Title:

Demonstrating the Impact of Brassica Cover Crops on Soil Management and Plant Health and Quality in Small Fruit Plantings in the Mid-South

Name, Mailing and Email Address of Principal Investigator(s):

Investigator
Zach Hansen, Asst. Prof., Extension Specialist, Dept. Ento. & Plant Path. G059 McCord Hall, 2640 Morgan Cir. Dr. Knoxville, TN 37996 zhansen1@utk.edu
Natalie Bumgarner, Assoc. Prof., Extension Specialist, Dept. Plant Sciences 252 Ellington Plant Sciences, 2431 Joe Johnson Dr. Knoxville, TN 37996 nbumgarn@utk.edu
Virginia Sykes, Asst. Prof., Extension Specialist, Dept. Plant Sciences 252 Ellington Plant Sciences, 2431 Joe Johnson Dr. Knoxville, TN 37996 vsykes@utk.edu
David Lockwood, Prof., Extension Specialist, Dept. of Plant Sciences 252 Ellington Plant Sciences, 2431 Joe Johnson Dr. Knoxville, TN 37996 lockwood@utk.edu
David Butler, Assoc. Prof., Plant Sciences 112 Plant Biotech, 2505 EJ Chapman Dr Knoxville, TN 37996 dbutler@utk.edu
Melody Rose, Extension Agent III, UT Greene County Extension 204 North Cutler Street Greeneville, TN 37745 mteague@utk.edu

Public Abstract:

In Tennessee and many areas of the mid-south, small to mid-scale small fruit production may be only a portion of the farm operation. These farms are often diverse in terms of crops, marketing methods, and sales niches. So, it is not uncommon for new or diversifying growers to install plantings without being able to invest in optimum soil preparation on the site. In some cases, site limitations such as sloping fields and highly erodable soil may preclude utilization of established practices such as deep plowing to incorporate lime or sulfur, organic amendments, and nutrients to desired depths. Likewise, older or previously unmanaged plantings may be salvaged if pH levels higher than optimum or organic matter levels lower than optimum are able to be addressed. Currently, post-planting adjustment of pH, soil nutrients, and organic matter levels can be a significant challenge in perennial cropping systems. One potential option for addressing these soil management needs of fruit growers could be the use of winter cover crops. To address these questions and provide

demonstration areas to implement and evaluate these cover crop practices, this project will demonstrate the potential impact of a brassica and a cereal cover crop on soil and plants in a young blueberry planting.

Introduction:

Many small fruit growers in Tennessee and other states in the mid-south are small to moderate in scale. For example, according to USDA-NASS, the average blueberry grower in Tennessee has around 1 acre of production. These smaller operations are often diverse in terms of crops, marketing methods, and sales niches. So, it is not uncommon for new or diversifying growers to install plantings without being able to invest in optimum soil preparation on the site. In some cases, site limitations such as sloping fields and highly erodable soil may preclude utilization of established practices such as deep plowing to incorporate lime, organic amendments, and nutrients to desired depths. Likewise, older or previously unmanaged plantings may be salvaged if pH levels higher than optimum or organic matter levels lower than optimum are able to be addressed. Currently, post-planting adjustment of pH, soil nutrients, and organic matter levels can be a significant challenge in perennial cropping systems.

One potential option for addressing these soil management needs of fruit growers could be the use of winter cover crops. Appropriately selected, winter cover crops can add organic matter while increasing soil porosity. However, root systems vary considerably among cover crop species, potentially leading to differences in how these species impact soil management. Tillage radishes develop a large taproot, leaving larger pores or soil channels as the plant decomposes. In contrast, cereals have a fibrous root system, creating a multitude of smaller soil channels. Either system may provide a route for elemental sulfur or other pH or nutrient management materials to move deeper in the soil profile in an established planting. However, this has not been evaluated in blueberry or small fruit systems in the mid-south.

To address these questions and provide demonstration areas to implement and evaluate these cover crop practices, this project will demonstrate the use of a tillage radish cover crop, an oat cover crop, and a negative control without over crops to observe their potential impact on soil and plants in a young blueberry planting. In-person Extension trainings will be conducted and recorded to demonstrate the use of varied cover crop species along with important soil and plant nutrient management techniques. Digital and print training resources will then be developed as the demonstration proceeds to illustrate impacts on plant health, growth, and productivity. This hybrid approach will enable real-time outreach that supports Extension personnel in attendance while creating a suite of training resources for future use that will enable agents to aid blueberry and other small fruit growers in best management practices for health and productivity in their plantings.

Description of Outreach Activity:

1) Establish demonstration plots to generate information that will help blueberry growers better understand and potentially utilize cover crops to support soil and pH management.

2) Evaluate soil parameters, plant nutrition, and crop productivity under different cover crops in blueberry plantings to provide information applicable to many other small fruit crops (caneberries, vineyards).

3) Develop Extension publications to support small fruit growers and Extension agents who support growers in appropriately selecting and utilizing cover crops to aid soil management and crop productivity.

Results or Outcome:

Objective 1. Establish demonstration plots to generate information that will help blueberry growers better understand and potentially utilize cover crops to support soil and pH management.

Demonstration plots of cover crops integrated with current or future small fruit plantings were established in fall 2020. At UT AgResearch and Education Centers in Greeneville (GREC), a new blueberry planting will be installed in spring 2021, so the cover crop demonstration will be used to show site preparation techniques. Oats and tillage radish cover crop plots were established in approximately 4' x 35' plots at a rate of 150 lb ac^{-1} and 12 lbs ac^{-1}, respectively, on September 27, 2020.

In Spring Hill (MTREC), young blueberry plantings were already established (spring 2019 planted), so cover crops were integrated with planting beds. Plots were 3' x 50' and were seeded at the same rates described above on September 1, 2020.

Figure 1. Blueberry demonstration site in Spring Hill, TN (MTREC) with 18 month-old plants on Sept. 1, 2020 prior to establishing cover crops.

Figure 2. Blueberry demonstration sites with oats (L row) and tillage radish (R row) cover crops about 8 weeks after planting in Spring Hill, TN (MTREC). Photo taken on Nov. 5, 2020.

Figure 3. Freshly prepared plot in Greeneville, TN (GREC) that was seeded in cover crop treatments in fall 2020 in preparation for a new blueberry planting in Spring 2021.

Objective 2. Evaluate soil parameters, plant nutrition, and crop productivity under different cover crops in blueberry plantings to provide information applicable to many other small fruit crops (caneberries, vineyards).

Baseline soil pH and nutrients were determined by collecting one 6 inch depth soil sample per plot in late summer/early fall 2020 prior to cover crop planting. These were combined and analyzed as a composite sample to determine necessary pH adjustments. Baseline soil pH at MTREC was 4.3 and at GREC was 6.0. At MTREC, no soil pH management was needed. At GREC, elemental sulfur was applied and incorporated prior to cover crop seeding. Cover crop treatments were then established in fall 2020.

In spring and fall 2021, eight cores at a depth of 12 inches were collected from each plot. Cores were divided into 0-3, 3-6, and 6-12 inch sections. Samples were sent to the UT Soil, Plant and Pest Center where they were analyzed for pH and nutrients (P, K, Ca, Mg, B, Fe, Mn, Na, and Zn) using a Mehlich 1 extraction.

Data were analyzed using a mixed model analysis of variance in SAS 9.4 (Cary, NC). Fixed effects included cover crop (oat, radish, control), depth (0-3 inch, 3-6 inch, 6-12 inch), location (GREC, MTREC), and sampling date (Spring, Fall). An alpha level of 0.05 was used to determine significance and mean separation were performed using Tukey's HSD.

Cover crop treatment exhibited a significant effect on soil pH, P, K, Mg, and B ($P < 0.05$)). For these variables, oat cover crops had significantly higher pH and nutrient values compared with radish or control treatments. Values for Ca and Zn were also significantly impacted by cover crop treatments, but the cover crop effect interacted with sampling date and location, respectively. For Ca, differences were less distinct among treatments at the spring sampling date, with oat not differing from radish and radish not differing from the control (Table 2). By the fall sampling date, Ca exhibited a similar trend to that of the other nutrients, with oat exhibiting a higher value than radish and the control. For Zn, oat and radish were both higher than the control at the Greeneville location only (Table 3).

Table 1. Effect of cover crop on soil pH, phosphorus (P), potassium (K), Magnesium (Mg), and Boron (B). Nutrients are reported as pounds per acre and were analyzed using a Mehlich-1 extraction. Mean separation were performed using Tukey's HSD. Means followed by the same letter do not differ significantly at an alpha level of 0.05.

	pH		P		K		Mg		B	
Oat	4.4	A	73	A	151	A	132	A	0.4	A
Radish	4.2	B	65	B	133	B	97	B	0.3	B
Control	4.2	B	65	B	119	B	94	B	0.3	B
Average	4.3		67		134		108		0.3	
SE	0.04		2.0		5.5		7		0.02	

Table 2. Interaction of cover crop by sampling date on soil Ca. Nutrients are reported as pounds per acre and were analyzed using a Mehlich-1 extraction. Mean separation were performed using Tukey's HSD. Means followed by the same letter do not differ significantly at an alpha level of 0.05.

	Spring		Fall	
Oat	1036	A	1029	A
Radish	910	AB	660	C
Control	809	BC	708	C
Average	918		799	
SE	53		53	

Table 3. Interaction of cover crop by location on soil Zn. Nutrients are reported as pounds per acre and were analyzed using a Mehlich-1 extraction. Mean separation were performed using Tukey's HSD. Means followed by the same letter do not differ significantly at an alpha level of 0.05.

	GREC		MTREC	
Oat	5.1	A	2.2	C
Radish	4.7	A	2.0	C
Control	3.9	B	2.0	C
Average	4.6		2.0	
SE	0.2		0.2	

At each location and sampling date, pH increased as depth increased, with a significantly lower pH observed at the 6-12 inch depth compared with the 0-3 inch depth (Table 4). At the GREC location, which received sulfur applications in fall 2020 and spring 2021, pH levels continued to drop in the lower 3-12 inches between spring and fall sampling. Cover crop treatments did not impact the variation in pH by depth.

Table 4. Interaction of depth by location by sampling date on soil pH. Mean separation were performed using Tukey's HSD. Means followed by the same letter do not differ significantly at an alpha level of 0.05.

	MTREC Spring		MTREC Fall		GREC Spring		GREC Fall	
0-3 inch	4.4	BCD	4.1	DE	3.6	F	3.6	F
3-6 inch	4.5	ABC	4.3	CD	4.2	CD	3.8	EF
6-12 inch	4.8	A	4.7	A	4.7	AB	4.3	CD
Average	4.5		4.4		4.2		3.9	
SE	0.08		0.08		0.08		0.08	

Additional significant interactions of location with depth and/or sampling date were noted. These are not examined in detail in this report as they did not interact with the cover crop treatment and were likely due to soil type and management differences between locations. Overall, results from this study do not support the hypothesis that cover crops can move soil nutrients or lower pH at deeper depths compared with a no cover crop control. The pH at the MTREC location was already quite low and, at the GREC location, sulfur application was likely too high. These may have impacted the findings in this study. This study also examined a short time period of only a year. Further examination over the course of two or more years would provide greater insight.

While results did not support the hypothesis that cover crops move nutrients through the soil profile more effectively than no cover crops within the first year, they did support cover cropping as a way to increase soil nutrients and alter pH. Oats were noted as providing a significant increase in both micro and macro nutrients. Oats did slightly raise pH compared to radish and control treatments, which may be counter-effective in systems where pH needs to be lowered.

Objective 3. (Current objective) Develop Extension trainings to support Extension agents who support growers in appropriately selecting and utilizing cover crops to aid soil management and crop productivity.

(Former objective) Develop Extension publications to support small fruit growers and Extension agents who support growers in appropriately selecting and utilizing cover crops to aid soil management and crop productivity.

Our Extension outreach objective had originally been intended to be online modules to support agents in assisting small fruit growers. However, what we determined in early 2021 was that our agent and citizen audience was in more need of hands-on and in the field programming after a year or more of all digital content. So, we shifted our focus to in the field events for 2021 and into 2022. We held in person agent in-service training events at both of the sites of our cover crop trial. On June 15th, 2021, we hosted over 25 agents for a ½ day in-season in-service at the Middle Tennessee Research and Education Center. This event actually followed a morning field day on the same day where approximately 100 residents were introduced to the cultivar and cover crop trials on site. Then, on June 17th, around 20 agents participated in a full-day in-service training at the Greeneville Research and Education Center. These trainings presented information on cover crop trials, cultivar trials and the successful establishment of blueberry crops in Tennessee by focusing on these SRSFC supported demonstration sites and the real time experiences of our research and Extension teams.