Chapter 12

Cover Crops in No-till Systems

Introduction

In areas of western Oklahoma (precipitation less than 35 inches per year); the use of cover crops in dryland cropping systems has generally been viewed as unacceptable due to the limited rainfall. During the last quarter of a century, crop production has switched from a relatively diversified system to a continuous winter wheat system. Wheat is often grazed, since many producers rely heavily on the production of beef as their main source of income. The current general consensus of many producers in the western part of Oklahoma is that no suitable summer crops exist for their climate and no suitable alternative exists to replace wheat forage for cattle. Consequently, they are reluctant to grow anything except winter wheat. The quality of winter wheat has continued to decline in this area due to increased weed and insect populations as a result of minimal crop rotation. No-till systems have not become popular in this region because of yield reduction and/or increased crop protection costs that can occur under no-till with continuous winter wheat. In order for Oklahoma producers to optimize their no-till cropping systems, they must be willing to rotate crops. One potential is through the use of cover crops, especially during the summer months when temperatures are high and rainfall is highly variable. Cover crops may be cheap, and if legumes are used, they may reduce nitrogen fertilizer inputs for the following crop.

Cover crops contribute a variety of conservation benefits. For water conservation, they offer an opportunity to utilize moisture that would otherwise be lost to evaporation during the fallow period. This is particularly true for the summer fallow period between wheat crops. In fact, on average a continuous wheat rotation in Oklahoma will lose approximately 60 percent of the water falling as precipitation to evaporation (Warren et al, 2009). A living cover crop can transfer this useless evaporation to useful transpiration to grow the cover crop. The aboveground biomass generated protects the soil surface from crusting and reduces erosion. This, along with increased porosity resulting from root growth, improves water infiltration. After termination, the residue remaining on the soil surface continues to minimize evaporation rates.

When selecting a cover crop or mix of cover crops, it is important to identify your objectives. As mentioned, cover crops can be used for production of surface residues. Additional objectives may be to break pest cycles, provide habitat for beneficial in-

"Cash crops grown are wheat, cotton, corn, milo, cowpeas, canola, and hay, along with cover crops...use cover crops to start a no-till rotation."

A. Mindemann
Apache, OK

Cover crops in a No-till cropping system can:

- Provide soil cover
- Prevent soil erosion by wind and water
- Be annual, perennial, or biennial plants
- Can be grown during all or part of the year
- Fix nitrogen in the soil
- Suppress weed, insect pests, and diseases
sects or wildlife, alleviate compaction, produce nitrogen or provide for supplemental grazing.

**Cover Crops in Rotation**

Cover crops can fit well into many different cropping systems during periods of the year when no cash crop is being grown. In some areas even the simplest corn/soybean rotation can accommodate a rye cover crop following corn, which will scavenge residual nitrogen and provide ground cover and forage in the fall and winter. When spring-killed as a no-till mulch, rye provides a water-conserving mulch and suppresses early-season weeds for the following soybean crop.

In Kansas, Claussen (2004) evaluated late-maturing soybeans as a cover crop. He found that they reached an average height of 24 inches, showed limited pod development, and produced 2.11 tons per acre of above-ground dry matter, with an N content of 2.11 percent, or 90 lb per acre. Sunn hemp averaged 72 inches in height and produced 3.19 tons per acre with 1.95 percent N, or 125 lb per acre. Soybean and sunn hemp suppressed volunteer wheat to some extent, but failed to give the desired level of control ahead of the wheat. Also, when averaged over N rates, soybean and sunn hemp significantly increased grain sorghum yields, by 9.7 and 13.4 bu per acre, respectively.

Perhaps the greatest challenge for dryland producers in the southwestern part of the U.S. is storing and using the precipitation they receive throughout the year. Figure 1 illustrates the average monthly precipitation and mean monthly temperatures for western Oklahoma.

Production of continuous winter wheat is the common practice in the area so producers are not fully taking advantage of moisture they receive during the summer months. If we assume 40 percent water storage efficiency for a no-till system, then 5.5 inches of water is lost during a given year or >15 percent of the precipitation they receive. Summer moisture has the potential to produce cover crops and use the soil moisture that may otherwise be lost during the fallow period.

**Nitrogen Contribution**

One of the biggest obstacles with nitrogen contribution from cover crops is estimating or measuring the amount of nitrogen that a given cover crop will contribute to the following crops, especially in a no-till system. A review of the literature provides wide ranges of nitrogen contribution from various nitrogen fixing cover crops (McLeod, 1982; Claassen, 2004; Heer and Janke, 2004).

Nitrogen production from legumes is a key benefit of growing cover crops, especially with the recent increase in nitrogen prices. The amount of nitrogen available from legumes depends on the species of legume grown, the total biomass produced, the percentage of nitrogen in the plant tissue and the rainfall and temperatures experienced after termination of the cover crop. These factors influence

<table>
<thead>
<tr>
<th>Crop</th>
<th>Tops %N</th>
<th>Roots %N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans</td>
<td>93</td>
<td>7</td>
</tr>
<tr>
<td>Vetch</td>
<td>89</td>
<td>11</td>
</tr>
<tr>
<td>Cowpeas</td>
<td>84</td>
<td>16</td>
</tr>
<tr>
<td>Red Clover</td>
<td>68</td>
<td>32</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>58</td>
<td>42</td>
</tr>
</tbody>
</table>

Figure 2. Cowpeas planted following wheat harvest in Major County.
the amount of N that can be released to the cash crop, and the rate at which it is mineralized to a form that can be utilized by the crop. Cultural and environmental conditions that limit legume growth, such as a delayed planting date, poor stand establishment, and drought will reduce the amount of nitrogen produced. Conditions that encourage good nitrogen production include getting a good stand, optimum soil nutrient levels, soil pH, good nodulation, and adequate soil moisture.

Generally, for legumes, each ton of biomass will contain approximately 50 pounds of N for most legume species prior to flowering and 40 pounds of N after flowering. The portion of green-manure nitrogen available to a following crop is usually about 40 to 60 percent of the total amount contained in the legume. For example, Hoyt (1987) estimated that 40 percent of plant tissue nitrogen becomes available the first year following a cover crop that is chemically killed and used as no-till mulch. Lesser amounts are available for the second or third crop following a legume, but increased yields are apparent for two to three growing seasons.

Nitrogen contributions in a no-till system will no doubt be affected by lack of tillage operations. Table 1 shows percent nitrogen in above and below-ground root mass. The most effective way to understand the amount of N supplied by a cover crop is to utilize sensor-based N recommendations combined with an N rich strip. This takes the guess work out of determining how cover crop N availability will impact your in-season N requirements. Another important thing to remember is that mineralization (release) of organic N from the cover crop takes time. Therefore you must plan on utilizing it late in the season, this being the case it is important to continue to use pre-plant or starter fertilizers to get the cash crop started and prevent early season deficiencies.

**Pest Suppression**

In addition to providing ground cover, and in the case of a legume, fixing nitrogen, cover crops also help suppress weeds and reduce insect pests and diseases. Weeds flourish on bare soil. Cover crops take up space and light, thereby shading the soil and reducing the opportunity for weeds to establish themselves. Providing weed suppression through the use of allelopathic cover crops and living mulches has become an important method of weed control in sustainable agriculture. Allelopathic plants are those that inhibit or slow the growth of other nearby plants by releasing natural toxins, or “allelochemicals.” Cover crop plants that exhibit allelopathy include the small grains like rye and summer annual forages related to sorghum and sudangrass. The mulch that results from mowing or chemically killing allelopathic cover crops can provide significant weed control in no-till cropping systems. Claassen (2004) observed soybean and sunn hemp effectively suppressed volunteer wheat and, in the fall, reduced the density of henbit compared to areas having no cover crop.

**Organic Matter and Soil Structure**

A major benefit obtained from green manures is the addition of organic matter to the soil. During the breakdown of organic matter by microorganisms, compounds are formed that are resistant to decomposition, such as gums, waxes, and resins. These compounds—and the mycelia, mucous, and slime produced by the microorganisms—help bind together soil particles as granules, or aggregates. A well-aggregated soil is well aerated, and has a high water infiltration rate. An actively growing root system has significant impacts on soil structure as well. The roots can serve to prevent consolidation of the soil and create biopores as they grow. The next time you are out in the field of an actively growing crop with a soil sampling probe or a steel rod try this experiment. First, push the rod into the soil between the rows. Notice any resistance, especially at the surface. Then push the rod into the soil right next to a plant crown. You should find that it is easier to push the rod into the ground next to the plant. This is most evident when soils are somewhat dry. The affect is due to the high density of roots near the crown of the plants.

**Limitations of Cover Crops**

The recognized benefits of cover cropping—soil cover, improved soil structure, nitrogen from legumes—need to be evaluated in terms of cash returns to the farm as well as the long-term value of sustained soil health. For the immediate growing season, seed and establishment costs need to be weighed against reduced nitrogen fertilizer requirements and the effect on cash crop yields. Water consumption by green manure crops is a concern and is pronounced in areas with less than 30 inches of precipitation per year. Additional management is required when cover crops of any sort are added to a rotation. Utilizing cover crops requires additional time and expense when compared to having no cover crop at all. Insect communities associated with cover crops work to the farmer’s advantage in some crops and create a disadvantage in others. For example, certain living mulches may enhance the biological control of insect pests but may serve as a host to non-beneficial pests. Therefore it is important to study these interactions and select cover crops that are well suited for your production goals. Because
there is a multitude of cover crop species and management options it may be difficult to find research data that is specific to your system. Therefore, it is useful to experiment with cover crops, perhaps with strips of cover crops planted in an otherwise fallow field or perhaps cover crop half of each field so that you can observe the benefits of the cover crop compared to your standard practice. Detail descriptions of a variety of cover crops, their benefits and limitations can be found in the book “Managing Cover Crops profitably” which is available in hard copy or pdf at http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition

Summary

The use of leguminous cover crops has gained attention due to increased nitrogen fertilizer prices. In western Oklahoma, the lack of precipitation has precluded producers from including cover crops in their rotations. It is believed that the use of cover crops can be effective in using soil moisture that would otherwise be lost during the fallow period. Remember that inclusion of cover crops represents an additional layer of management to your cropping system. Also, some of the benefits such as improvements to the soil structure may take time to realize. Further challenges may exist when determining their impact on pest cycles. Other factors such as N production from legumes can be seen in the first year. If you are a keen observer of the effects that cover crops are having on your system, you can take advantage of those benefits that may not simply be increasing yield.

References

Claassen, M.M. 2004. Effects of late-maturing soybean and sunn hemp summer cover crops and nitrogen rate on no-till grain sorghum after wheat. Kansas State University, SRP928.