Kansas Agricultural Experiment Station Research Reports

Volume 1
Issue 4 *Southeast Agricultural Research Center Reports*
Article 7

January 2015

Improving Yield Stability and Resiliency of Agronomic Production Systems in Southeast Kansas

G. F. Sassenrath
Kansas State University, gsassenrath@ksu.edu

J. K. Farney
Kansas State University, jkj@ksu.edu

DeAnn Presley
Kansas State University, deann@ksu.edu

See next page for additional authors

Recommended Citation

Sassenrath, G. F.; Farney, J. K.; Presley, DeAnn; and Davis, C. (2015) "Improving Yield Stability and Resiliency of Agronomic Production Systems in Southeast Kansas," *Kansas Agricultural Experiment Station Research Reports*: Vol. 1: Iss. 4. https://doi.org/10.4148/2378-5977.1057

Cover Page Footnote

We would like to thank the Kansas Center for Sustainable Agriculture and Alternative Crops for providing funds to G.F. Sassenrath to support this project. We are also grateful to the producer who collaborated in this research project.

Authors

G. F. Sassenrath, J. K. Farney, DeAnn Presley, and C. Davis

Improving Yield Stability and Resiliency of Agronomic Production Systems in Southeast Kansas

G.F. Sassenrath, J. Farney, D. Presley, C. Davis

Summary

Soil health is a critical determinant of crop performance. Soil physical, chemical, and biological properties can be modified through production practices such as tillage. Use of cover crops has been shown to benefit soil health and may improve productive capacity of soils. High rainfall and intense crop production practices limit the ability to implement cover crops in current production systems in southeast Kansas. This study explores potential management of cover crops and their contribution to soil health, crop productivity, and animal grazing.

Introduction

Integrated animal and crop management systems can benefit from greater integration of production practices. Integrated practices, such as using animal manures for crop fertilizer and grazing of crop residues, utilize waste products from one system as inputs to the other system. Additional benefits are possible through use of cover crops for improving soil health. Grazing cover crops may also benefit animal production by providing alternate forage, reducing the need for supplemental feed and relieving pastures.

Changes in crop rotations, tillage, and crop residue improve the soil health and enhance long-term sustainability of the agronomic production system. Cover crops can provide additional benefits by reducing erosion and increasing soil quality, nutrients, moisture content, and organic matter, but have added challenges in wet years for timely field preparation and planting due to excessive soil moisture in poorly drained clay soils. The goals of this research are to determine potential cover crops for use in the current rotation system in southeast Kansas and assess their impacts on soil quality and potential for grazing. We will also determine the productivity and profitability of cover crop systems.

Experimental Procedures

A variety of cover crops and cover crop mixes were established in corn, sorghum, and soybean fields to test planting methods and cover crops for establishment and performance. Cover crops were either planted or drilled into corn or sorghum stubble after harvest. Cover crops were broadcast into a standing soybean crop prior to harvest. The cover crops were chosen for variation in rooting structure, nitrogen and biomass production, and potential grazing quality and included grasses (fibrous root system, high biomass production), brassicas (dense root structure for creating macropores, nitrogen scavengers), and nitrogen fixers (natural source of N through root nodulation) (Table 1). All cover crops were chosen for their palatability to grazing cattle. In addition to individual cover crops, mixtures of cover crops were planted.

Results and Discussion

Cover crops alter the physical structure of the soil through various rooting structures and can provide additional benefits through N fixing or nutrient cycling. Cover crops planted individually were straightforward to plant. Overall, brassicas were easiest to establish and developed the most biomass (Figure 1). Sunn hemp, a high biomass producer that fixes N, also performed well. Cover crop mixes were more challenging to plant, primarily because of extreme differences in seed size and seed depth placement requirements. All cover crops were suitable for forages and could allow extended grazing during the winter months.

Winterkill is important to prevent cover crops from becoming weeds in subsequent crop production. Of the cover crops planted, the grasses overwintered as expected. Wheat and barley did particularly well. Winter oats suffered some freeze damage, but they recovered. Rye was hardy but had surprisingly poor plant stands. Sunn hemp was particularly cold-sensitive and died rapidly in the fall when temperatures fell. It is especially important to terminate sunn hemp prior to flowering, because sunn hemp seeds are toxic. Of the brassicas, the nitro radish was the most cold-sensitive. Purple-top turnip was also mostly winterkilled, but some did survive. The Appin and Pasja turnips also had some regrowth in the spring. The Dwarf Essex or Buckbuster rapeseed was particularly cold-hardy, with substantial spring regrowth. This limits the utility of these for cover crops, as they will require management in the spring to eliminate reseeding. This will be especially important for cover crop mixes or when cover crops are incorporated into a cash crop, such as winter wheat, where control of the cover crop could damage the cash crop.

Grasses

The thick, fibrous rooting structures of grasses provide a mesh of roots that hold soil particles, reducing erosion and improving aeration into the soil matrix. The fibrous rooting cover crops tested included cereal rye (not annual ryegrass), winter oats, winter wheat, winter barley, and pearl millet. Grasses have excellent forage quality. The depth of planting and planting rate depends on species. Because most overwinter, if they are used only as a cover crop or green manure, they will need to be terminated in the spring to avoid carryover into subsequent crops. This is especially true for cereal rye, which contains allellopathic chemicals that can suppress growth of subsequent crops for up to a month after termination. Cereal rye should be terminated several weeks prior to planting a following crop to allow time for the allellopathic chemicals to dissipate. Pearl millet is the exception, because it is easily killed by frost.

Brassicas

Brassica species, including turnips, radishes and rapeseed, commonly have large taproots that create macropores in the soil matrix (Figure 2). These cover crops can also be used for nutrient cycling by scavenging residual N following the cash crop, a process known as "bio-drilling." The N is then slowly released to the subsequent crop as the large taproot decays. Several varieties of radishes are available, ranging from large-rooted cultivars with less foliage (tillage radish and nitro radish), to cultivars with more foliage but smaller roots (Appin forage turnip and Pasja turnip). The larger-rooted varieties build the soil organic matter and reduce soil erosion. Many of the brassicas are identical and vary only in the common name given by the seed company. Although the brassicas provide excellent high-energy forage, testing for nitrate levels is advised to avoid nitrate toxicity. Mixing brassicas with other cover crops, especially grasses, can improve the forage quality and minimize potential toxicity. Brassica species contain varying amounts of organic compounds termed glucosinolates that can be used as a biofumigant, reducing soilborne pests such as nematodes. Brassicas are very small-seeded and require shallow planting (1/4- to 3/4-in. depth). They are fast-growing but can become a weed problem if they go to seed, so they require termination prior to seed formation.

Nitrogen fixers

Nitrogen-fixing cover crops such as clover traditionally have been grown to provide supplemental N to the next crop. Here, we tested Berseem clover, Austrian winter pea, and sunn hemp. Sunn hemp germinated and grew particularly well in this study. Although it is suitable for forage and can be hayed, the quality declines quickly after 4 weeks of growth (Warren et al., 2015). The clover and winter pea had very poor germination, resulting in poor plant stands, especially when mixed with other cover crops.

Reference

Warren, J., T. Wilson, and J. Edwards. 2015. Using sunn hemp as a cover crop in Oklahoma. Oklahoma Cooperative Extension Service. PSS-2273. Available online at: http://osufacts.okstate.edu

Table 1. Summary of cover crops used in the study, with planting information, forage quality, benefits for soil health, and cautions

Common name	Planting rate, lb/a	Planting depth, in.	Forage quality	Other benefits	Cautions	Additional information
Grasses						
Winter barley	80–125	3/4–2	Excellent	Erosion control, nitrogen (N) scavenger	Thick root system	https://greencoverseed.com/species/Winter%20Barley.html
Winter oats – "Bob"	100–150	1/2–1	Excellent	Reduces erosion, does not reseed	Needs high fertility	https://greencoverseed.com/species/Oats%20-%20Winter%20(Bob).html
Cereal rye	60–120	3/4–2	Excellent	Erosion control, N scavenger, high biomass	Allellopathic properties may suppress next crop	http://gostarseed.com/products/rye-56-bag
Pearl millet	4–10	1/2–1	Excellent, high protein	No prussic acid, winterkills		http://www.johnnyseeds.com/p-7481-hybrid-pearl-millet-f1.aspx
Nitrogen fixers						
Berseem clover	8–20	1/4–1	Excellent, non-bloating	Comparable to alfalfa, but better in wet soils		https://greencoverseed.com/content/berseem-clover
Winter peas	50–100	1 1/2–3	Forage booster, high protein	Top N producer	May increase disease carryover when other legumes in rotation	https://greencoverseed.com/species/Winter%20Pea.html
Sunn hemp	30–40	1/4–1	Good when small	High biomass, N fixer, nematode-resistant	Till under at flowering to avoid fibrous stems	http://www.johnnyseeds.com/p-9113-sunn-hemp-tillage-sunn.aspx
Brassicas						
Dwarf Essex or buckbuster rapeseed	4–20	1/4–3/4	Excellent, palatable, high energy, high protein; pasture 6–8 weeks after sowing, can be grazed multiple times	Fast germination and growth, weed suppression, erosion control; builds soil organic matter; bio-drilling–nutrient scavenger; biofumigant–nematode control	May become weedy if allowed to flower	http://gostarseed.com/products/rapeseed-dwarf-essex-bulk-pound
Oilseed radish	25	1/2				http://www.johnnyseeds.com/p-5813-oilseed-radish.aspx
Nitro radish	5–12	1/4–3/4				https://greencoverseed.com/content/nitro-radish
Purple-top turnip	5–8	1/2				http://www.johnnyseeds.com/p-7492-purple-top-forage-turnips.aspx
Appin forage turnip	1–3	1/4–1/2				http://gostarseed.com/products/appin-forage-turnip-bulk-pound
Pasja turnip	3–6	1/4–3/4				http://gostarseed.com/products/pasja-hybrid-brassica-forage-bulk-pound

Figure 1. Tillage radish planted after corn harvest; center square is 1 sq. yard.

Figure 2. Tillage radish planted after corn harvest. The large taproot of the tillage radish creates macropore spaces, improving soil aeration and providing a good seed bed for subsequent crop.