Chapter 4

Organic Weed Control and Cover Crop Residue Integration Impacts on Weed Control, Quality, Yield and Economics in Conservation Tillage Tomato-A Case Study

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Abstract

The increased adoption of conservation tillage and organic weed control practices in vegetable production requires more information on the role of various cover crops in integrated weed control, tomato quality, and yield. Two conservation-tillage systems utilizing crimson clover and cereal rye as winter cover crops were compared to a conventional black polythene mulch system, with or without organic weed management options, for weed control, tomato yield, and profitability. All cover crops were terminated with a mechanical roller/crimper prior to planting. Organic weed control treatments included: 1) flaming utilizing a one burner hand torch, 2) PRE application of corn gluten, 3) PRE application of corn gluten followed by flaming, or 4) intermittent hand weeding as needed. A non-treated control and a standard herbicide program were included for comparison. The herbicide program consisting of a PRE application of S-metolachlor (1.87 kg a.i./ha) followed by an early POST metribuzin (0.56 kg a.i. /ha) application followed by a late POST application of clethodim (0.28 kg a.i./ha). In general, high-residue clover and cereal rye cover crops provided substantial suppression of Palmer amaranth, large crabgrass, and yellow nutsedge. Across systems, minimum input in high-residue systems provided the highest net returns above variable costs compared to organic herbicide treatments that are costly and provide marginal benefit.

Keywords: Conservation agriculture, cover crop, fruit

1. Introduction

In recent years, growing concerns over the environmental impact of conventional agricultural practices, coupled with a surge in consumer demand for sustainably-produced products, have led to increased grower adoption of organic agriculture. In 2011, cropland in the United States (U.S.) dedicated to organic vegetable production totaled over 47 thousand ha [1]. Organically produced vegetable sales, were estimated at 1.07 billion USD in 2011 [1]. Given the steady rise in organic product interest and efforts to ensure agricultural sustainability, a substantial amount of research has been dedicated to organic fruit and vegetable production in order to guarantee successful adoption of these practices as an alternative to conventional agriculture.

Unlike conventional agricultural practices, an organic approach to agriculture eliminates the use of synthetic pesticides and fertilizers and, instead, relies on biological and cultural pesticide control and organic soil amendments such as manure and crop residue to maintain soil fertility [2]. The goal of organic agriculture includes producing food and fiber products in a manner that increases biodiversity, promoting soil health, and reducing environmental degradation due to agricultural practices. A number of ecological differences have been noted in previous research when comparing conventional and organic agriculture [3,4]. Comparisons of soil properties and pest population dynamics for organic and traditional farming practices note differences between these systems that affect the agroecosystem [3,4].

2. Case study

In the U.S. approximately 1.36 million tons of in the open, fresh market tomatoes, worth over 1.134 billion USD, were produced on nearly 41.2 thousand ha in 2014 [5]. Tomato production systems typically utilize conventional tillage, a bedded plastic mulch culture, and multiple herbicide applications to control weeds. These conventional tillage systems enhance soil erosion and nutrient loss by reducing rainfall infiltration [6]. Additionally, tillage increases aeration which increases the rate of organic matter mineralization in the surface soil, thus reducing soil organic matter content, soil cation exchange capacity and potential productivity [7, 8].

Plastic mulch can increase soil temperature which can expedite tomato harvest [9]. Tomato harvest was not early following a hairy vetch mulch system [10, 11]. The use of plastic mulches in sustainable or organic production systems is in question by some producers and consumers since the mulch itself is non-biodegradable and made of non-renewable resources. Another environmental disadvantage with using plastic mulch vs. organic mulches is increased chemical runoff from plastic mulch systems and subsequent offsite chemical loading [12]. Thus, the intensive use of pesticides in vegetable production has resulted in ecological concerns. Therefore, alternative production practices that reduce tomato production inputs while maintaining yield and quality are desired.

One alternative for alleviating the aforementioned concerns is the use of high residue cover crops combined with reduced tillage. Cover crops in conservation-tillage systems can be

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terminated during early reproductive growth by mechanically rolling and treating with burndown herbicides to leave a dense mat of residue (> 4,500 kg/ha) on the soil surface into which cash crops are planted [13, 14]. Adoption of high residue cover crops is increasing in southeastern U.S. corn (*Zea mays* L.) and cotton (*Gossypium hirsutum* L.) row crop systems [15, 16, 17, 18, 19, 20]. Because the southeastern U.S. typically receives adequate rainfall in the winter months, timely planted winter cover crops can attain relatively high maturity and biomass before termination. Cover crops can enhance the overall productivity and soil quality by increasing organic matter and nitrogen content [21], as well as aid in water conservation by increasing soil water infiltration rates [22]. Additionally, previous research has also focused on weed control provided by high residue cover crops in both field and vegetable crops [23, 24, 25].

Winter cover crop biomass can affect subsequent early season weed control [26, 27]. Cover crop residue facilitates weed control by providing an unfavorable environment for weed germination and establishment under the residue as well as allelopathy [28, 29]. Teasdale and Daughtry [30] reported 52–70% reduction in weed biomass with live hairy vetch cover crop compared to a fallow treatment owing to changes in light and soil temperature regimen under the vetch canopy. Teasdale and Mohler [27] reported that legume mulches such as crimson clover and hairy vetch (*Vicia villosa* Roth) suppressed redroot pigweed (*Amaranthus retroflexus* L.) at an exponential rate as a function of residue biomass.

However, adoption of cover crops in tomato production has been limited because (1) currently available transplanters have problems penetrating heavy residue and (2) heavy cover crop residue can intercept delivery of soil-active herbicides. Research in the last two decades has extensively debated the advantages and disadvantages of cover crops vs. conventional plastic mulch systems for tomato production. Better or comparable tomato yields with hairy vetch cover crop system have been reported compared to the conventional polyethylene mulch system [31, 32]. Akemo et al. [33] also reported higher tomato yield with spring sown cover crops than the conventionally cultivated check. However, weed control with cover crops varies with cover crop species, amount of residue produced, and environmental conditions. Teasdale [28] reported that biomass levels achieved by cover crops before termination was sufficient only for early season weed control. Supplemental weed control measures are usually required to achieve season long weed control and to avoid yield losses [34, 23].

Cereal rye and crimson clover are two common winter cover crops widely used in the southeastern U.S. Both cover crops contain allelopathic compounds and produce residues that inhibit weed growth [15, 29, 35]. Brassica cover crops are relatively new in the southeastern U.S. but are becoming increasingly popular due to their potential allelopathic effects. Therefore, the objectives of this research were to evaluate: 1) weed control in two different high residue cover crop conservation tillage systems utilizing the Brazilian [13] high residue cover crop management system including cover crop rolling and 2) tomato stand establishment, yield, and net returns of conservation-transplanted tomatoes compared to the polythene mulch system following three different organic herbicide management systems.

3. Materials and methods

Field Experiment. The experiment was established in autumn 2006 at the North Alabama Horticulture Experiment Station, Cullman, AL on a Hartsells fine sandy loam soil (Fine-loamy, siliceous, sub-active, thermic Typic Hapludults). The experimental design was a randomized complete block with four replicates. Plot size at both locations was 1.8 by 6 m containing a single row of tomatoes with a 0.5 m spacing between plants.

The two winter cover crops (cereal rye cv Elbon and crimson clover cv AU Robin) were compared to black polythene mulch for their weed suppressive potential and effect on yield and grade of fresh market tomatoes. Winter cover crops were planted with a no till drill in the fall. Rye was seeded at a rate of 100 kg/ha, whereas clover was seeded at 28 kg/ha. Since the overall objective was to evaluate weed control practices, general production practices included staking, traditional plant pest and plant pathogen methods, and fertilization was utilized to exclude any other pest and fertilization interactions and is a limitation of this case study. Nitrogen was applied at a rate of 67 kg/ha on rye plots in early spring of each year. Cover crops were terminated at flowering stage in late spring. To determine winter cover crop biomass production, plants were clipped at ground level from one randomly selected 0.25 m^2 area per replicate immediately before termination. Plant samples were dried at 65 C for 72 hours and weighed. Cover crops were terminated with a mechanical roller crimper prior to an application of glyphosate at 1.12 kg a.e. /ha^{-1}. The rolling process produced a uniform residue cover over the plots.

All three systems (two winter cover crops plus plastic mulch) were evaluated with and without herbicide for weed control. Organic weed control treatments included: 1) flaming utilizing a one burner hand torch, 2) PRE application of corn gluten, 3) PRE application of corn gluten followed by flaming, or 4) intermittent hand weeding as needed. A non-treated control and a standard herbicide program were included for comparison. The herbicide program consisting of a PRE application of S-metolachlor (1.87 kg a.i. ha^{-1}) followed by an early POST (EPOST) metribuzin (0.56 kg a.i. ha^{-1}) application followed by a late POST (LPOST) application of clethodim (0.28 kg a.i.ha^{-1}). The PRE corn gluten application occurred immediately after tomato transplanting while the PRE herbicide application occurred prior to placing the plastic on top of the beds, the EPOST application was applied two weeks after transplanting, and the LPOST application was delayed until tomatoes were near mid-bloom. Flaming and hand hoeing was accomplished one week after transplanting and subsequently every two weeks following until harvest. Tomato cv. ‘Florida 47’ seedlings were transplanted on April 12, 2007.

Tomato seedlings were planted with a modified RJ no-till transplanter (RJ Equipment, Blenhiem, Ontario, Canada), which included a subsoiler shank installed to penetrate the heavy residue and disrupt a naturally occurring compacted soil layer found at both experimental sites at a depth of 30-40 cm. Additionally, two driving wheels were utilized (one wheel on each side of the tomato row) instead of the original single wheel at the center of the row, to improve stability and eliminate drive wheel re-compaction of the soil opening created by the shank. The plastic-mulch plots were conventionally tilled utilizing a tractor mounted rototiller prior to bedding and plastic installation; tomatoes were hand transplanted in the plastic mulch each

http://dx.doi.org/10.5772/61315

year. Water was applied to all the plots immediately after transplanting. Thereafter, plots were irrigated every other day using a surface drip tape. Fertilizer 13-13-13 was applied prior to planting achieving 448 kg of N/ha^{-1} and then 7.8 kg of calcium nitrate ha^{-1} was applied once every week with the irrigation system.

Weed control was evaluated by visual ratings (0% = no control, 100% = complete control) 28 days after treatment (DAT) of the EPOST herbicide application. All weed species present were evaluated for control (as a reduction in total above ground biomass resulting from both reduced emergence and growth). Stand establishment was determined by counting the number of living tomato plants in each plot two weeks after LPOST application. Ripe tomatoes were hand harvested from the entire plot area in weekly intervals and sorted according to size (small, medium, large, and extra large categories).

Statistical Analysis. Non-normality and heterogeneous variances were encountered with percent control data. Various approaches were tried to alleviate these statistical problems and the arcsine transformation was deemed the best compromise between achieving normality of residuals and among treatment homogeneity of variances. The transformed data were subjected to mixed models analysis of variance as implemented in JMP statistical software. Years, organic herbicide treatments and ground cover treatments were considered fixed effects while their interaction with treatment replication was considered random effects. Differences between treatments means were determined by Fisher's protected LSD (α = 0.05).

Economic analysis. Net returns above variable treatment costs (NRAVTC) were estimated as the difference between revenues and variable treatment costs (US$ ha^{-1}). The average weekly dollar per box (assuming an 11.34 kg box^{-1}) price for the four harvest weeks was used to calculate revenue by grade (i.e., small, medium, large, and extra-large). The weekly prices were from domestic suppliers at the terminal market in Atlanta, Georgia [36]. Low- and high-end prices from 2007 were reported for each grade category from suppliers (domestic suppliers aggregated by State), excluding international suppliers. The low-end and high-end tomato prices by size were the average of prices in 2007 across suppliers, and are presented in Table 1. All prices were reported in 2007 US$.

Tomato Size	Low-end Price	High-end Price	Mean
	US$ box^{-1}		
Small	10.06	10.69	10.38
Medium	9.47	10.14	9.81
Large	9.34	9.99	9.67
Extra-large	9.41	10.28	9.85
Mean	9.57	10.58	

Table 1. Tomato prices by size by low-end and high-end price.

The average marketing year price, regardless of organic certification, received by producers in Alabama in 2007 for fresh market tomatoes across all sizes (7.21 US$ box^{-1}). For organically produced tomatoes, the average price received by Alabama producers for organic tomatoes in 2008 of 9.32 US$ box^{-1} across all sizes [37]. Data for organic tomatoes was not available in 2007. Therefore, the low-end prices by size were used in the analysis.

Productions costs for the three covers and five weed control treatments were adapted from 2008 tomato enterprise budgets [38] and experiment specific treatment costs. A partial budgeting approach was used to calculated variable treatments costs; therefore, the only costs considered were costs that differed by treatment and costs that varied by yield (Table 2). Costs that vary by yield include harvest costs, as well as grading and packing labor costs. Fixed costs, such as management costs, rent, and depreciation on machinery and buildings, differ by operation; therefore, they were not included in the analysis.

Weed Control	Cover Type		
	Plastic	Rye	Clover
	US$ ha^{-1}		
No Treatment	2226	505	376
Handweed	3658	1937	1808
Flame Corn Gluten	12935	11214	11085
Flame	2859	1138	1009
Herbicide	2392	671	542

Table 2. Variable treatment costs (excluding costs that vary by yield).

4. Results and discussion

Cover Crop Biomass. The quantity of cover crop biomass produced at both locations differed among cover crops, with rye producing 9363 kg/ha, and crimson clover producing 5481 kg/ha of dry matter.

Weed Control. The major weeds in the cover crop and plastic mulch plots included Palmer amaranth (*Amaranthus Palmeri* L.), large crabgrass (*Digitaria sanguinalis* L.), and yellow nutsedge (*Cyperus esculentus* L.).

Palmer amaranth. Early *Palmer amaranth* control averaged over weed management systems, clover and rye cover treatments provided excellent *Palmer amaranth* control (90 and 96% respectively) compared to the conventional plastic system (5% control) (Table 3). The plastic system provides some inherent weed control regardless of additional inputs, however, it provided no weed control in the punched holes and the area adjacent the bed. *Palmer amaranth* control in clover utilizing corn gluten and flaming was equivalent to the clover plus

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herbicide standard. *Palmer amaranth* in rye utilizing all organic methods excluding hand weeding provided weed control equivalent to the rye plus herbicide standard. Late *Palmer amaranth* control ratings generally remained stable except increases for plastic due to the inherent control discussed above.

Large Crabgrass. Early crabgrass control averaged over weed management system reflected control similar to Palmer amaranth, clover and rye cover treatments provided excellent crabgrass control (92 and 98% respectively) compared to the conventional plastic system (5% control) (Table 4). All rye systems provided excellent control. Late season crabgrass control was generally higher than that of *Palmer amaranth*.

Yellow nutsedge. Early yellow nutsedge control averaged over weed management systems reflected control similar to Palmer amaranth and large crabgrass with clover systems providing an average 93% control and rye systems providing an average 95% control. Control in both clover and rye systems was excellent regardless of treatment revealing that winter cover crops suppress nutsedge in high-residue systems.

	% Weed Control					
	Early Control			Late Control		
Cover	**Pigweed**	**Crabgrass**	**Nutsedge**	**Pigweed**	**Crabgrass**	**Nutsedge**
Clover	90[a]	92[a]	93[a]	92[a]	98[a]	98[a]
Rye	96[a]	98[a]	95[a]	88[a]	97[a]	98[a]
Plastic	5[b]	5[b]	5[b]	33[b]	37[b]	43[b]
LSD (α = 0.10)	7	13	9	12	14	13
Weed Control[1]						
1	63[ba]	64[a]	63[ba]	60[b]	71[a]	73[ba]
2	57[b]	61[a]	64[ba]	73[ba]	81[a]	82[ba]
3	61[ba]	61[a]	55[b]	77[ba]	80[a]	82[ba]
4	65[ba]	65[a]	66[ba]	61[b]	65[a]	66[b]
5	72[a]	72[a]	74[a]	86[a]	87[a]	96[a]
LSD (α = 0.10)	10	10	12	15	18	17
Combination						
Clover 1	93[a]	96[a]	90[a]	88[a]	97[a]	98[a]
Clover 2	80[a]	86[a]	93[a]	92[a]	98[a]	98[a]
Clover 3	85[a]	85[a]	86[a]	91[a]	98[a]	99[a]
Clover 4	97[a]	97[a]	99[a]	92[a]	97[a]	98[a]
Clover 5	97[a]	96[a]	97[a]	99[a]	99[a]	98[a]
Plastic 1	0[b]	0[b]	0[b]	6[b]	20[bc]	23[b]

	% Weed Control					
	Early Control			Late Control		
Cover	**Pigweed**	**Crabgrass**	**Nutsedge**	**Pigweed**	**Crabgrass**	**Nutsedge**
Plastic 2	0[b]	0[b]	0[b]	49[ba]	50[bac]	50[ba]
Plastic 3	0[b]	0[b]	0[b]	50[ba]	50[bac]	50[ba]
Plastic 4	0[b]	0[b]	0[b]	0[b]	0[c]	0[b]
Plastic 5	23[b]	23[b]	25[b]	61[a]	65[ba]	90[a]
Rye 1	97[a]	97[a]	98[a]	86[a]	97[a]	99[a]
Rye 2	92[a]	97[a]	98[a]	79[a]	96[a]	99[a]
Rye 3	97[a]	99[a]	81[a]	90[a]	94[a]	96[a]
Rye 4	98[a]	99[a]	99[a]	90[a]	98[a]	99[a]
Rye 5	96[a]	98[a]	99[a]	98[a]	99[a]	99[a]
LSD (α = 0.10)	17	17	21	27	31	29

[1]Weed control methods are as follows: (1) non-treated; (2) hand-weeded; (3) corn gluten + flame; (4) flame; and (5) herbicide.

Table 3. Weed Response to Cover Crops and Weed Control Methods – North Alabama Horticultural Research Center 2007.

Yield

Aside from the herbicide treatment, greater than 20% of the total tomato yield were cull tomatoes under plastic cover.

	Tomato Yield (kg/ha)						
Cover	**Cull**	**S**	**M**	**L**	**XL**	**Total**	**Market[2]**
Clover	5577[a]	4838[a]	9906[a]	12298[a]	263[a]	32883[a]	27305[a]
Rye	5479[a]	4778[a]	9649[a]	11031[a]	272[a]	31210[a]	25731[a]
Plastic	4226[b]	2599[b]	4566[b]	7526[b]	158[a]	19074[b]	14848[b]
LSD (α = 0.10)	612	576	1078	1931	197	3254	2931
Weed Control[1]							
1	4159[c]	4006[a]	6669[b]	7149[c]	283[ba]	22266[c]	18107[c]
2	5112[bac]	4634[a]	8220[b]	8466[cb]	54[b]	26486[cb]	21374[cb]
3	5554[ba]	4003[a]	8355[b]	11248[b]	241[ba]	29402[b]	23848[b]
4	4547[bc]	3871[a]	6471[b]	6565[c]	58[b]	21512[c]	16966[c]
5	6098[a]	3845[a]	10486[a]	17996[a]	518[a]	38944[a]	32846[a]

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	Tomato Yield (kg/ha)						
Cover	**Cull**	**S**	**M**	**L**	**XL**	**Total**	**Market**[2]
LSD (α = 0.10)	790	744	1392	2493	255	4201	3784
Combination							
Clover 1	5076^{bac}	4972^{bdac}	9197^{bdac}	10390^{bedc}	240^{a}	29874^{bc}	24799^{bc}
Clover 2	6204^{a}	6395^{a}	10218^{bdac}	10004^{bedc}	161^{a}	32982^{bac}	26779^{bac}
Clover 3	5673^{ba}	5315^{bac}	10814^{bac}	11284^{bc}	194^{a}	33280^{bac}	27608^{bac}
Clover 4	4233^{bac}	381^{ebdc}	7463^{bdc}	8029^{edc}	125^{a}	23660^{edc}	19427^{dc}
Clover 5	6702^{a}	3698^{ebdc}	11838^{ba}	21782^{a}	594^{a}	44615^{a}	37913^{a}
Plastic 1	2974^{c}	2107^{e}	2226^{e}	2629^{ed}	0^{a}	9937^{e}	6963^{d}
Plastic 2	4556^{bac}	2676^{ed}	5953de	8388^{edc}	0^{a}	21574^{edc}	17018^{dc}
Plastic 3	5098^{bac}	2838^{edc}	5693de	10491^{bdc}	238^{a}	24357^{dc}	19259^{dc}
Plastic 4	3494^{bc}	2143^{e}	2668^{e}	1892^{e}	0^{a}	10197^{ed}	6703^{d}
Plastic 5	5006^{bac}	3229^{ebdc}	6289^{dec}	14228^{bac}	552^{a}	29304^{bc}	24297^{bc}
Rye 1	4428^{bac}	4937^{bdac}	8584^{bdc}	8429^{edc}	610^{a}	26988^{c}	22560^{c}
Rye 2	4577^{bac}	4831^{bdac}	8490^{bdc}	7005^{edc}	0^{a}	24902^{c}	20325^{c}
Rye 3	5892^{ba}	3855^{ebdc}	8559^{bdc}	11970^{bc}	292^{a}	30567^{bac}	24676^{bc}
Rye 4	5913^{ba}	5659^{ba}	9283^{bdac}	9775^{bedc}	50^{a}	30679^{bac}	24767^{bc}
Rye 5	6587^{a}	4608^{ebdac}	13332^{a}	17978^{ba}	409^{a}	42913^{ba}	36327^{ba}
LSD (α = 0.10)	1368	1288	2410	4319	441	7277	6554

[1]Weed control methods are as follows: (1) non-treated; (2) hand-weeded; (3) corn gluten + flame; (4) flame; and (5) herbicide.

[2]Market is the marketable yield calculated by subtracting the culls from the total.

Table 4. Tomato Yield Response to Cover Crops and Weed Control Methods - North Alabama Horticultural Research Center 2007.

Economics

All treatments produced numerically higher NRVTC than the control, with the exception of plastic cover with flame treatment (Table 5). The clover cover and herbicide treatment produced the highest NRAVTC in 2007, followed by rye cover and herbicide treatment (Table 6). Both the non-treated control combined with clover and rye, as well as flame and hand-weeded treatments with clover cover, yielded higher NRAVTC than plastic with herbicide treatment. Across all cover treatments, corn gluten + flame had the lowest NRAVTC. The performance of corn gluten + flame was directly related to the cost of the corn gluten. As discussed above the corn gluten + flame weed control with clover cover had the third highest market tomato yields.

While total market yield is an important indicator of net returns, the distribution of tomatoes by size determines the level of revenue depending on the price by size. The price for each size is driven by the supply of each type of size and when the tomatoes are harvested during the season. This analysis did not consider harvest period in the revenue determination.

Cover Type	Weed Control[1]	NRAVTC[2] Mean	NRAVTC[2] SD	Difference from Control[3]
		(US$ ha^{-1})		
Clover	1	4680	1568	2254
	2	3718	1524	1293
	3	-5465	702	-7890
	4	2951	1526	525
	5	6910	1167	4485
Plastic	1	-769	421	-3194
	2	-245	2079	-2671
	3	-9088	1809	-11513
	4	-1439	480	-3865
	5	2426	549	0
Rye	1	4130	625	1704
	2	2262	651	-164
	3	-6261	1024	-8686
	4	3954	1663	1528
	5	6563	261	4137

[1] Weed control methods are as follows: (1) non-treated; (2) hand-weeded; (3) corn gluten + flame; (4) flame; and (5) herbicide.

[2] Net returns above variable treatment cost (NRAVTC); standard deviations are shown in parentheses.

[3] The control is plastic cover with no weed control.

Table 5. Net returns above variable treatment costs by treatment and the difference between treatments and the control.

This research demonstrates that high residue cover crops like cereal rye and clover can provide improved weed control compared to black polyethylene mulch. Previous research has also reported improved weed control with increased biomass production by cover crops [39]. Increased weed control has also been observed by Nagabhushna et al. [40] with an increase in the seeding rate of rye. Another important factor which could have facilitated increased weed control by rye and clover residue is rolling with mechanical roller crimper. The rolling process resulted in a uniform mat of residue on the soil surface that was a substantial physical barrier for weed seedlings to emerge through compared to tomato plant openings in the plastic mulch system that provides no barrier. Yenish et al. [41] also reported inconsistent control with cover crop residue and concluded herbicides were always required to achieve optimum weed control in corn. However, Yenish et al. cautioned weed control should not be the only criterion in selection of cover crops. Factors like cost and ease of establishment, impact on yield should be taken into consideration before selecting a cover crop. Results in this paper are short term effects of converting from a conventional plastic mulch system to two high-residue conservation tillage systems. These results indicate the economic possibility of growing fresh market tomatoes utilizing a conservation tillage system while maintaining yields and economic returns. However, the long term impact of these systems on yield and profitability require further investigation.

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References

[1] United States Department of Agriculture. 2015. Quick States 2.0. http://quickstats.nass.usda.gov/.

[2] Lammerts van Bueren, E. T., S. S. Jones, L. Tamm, K. M. Murphy, J. R. Myers, C. Leifert, and M. M. Messmer. 2011. The need to breed crop varieties suitable for organic farming, using wheat, tomato and broccoli as examples: A review. NJAS-Wageningen Journal of Life Sciences. 58:193-205.

[3] Madden, N. M., J. P. Mitchell, W. T. Lanini, M. D. Cahn, E. V. Herrero, S. Park, S. R. Temple, and M. van Horn. 2004. Evaluation of conservation tillage and cover crop systems for organic processing tomato production. HortTechnology 14:243:250.

[4] Drinkwater, L. W., D. K. Letourneau, F. Workneh, A. H. C. van Bruggen, and C. Shennan. 1995. Fundamental differences between conventional and organic tomato agroecosystems in California. Ecological Applications. 5:1098-1112.

[5] United States Department of Agriculture. 2015. Quick States 2.0. http://quickstats.nass.usda.gov/. Accessed: July 28, 2015.

[6] Blough, R. F., A. R. Jarrett, J. M. Hamlett and M. D. Shaw. 1990. Runoff and erosion rater from silt, conventional, and chisel tillage under simulated rainfall. Transactions of ASAE. 33:1557–1562.

[7] Franzluebbers, A.J., G.W. Langdale, and H.H.Schomberg. 1999. Soil carbon, nitrogen, and aggregation in response to type and frequency of tillage. Soil Sci. Soc. Am. J. 63:349–355.

[8] Mahboubi, A.A., R. Lal, and N.R. Faussey. 1993. Twenty-eight years of tillage effects on two soils in Ohio. Soil Sci. Soc. Am. J. 57:506–512.

[9] Teasdale, J.R.and A.A. Abdul-Baki. 1995. Soil temperature and tomato growth associated with black polythene and hairy vetch mulches. J. Amer. Soc. Hort. Sci. 120:848-853.

[10] Abdul-Baki. A.A., J.R. Teasdale, R. Korcak, D.J. Chitwood, and R.N. Huettel. 1996. Fresh-market tomato production in a low-input alternative system using cover crop mulch. HortScience. 31:65-69.

[11] Teasdale, J.R.and A.A. AbdulBaki. 1997. Growth analysis of tomatoes in black plastic and hairy vetch production systems. Hortscience. 32:659-663.

[12] Arnold, G. L., M. W. Luckenbach, and M. A. Unger. 2004. Runoff from tomato cultivation in the estuarine environment: biological effects of farm management practices. J Exp Marine Biol and Ecol. 2:323-346.

[13] Derpsch, R., C. H. Roth, N. Sidiras, and U. Köpke. 1991. Controle da erosão no Paraná, Brazil: Sistemas de cobertura do solo, plantio directo e prepare conservacionista do solo. Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, Eschborn, SP 245, Germany.

[14] Reeves, D.W. 2003. A Brazilian model for no-tillage cotton production adapted to the southeastern USA. Proc. II World Congress on Conservation Agriculture- Producing in Harmony with Nature. Iguassu Falls, Paraná, Brazil. Aug 11-15, 2003:372-374.

[15] Price, A.J., C. D. Monks, A. S. Culpepper, L. M. Duzy, J. A. Kelton, M. W. Marshall, L. E. Steckel, L.M. Sosnoskie and R. L. Nichols. High Residue Cover Crops Alone or with Strategic Tillage to Manage Glyphosate-Resistant Palmer amaranth (Amaranthus palmeri) in Southeastern Cotton (Gossypium hirsutum). Journal of Soil and Water Quality. (in press).

[16] Aulakh, J.S. M., Saini, A.J. Price, W.H. Faircloth, E. van Santen, G.R. Wehtje, and J.A. Kelton. 2015. Herbicide and Rye Cover Crop Residue Integration Affect Weed Control and Yield in Strip-Tillage Peanut. Peanut Sci. 42:30-38.

[17] Price, A. J., K. S. Balkcom, L. M. Duzy, and J. A. Kelton. 2012. Herbicide and cover cop residue integration for Amaranth control in conservation agriculture cotton. Weed Technol. 26:490-498

[18] Price, A.J., D.W. Reeves, and M.G. Patterson. 2006. Evaluation of weed control provided by three winter cereals in conservation-tillage soybean. Renewable Agric. and Food Systems. 21:159-164.

[19] Reeves, D.W., A.J. Price, and M.G. Patterson. 2005. Evaluation of three winter cereals for weed control in conservation-tillage nontransgenic cotton. Weed Technol. 19: 731-736.

[20] Sainju, U.M., and B.P. Singh. 2001. Tillage, cover crop, and kill-planting date effects on corn yield and soil nitrogen. Agron. J. 93: 878–886

[21] Sainju, U.M., B.P. Singh, and W.F. Whitehead. 2002. Long-term effects of tillage, cover crops, and nitrogen fertilization on organic carbon and nitrogen concentrations in sandy loam soils in Georgia, USA. Soil Till. Res. 63:167-179.

[22] Arriaga, F.J. and K.S. Balkcom. 2006. Benefits of conservation tillage on rainfall and water management. In: Hatcher, K. J., editor. Proceedings of the 2005 Georgia Water Resources Conference, April 25-27, 2005.

[23] Teasdale, J.R.and A.A. Abdul-Baki. 1998. Comparison of mixtures vs. monocultures of cover crops for fresh-market tomato production with and without herbicide. Hortscience. 33:1163-1166.

[24] Creamer, N.G., M.A. Bennett, and B.R. Stinner. 1997. Evaluation of cover crop mixtures for use in vegetable production systems. HortScience. 32:866-870.

[25] Price, A. J. and J. K. Norsworthy. 2013. Cover crop use for weed management in Southern reduced-tillage vegetable cropping systems. Weed Technol. 27:212-217.

[26] Saini, M., A. J. Price, and E. van Santen. 2006. Cover crop residue effects on early-season weed establishment in a conservation-tillage corn-cotton rotation. 28th Southern Conservation Tillage Conference 28:175-178.

[27] Teasdale, J.R.and C.L. Mohler. 2000. The quantitative relationship between weed emergence and the physical properties of mulches. Weed Sci. 48:385-392.

[28] Price A.J., M.E. Stoll, J.S. Bergtold, F.J. Arriaga, K.S. Balkcom, T.S. Kornecki, and R.L. Raper. 2008. Effect of cover crop extracts on cotton and radish radicle elongation. Comm. Biometry Crop Sci. 3:60-66.

[29] Teasdale, J.R. 1996. Contribution of cover crops to weed management in sustainable agricultural systems. J. Prod. Agric. 9:475-479.

[30] Teasdale JR & Daughtry CST (1993) Weed control by live and desiccated hairy vetch (Vicia villosa). Weed Science 41, 207 212

[31] Abdul-Baki A.A., and J.R. Teasdale. 1993. A no-tillage tomato Production system using hairy vetch and subterranean clover mulches. HortScience. 28:106-108.

[32] Abdul-Baki, A.A., J.R. Teasdale, R.W. Goth, and K.G. Haynes. 2002. Marketable yields of fresh-market tomatoes grown in plastic and hairy vetch mulches. HortScience. 37:878-881.

[33] Akemo, M.C., M.A. Bennett, and E.E. Regnier. 2000. Tomato growth in spring-sown cover crops. HortScience. 35:843-848.

[34] Masiunas, J.B., L.A. Weston, and S.C. Weller. 1995. The impact of rye cover crops on weed populations in a tomato cropping system. Weed Sci. 43:318-323.

[35] Barnes, J.P. and A.R. Putnam. 1983. Rye residues contribute weed control in no-tillage cropping systems. J. of Chem. Ecol. 9:1045-1057.

[36] USDA. 2015. Fruit and Vegetable Market News. Agricultural Marketing Service, United States Department of Agriculture (USDA). Available at Web site https://www.marketnews.usda.gov/mnp/fv-home (verified August 3, 2015).

[37] USDA. 2015. Quick Stats. National Agricultural Statistics Service, United States Department of Agriculture (USDA). Available at Web site http://quickstats.nass.usda.gov/ (verified August 3, 2015).

[38] MSU. 2007. Traditional and organic vegetables 2008 planning budgets. Budget Report 2007–08. Department of Agricultural Economics, Mississippi State University (MSU). Available at website http://www.agecon.msstate.edu/whatwedo/budgets/archive.asp (verified August 3, 2015)

[39] Mohler, C. L. and J. R. Teasdale. 1993. Response of weed emergence to rate of Vicia villosa Roth and Secale cereale L. residue. Weed Res. 33:487–499.

[40] Nagabhushana, G.G., A.D. Worsham, and J.P. Yenish. 2001. Allelopathic cover crops to reduce herbicide use in sustainable agricultural systems. Allelopathy J. 8:133-146.

[41] Yenish, J.P., A.D. Worsham, and A.C. York. 1996. Cover crops for herbicide replacement in no-tillage corn (Zea mays). Weed Technol. 10:815-821.