PRACTICAL farmers of Iowa
Healthy Food, Diverse Farms, Vibrant Communities

Cover crops do double duty: cover and grain

Written by Sarah Carlson and Amber Anderson

Abstract

Cover crops have been increasing in popularity because of the benefits they provide to the soil and the environment, among others; however, they are rarely harvested. Not only can a cover crop protect Iowa's soil from erosion during late fall and early spring when it's most vunerable and following a corn or soybean harvest, it can also be harvested as a grain crop. A variety of winter small grains were tested as cover crops in the fall of 2010 to determine if these grains could be effective cover crops and also produce a quality grain crop, even though planted at a later than optimal date for typical grain planting. There were varietal differences in overwinter percentages and yield. Only the winter lentil did not overwinter or produce a grain crop. The percent of fall cover was positively correlated to the yield. All but one of the winter wheat varieties had optimum protein levels for baking.

Project Timeline

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Web Link

http://tinyurl.com/doubledutycovercrops

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Background

Cover crops are normally planted without the intention of a direct harvest. They provide several benefits to the farmer or the environment. In Iowa, cover crops are usually planted into standing corn or soybean crops or planted after grain harvest. These dates differ from a typical winter small grain planting date for grain that will be harvested the following year. In the fall of 2011, some farmers noticed a severe shortage of some winter small grains. Others have been asking if a winter small grain could be planted at a typical cover crop date, later than normal, and give the farmer the flexibility to either tear it up in the spring or leave it go till mid-July for grain harvest. If a grain crop could also be harvested, it could become more attractive to plant a cover crop as part of a rotation instead of just for the cover's benefits. A few of the benefits include enhanced soil quality by protecting soil from erosion (Lal et al, 1991, Karlen and Cambardella, 1996), increased soil microbial activity and nutrient cycling, (Karlen and Cambardella, 1996), decreased excess nitrogen (Kaspar et al., 2007) or added soil carbon.

Iowa's land has lost significant amounts of soil since annual crop farming began. Iowa lost an average of 5.2 tons/acre/year of soil last year (Cox et al, 2011) with some areas of the State losing significantly more. Cover crops keep the ground under cover year-round, capture more sunlight to grow plants that build soil and trap any excess nitrogen, minimizing soil and nutrient loss.

Method

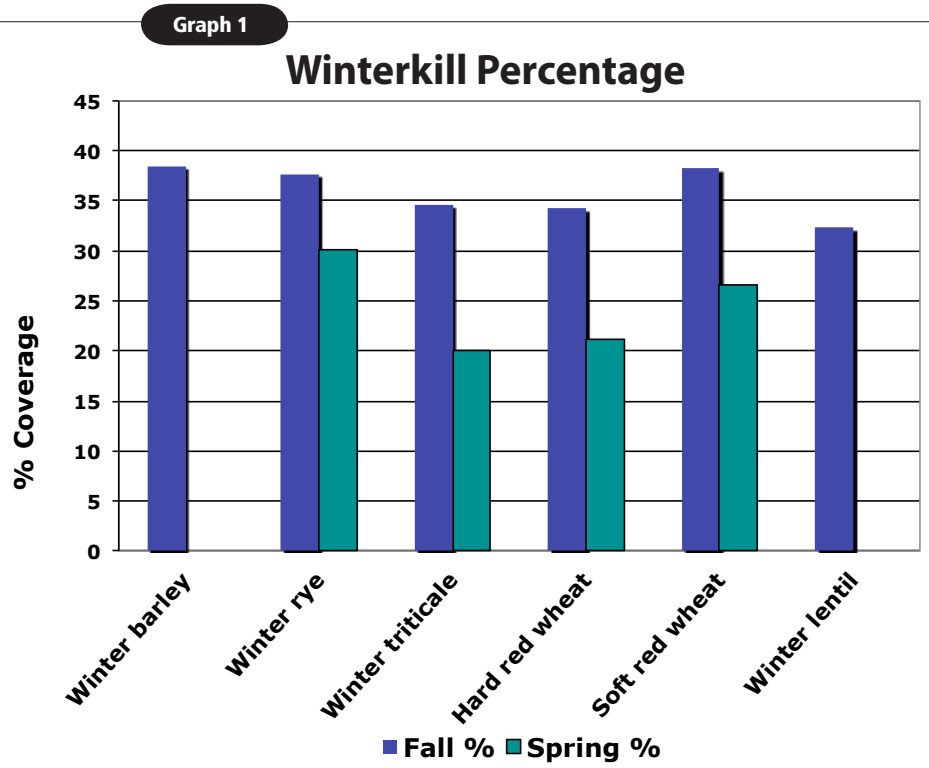
On October 7, 2010 after soybean harvest, 16 varieties of five different small grains and one winter lentil variety were drilled at the ISU Agronomy Farm near Boone, IA in two replicated plots measuring 12.5' by 30'. No additional fertilizer was applied to the crop. Percentage ground coverage of each plot was measured prior to snowfall, on November 29, 2010 and also on March 2, 2011 after snowmelt to examine how well each variety overwintered.

Samples of spring biomass were taken to determine nitrogen uptake. Three quadrates in half of each plot were harvested on April 28, 2011. Samples were harvested at this time because it was a common date for killing a cover crop before planting corn. To determine potential nitrogen uptake as a cover crop the plants needed to be assessed during their typical life cycle as a cover crop. To assess their grain production they were then allowed to continue to grain harvest. Dried and ground aboveground biomass samples were analyzed for carbon and nitrogen

content using the dry combustion-gas chromatography method (Schepers et al., 1989) with an EA1112 Flash NC Elemental analyzer (Thermo Electron Corp., Waltham, MA) at the National Laboratory for Agriculture and the Environment. After plants were harvested on July 15, 2011, seed was air dried in cloth bags for ten days. Seed was then cleaned at the Seed Science Lab at Iowa State University (ISU). Test weight and moisture of the harvested grain were measured using a Grain Analysis Computer (GAC). Protein content of wheat and triticale was measured using near-infrared spectroscopy at the Grain Quality Testing Laboratory at ISU. No calibration was available to measure the protein content of rye and barley.

Statistics were analyzed using JMP 9 (SAS Institute Inc., Cary, NC) and yield comparisons employ least squares means for accuracy. Grain yields are reported at 13% moisture.

Graph 1



Graph 1. *Winterkill percentage of winter cover crops grown near Boone, Iowa from 2010-2011. The smaller the difference between the blue and green bars, the better the overwintering. All green bars are statistically different.*

Results and Discussion

Winterkill Percentage

Spring coverage percentage among cover crop species was statistically different but not between varieties **(Graph 1)**. The winter lentil winterkilled under these growing conditions while the 'Arapahoe' winter wheat variety did grow under the snow resulting in slightly more early spring cover than fall cover. The winter barley had almost non-existent aboveground growth after snowmelt when these measurements were taken. By April when the spring biomass samples were taken, some growth had occurred, but the plant growth was severely retarded compared to the other winter small grains. It is speculated that the winter barley varieties produced enough root growth in the fall of 2010 so that once spring temperatures increased, the plant achieved sufficient spring growth to produce a grain crop. The winter lentil did not have enough fall growth to grow in the spring.

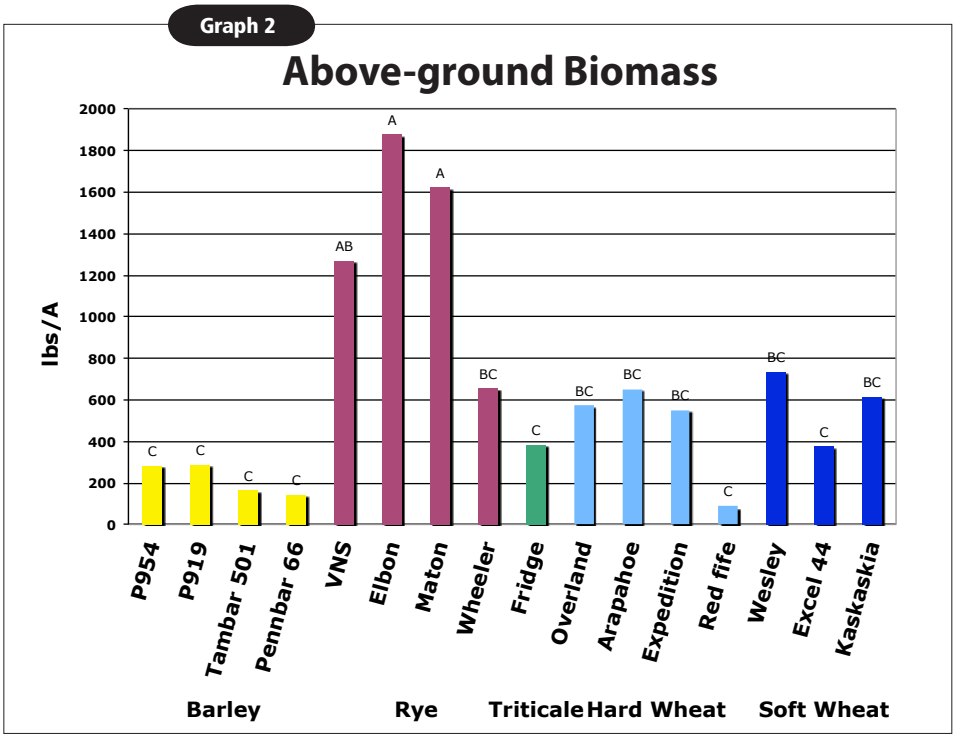
Spring Biomass

'Elbon,' 'Maton' and 'VNS' winter rye varieties grew significantly more aboveground biomass measured in dry lbs/A than the other cover crop varieties **(Graph 2)**. 'Wesley,' 'Kaskaskia,' 'Overland,' 'Arapahoe,' 'Expedition' winter wheat and 'Wheeler' winter rye varieties were not statistically different. 'Fridge' winter triticale; 'Red fife' and 'Excel 44' winter wheats and all winter barley varieties yielded the least amount of aboveground biomass. Aboveground biomass is another important characteristic of a winter cover crop. Cover crops that grow greater amounts of aboveground biomass can improve the soil through increased amounts of carbon; however, too much aboveground biomass can be hard for farmers to kill in the spring. A good balance between allowing spring growth and managing a cover crop is critical to successfully adding a cover crop to a farming system.

Nitrogen Content of Biomass

The more a cover crop can grow, the more nitrogen it is taking from the soil and putting into a stable, organic form such as roots, shoots, leaves and plant material. This decreases the amount of nitrogen that potentially can leach from the soil surface. The nitrogen percentage (%N) of the aboveground biomass harvested in the spring was measured, then the %N was converted using the pounds of dry matter to pounds of nitrogen per acre (lbs-N/A). Percentage N of the different varieties was statistically different, ranging from 3.99% (Winter wheat 'Red fife'), 3.98% and 3.77% (Winter barley 'P919' and 'Pennbar 66,' respectively) down to 2.48% (Winter rye 'Wheeler'). However, after converting the %N to lbs-N/A, the amount of N used by the cover crops trended similarly to the amount of aboveground biomass the cover crops produced **(Graph 2)**. Pounds of nitrogen/A ranged from 'Elbon' winter

Graph 2



Graph 2. *Yield of dried, aboveground biomass (lbs/A) of winter cover crop varieties harvested spring 2011. Different letters indicate significant differences using Student's t-test at an α=.05 level.*

rye yielding 48lbs-N/A and the lowest 'Red fife' winter hard wheat 3.5lbs-N/A. Winter barley varieties ranged from 11.4 lbs-N/A to 4.9 lbs-N/A. If the 'Red fife,' and winter barley varieties could have grown more biomass under Iowa growing conditions they would have had greater overall lbs-N/A but agronomically these varieties did not perform as well as the three top-performing winter rye varieties.

Grain Yield

Percent cover in the fall had significant (α=0.05) impact on the summer grain yield while spring cover did not. This would tend to indicate that a good fall establishment with good root growth is crucial for reducing winterkill potential and also positively affects the resulting grain yield. In addition to the resulting higher yield, this higher level of cover protects the soil throughout the winter and early spring.

The relationship between fall cover and yield for this year can be described by the equation: Yield = 130.9 x (Fall %) – 9.1. Additional testing will determine if this relationship is consistent across other locations and years.

Variety was a significant factor in yield (α=0.05 level) in addition to fall cover. Mean yield ranged from 0 bu/A (failure to overwinter) to 58.6 bu/A for VNS winter rye variety ***(Graph 3)****. Bars with the same letter are not statistically different. The VNS winter rye yielded statistically more grain than the 'Tambar 501', 'Pennbar 66', 'Wheeler', 'Fridge' and 'Red fife'.*

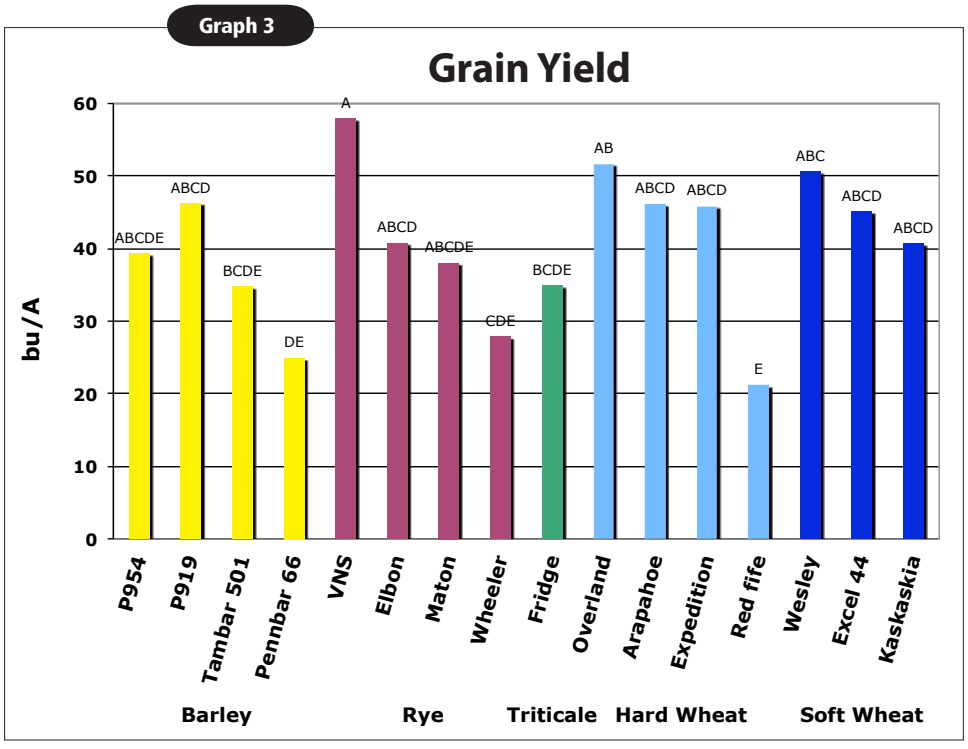
Seed Quality

If cover crop grains are harvested they can be used for seeding a future stand of cover crops, animal feed or human uses like bread or beer. A germination test was run on all of the harvested seed to determine if seed was fit for re-planting as a cover crop. 'Red fife' winter wheat (78%), VNS winter rye (84%) and 'Fridge' winter triticale (76%) were the only seeds to have a germination rate below 90%. Farmers should always test the germination rate of farm-raised seed. Post-harvest handling can greatly reduce seed quality.

Wheat and Food Quality

While protein content and quality are important for examining the baking potential of flour (P. Baardseth, K. Kvaal, P. Lea, M.R. Ellekjær, E.M. Færgestad, 2000),

Graph 3



Graph 3. *Grain yield at 13% moisture of winter cover crop varieties grown near Boone, IA in 2010-2011. Different letters indicate significant differences using Student's t-test at an α=.05 level.*

higher protein does not necessarily mean better baking quality, as it is commonly perceived. In fact, late Raymond Calvel, French professor of baking and bread expert, expresses the concerns for high gluten wheat grown in the US and instead recommends a moderate protein level (11-13%) for baking in his book, **The Taste of Bread (Le goût du pain)** *(Calvel, 2001). All but one variety tested contained protein levels within the range that Calvel recommends* ***(Graph 4)****.*

According to the test bake specialist at a bakery in Montana, good quality wheat should have a nice plump kernel, whether it is low or high in protein. This is because all gluten-forming properties are found in the endosperm. If the endosperm is small, most of the time it will be hard to get good volume. Therefore, in addition to testing baking quality of wheat by running tests on proteins, visual examination of wheat kernels are important as well. However, due to current processor purchasing habits, quantity requirements and perceived low-protein levels of Iowa wheat, markets for Iowa wheat have not taken off.

Conclusions

In 2010, most of the winter cover crop varieties tested effectively established, overwintered and yielded grain the following summer. Only 'Toni' winter lentil did not overwinter nor produce a grain crop. Higher yields generally resulted from varietal differences and those cover crops that had greater amounts of fall cover.

Most varieties of hard wheat, soft wheat, winter rye and winter triticale were able to overwinter and reach yields near to or above 40 bu/A the following season. The plants took up excess nitrogen, reducing nitrogen lost and possibly resulting in the off-site benefit of cleaner water. Overall, a small grain used as a cover crop may be a valuable part of a water and soil conservation strategy. Additional flexibility could be provided to the farmer by leaving the cover crop to mature and providing farm-raised cover crop seed or even the potential to sell the grain to bakers or other end-users.

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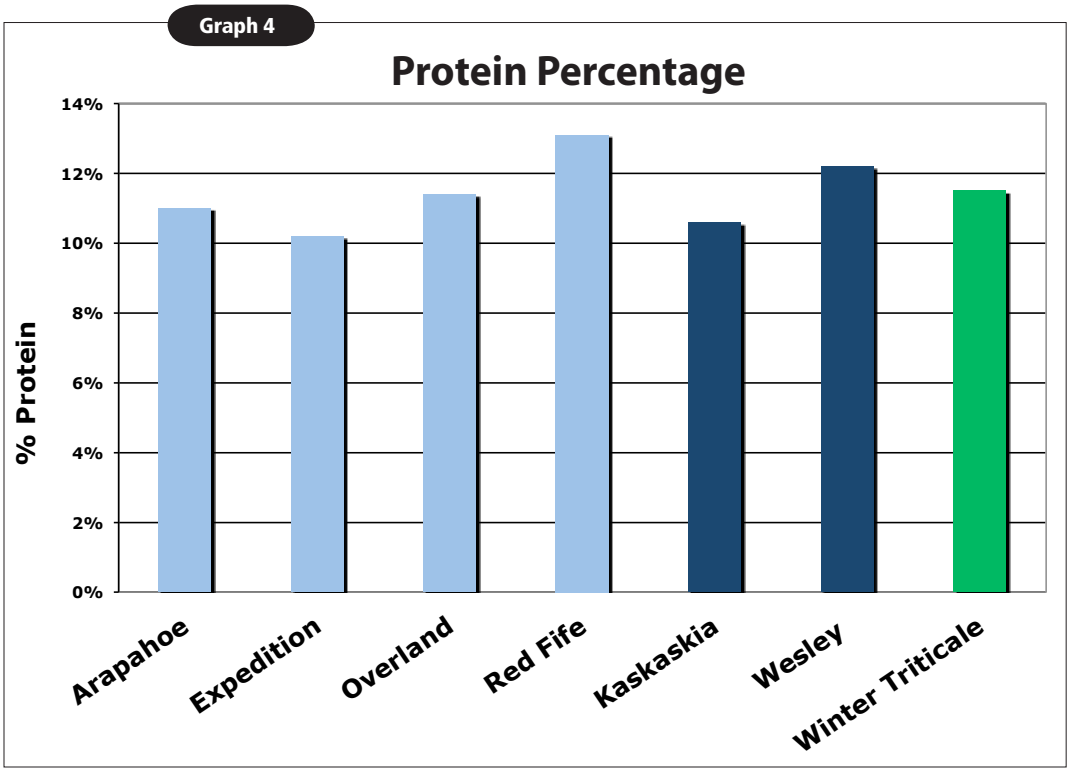
Graph 4



Graph 4. *Percent Protein of Six Winter Wheat Varieties and One Winter Triticale Grown near Boone, Iowa in 2011.*