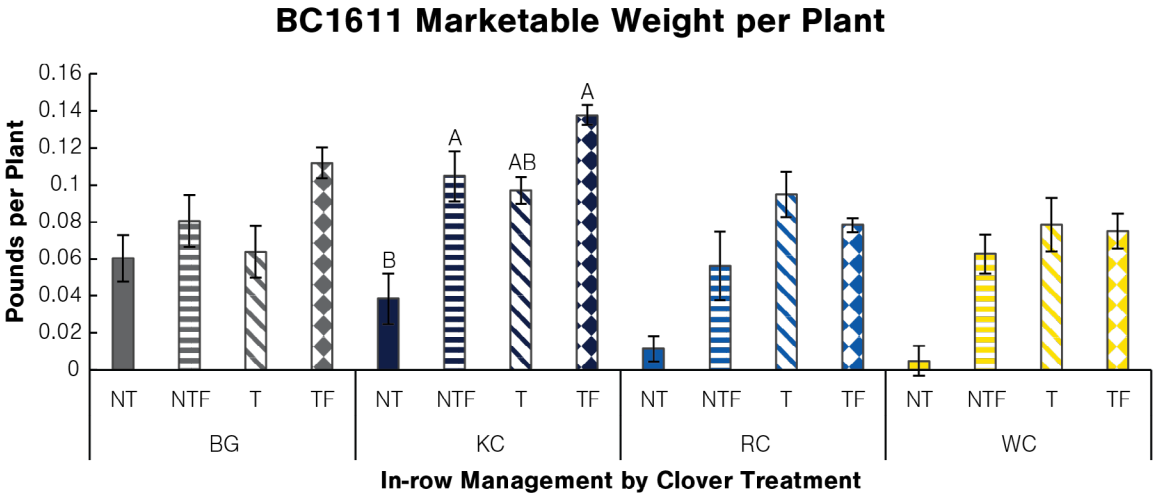

Figure 11. Marketable weight yield responds per plant of 'BC1611' broccolini from in-row management and clover treatments. BG= Bare ground, KC= Kura Clover, WC= White Clover, RC= Red Clover. TF= Tilled Fabric, T= Tilled no Fabric, NTF= No-till Fabric, NT= No-till No Fabric. Clover cultivar and management treatment used affected. Mean separations are affected within each clover treatment, RC (p = 0.0877), WC (p = 0.1298), KC (p = 0.0460) and BG (p = 0.1298). Values followed by the same letter within a column are not different from each other based on Fisher's protected least significant difference test (α = 0.05).

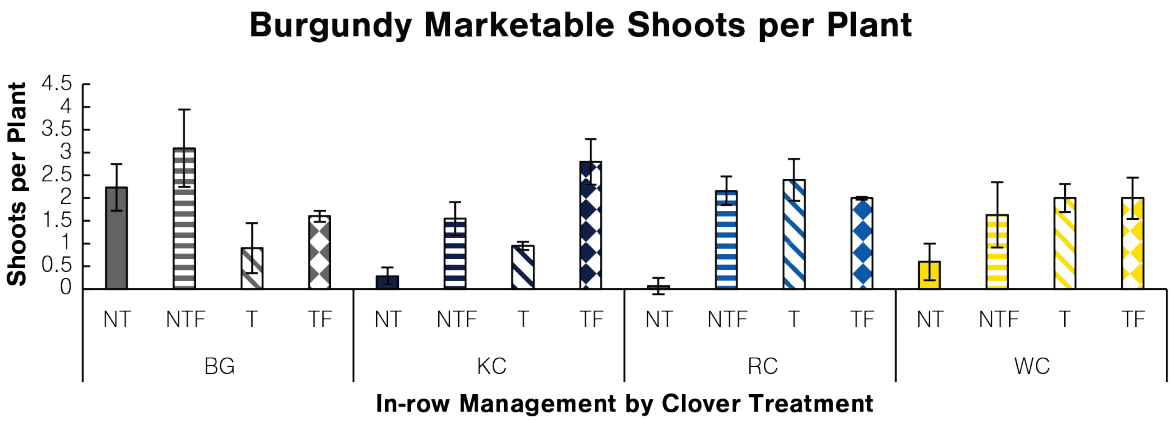

Figure 12. Marketable shoot yield responds per plant of 'Burgundy' broccolini from in-row management and clover treatments. BG= Bare ground, KC= Kura Clover, WC= White Clover, RC= Red Clover. TF= Tilled Fabric, T= Tilled no Fabric, NTF= No-till Fabric, NT= No-till No Fabric. Clover cultivar and management treatment used affected. Mean separations are affected within each clover treatment, RC (p = 0.1388), WC (p = 0.5723), KC (p = 0.1455) and BG (p = 0.3743). Values followed by the same letter within a column are not different from each other based on Fisher's protected least significant difference test (α = 0.05).

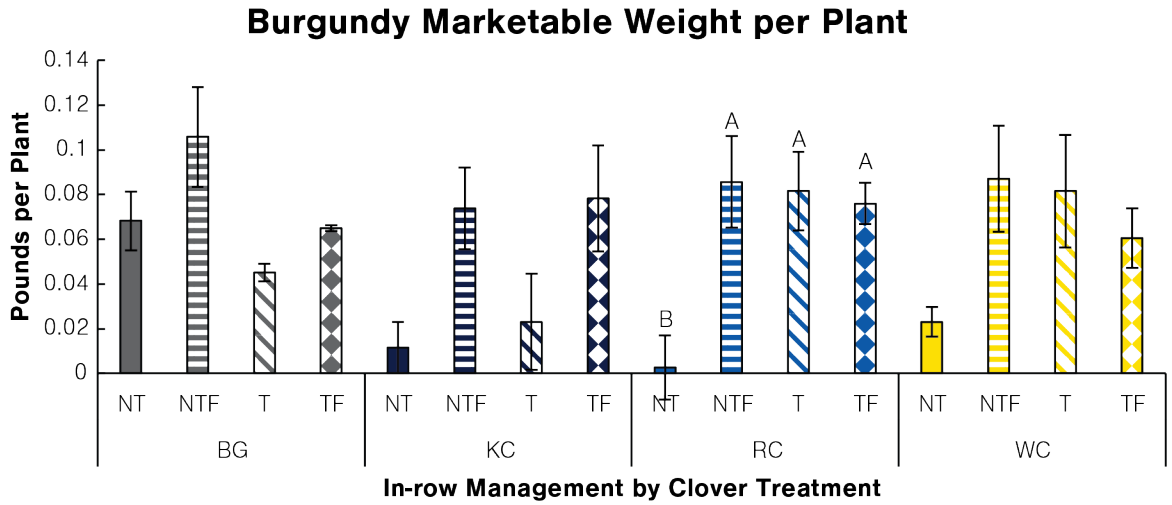

Figure 13. Marketable weight yield responds per plant of 'Burgundy' broccolini from in-row management and clover treatments. BG= Bare ground, KC= Kura Clover, WC= White Clover, RC= Red Clover. TF= Tilled Fabric, T= Tilled no Fabric, NTF= No-till Fabric, NT= No-till No Fabric. Clover cultivar and management treatment used affected. Mean separations are affected within each clover treatment, RC (p = 0.1572), WC (p = 0.0601), KC (p = 0.0003) and BG (p = 0.8804). Values followed by the same letter within a column are not different from each other based on Fisher's protected least significant difference test (α = 0.05).

Discussion

Once established, clover living mulch can reduce weed pressure in the pathways, which allows farmers to focues on the in-row weeding and maintenance, reducing labor requirements. In this study, all clovers accumulated more than 9000 lbs/ac biomass, which is 150% of the required biomass to show weed suppression (Fig. 14) (Pittman, 2020). Clover height had little to do with total biomass with all three-clovers having no difference in biomass per acre. WC and KC suppressed annual weeds better throughout the season, likely because of the prostrate growth habit. This allowed them to shade out any germinating weed seeds. Some perennial weeds did survive within the clover mulch. However, it is possible those perennials were already established so there will not be new perennials becoming established within the clover. Overall, clover living mulch greatly reduced the weed biomass throughout the season, reducing the labor and tillage input needed to control weeds. KC was shorter than WC making it more suitable for use in the in-row with NTF since it will be less likely to compete with the cash crop for light. RC is much taller than WC and KC, which makes it more competitive for light with the cash crop. The upright growth habit of RC allows annual weeds to germinate between the rows and compete with the cash crop. RC is not the ideal clover to use in a living mulch system and KC is the most ideal because of its competitive prostrate growth and short stature.

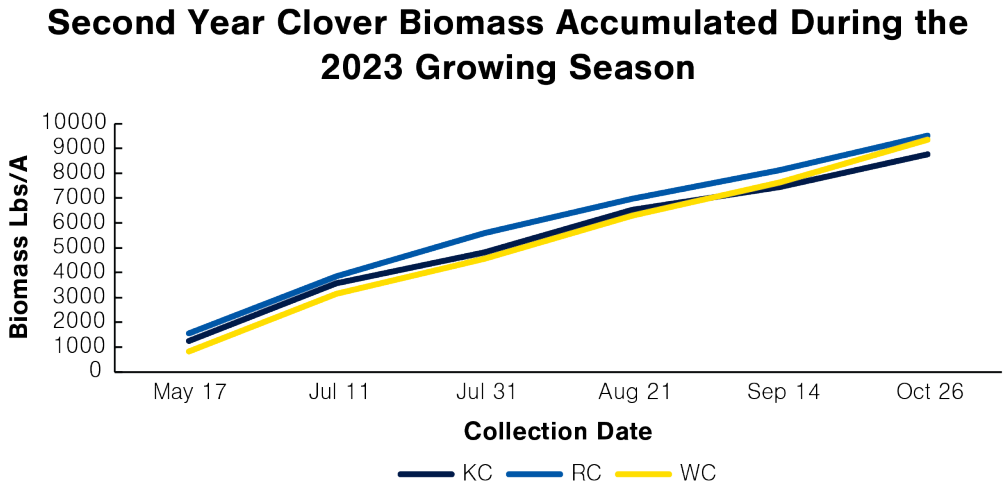

Figure 14. Broccolini whole plot clover biomass accumulated during the 2023 growing season. KC = Kura Clover, WC = White Clover, RC = Red Clover.

Many weed species were observed throughout the 2023 growing season (Table 5). Most of the annual weeds were controlled by the living mulch except for purslane and prostrate knotweed. Purslane and prostrate knotweed both have prostrate growth habit like the clover which prevents their management using mowing. Purslane has a thick waxy cuticle that makes it drought resistant which could allow it to thrive when other crops struggle.

Table 5. Weed observed during the 2023 season.

Perennial	Annual	
Dandelion	Yellow foxtail	Prostrate knotweed
Perennial sow thistle	Green foxtail	Barnyard grass
Canada thistle	Venice mallow	Purslane
Bull thistle	Giant crabgrass	Field pennycress

Broccolini has shown promise in producing marketable shoots in the T, TF, and NTF soil management treatments, with no difference between the treatments for the varieties tested. NT soil management treatments were not as appealing because of the reduction in marketable yield. Broccolini does not bolt as quickly as broccoli does when the daily temperature rises, allowing farmers to decrease risk. If Broccolini bolts, simply cut off the floret and wait for the next floret to harvest. Some chefs prefer some open florets for decorative purposes (Tong, 2022).

Water scarcity was a major issue in the 2023 growing season. The combination of NT soil management with a cover crop showed a large increase in water infiltrating the soil profile compared to other soil management treatments. This additional water can be beneficial to the cash crop in a year when precipitation is lacking.

'Melody' was the fastest maturing and short stature broccolini compared to the other three varieties. The later planting date made it so 'Melody' was harvested five times, 'BC1611' was harvested four times, and 'Burgundy' was harvested three times. 'BC1611' and 'Burgundy' both had larger apical florets than 'Melody', so if more plants had made it to harvest before the end of season both varieties may have caught or surpassed 'Melody' in shoots and weight of shoots per plant. This added time may explain statistical differences in the number of shoots and weight per plant in 'BC1611' and 'Burgundy.'

One of the advantages of using clover as living mulch is that it fixes nitrogen. This reduces the nitrogen fertilizer requirement for the cash crop. The clover is perennial and the presence of the cover crops in the ground prevents leaching of water-soluble nutrients. Adding a later season cover crop in-row in systems that continue to use tilled soil management could have similar advantages of a clover living mulch but decrease the yield reduction that no-till clover living mulch has on the cash crop. Finding the critical weed free period for horticultural crops might help in determining when the cover crops could be added without reducing the cash crop yield.

Conclusion

The use of a clover living mulch can effectively suppress weeds and reduce cultivation requirements and labor while improving soil health by adding nitrogen to the soil and increasing water infiltration rates. The use of broccolini in a living mulch system can be successful when in-row management includes TF, T, and NTF. Selecting a tolerant cash crop is essential in a living mulch to protect farmers from yield loss.

Acknowledgment

Funding for this ongoing work is, in part, from the USDA NIFA Organic Transitions and USDA Specialty Crop Block Grant Programs. Thank you to former and current undergraduate and graduate research assistants. Thank you to the SDSU Lang lab Undergraduate Research Assistants Trevor Ruen, Ashtyn Schultz, Ellie Fitzpatrick, Jacob Koch, Emily Guggisberg, Mackenzie Christopher, Ruth Wilford, and Johanna Livermore and the students of ABS 475 for their support during the 2023 field season.

References

Barnes, Alexis, Lang K., Burrows R., "Clover Cover Crops as a Living Mulch for Broccoli Production in Eastern South Dakota: 2022 Preliminary Results." SDSU Extension, 9 May 2023, extension.sdstate.edu/clover-cover-crops-living-mulch-broccoli-production-eastern-south-dakota-2022-preliminary-results.

Barnes, Alexis, Lang K., Burrows R., "How to Prepare Landscape Fabric for In-Row Weed Control for Flower and Vegetable Production." SDSU Extension, 5 June 2023, extension.sdstate.edu/how-prepare-landscape-fabric-row-weed-control-flower-and-vegetable-production.

"Broccoli for Processing Grades and Standards." Broccoli for Processing Grades and Standards | Agricultural Marketing Service, ams.usda.gov/grades-standards/broccoli-processing-grades-and-standards. Accessed 28 Feb. 2024.

Bruce, D., Silva, E. and Dawson, J., 2022. "Suppression of Weed and Insect Populations by Living Cover Crop Mulches in Organic Squash Production." Frontiers in Sustainable Food Systems, p.406.

Miles, Carol. "Broccolini." Vegetable Research & Extension Center, agsyst.wsu.edu/Broccolini.html. Accessed 28 Feb. 2024.

Pittman KB, Barney JN, Flessner ML. "Cover crop residue components and their effect on summer annual weed suppression in corn and soybean." Weed Science. 2020;68(3):301-310. doi:10.1017/wsc.2020.16

Tong, Cindy. "Broccolini Variety Trial Results." University of Minnesota Extension, 2 Nov. 2022, blog-fruit-vegetable-ipm.extension.umn.edu/2022/11/broccolini-variety-trial-results.html.

South Dakota State University Extension

SOUTH DAKOTA STATE UNIVERSITY®
AGRONOMY, HORTICULTURE & PLANT SCIENCE DEPARTMENT

P-00294