University of Kentucky
College of Agriculture, Food and Environment
Cooperative Extension Service

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Wheat Science

Research & Education Center
Princeton, KY 42445

What's inside

University of Kentucky
College of Agriculture, Food and Environment
Grain and Forage Center of Excellence

Economics of Various Winter Wheat Management Strategies

Dr. Jordan Shockley, Extension Ag Economist

Planting season is right around the corner for those in Kentucky growing winter wheat this year. Are you thinking about adjusting management practices by increasing seeding rates or adding phosphorus in anticipation of increased yields? Have you ever wonder how planting and harvest timings affect winter wheat yields? Over the past three years, Dr. Katherine Rod (former Plant and Soil Science graduate student) and Dr. Carrie Knott conducted research funded by the KY Small Grain Growers' Association to answer these questions.

Experiments conducted in Princeton, KY, examine how various winter wheat management strategies affect yields and overall economics, compared to the University of Kentucky's recommendations. The specific input adjustments examined include increasing the seeding rate of winter wheat from 35 plants/ft^2 (University of Kentucky's recommended rate) to 56 plants/ft^2 and applying in-furrow phosphorus (P_2O_5) at a rate of 42 lbs./ac (University of Kentucky's recommended rate is 0 lbs./ac of P_20_5). Table 1 illustrates that increasing the seeding rate for winter wheat and applying in-furrow phosphorus increases yields slightly, but not enough to offset the cost of the additional inputs for all scenarios. Given a winter wheat price of \$5.25/bu, seed price of \$16.50/bag, and a triple superphosphate price of \$522/ton, these adjustments in management strategies result in losing up to \$31.15/ac as compared to University of Kentucky's recommended rates.

Table 1. Yields and economic returns for applying phosphorus (P_20_5) and an increased seeding rate for winter wheat in Kentucky as compared to UK's recommended rates (Base).

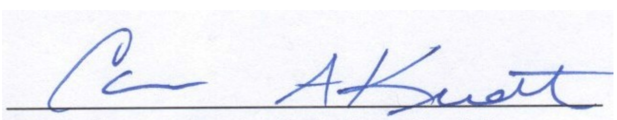
	Seeding Rate (Plants/ft^2)	P_20_5 Rate (lbs/ac)	Wheat Yields (bu/ac)	Additional Cost (\$/ac)	Additional Revenue (\$/ac)	Net Returns (\$/ac)
Base	35	0	74.1	—	—	—
Base + P_20_5	35	42	75.3	\$23.75	\$6.60	-\$17.15
High Seed	56	0	75.7	\$22.60	\$8.45	-\$14.15
High Seed + P_20_5	56	42	77.5	\$47.60	\$16.45	-\$31.15

Other management strategies examined included how planting and harvest timings affect both winter wheat and double-crop soybean yields. Harvesting winter wheat earlier (mid-June) than normal (beginning of July) allows for earlier planting of double-crop soybeans, affecting both yields in a double-crop wheat and soybean rotation common in Kentucky. However, harvesting earlier requires on-farm drying of winter wheat to avoid a moisture dockage at the elevator. The prices used for this analysis include a wheat price of $5.25/ac, a soybean price of $8.50/ac, and a $0.05/bu point removed for drying and storing winter wheat. Table 2 illustrates that October planting is optimal for winter wheat in Kentucky compared to November planting. Furthermore, a management strategy of planting winter wheat in October and harvesting earlier than normal results in a net return increase of $35.20/ac. Anecdotal evidence suggests that most wheat producers in Kentucky have already adopted the October planting and early harvest strategy. However, this research highlights the economic justification for this strategy based on yield gains alone. Couple this management strategy with a good marketing strategy and October planting with an early harvest can result in further increases in net returns for a double-crop wheat and soybean system in Kentucky.

Table 2. Double-crops wheat and soybean yields and overall economic returns for various planting and harvest timings for winter wheat in Kentucky.

		Wheat Yields (bu/ac)	Reduced Revenue ($/ac)	Soybean Yields (bu/ac)	Additional Revenue ($/ac)	Net Returns ($/ac)
Planting Timing	Harvest Time					
October	Normal[1]	88	0	52	0	0
November	Normal	64	-$129.30	52	0	-$129.30
October	Early[2]	89	-$49.80	62	$85.00	$35.20
November	Early	59	-$195.30	62	$85.00	-$110.30

[1]Normal harvest around July 1st
[2]Early harvest around June 12th



Carrie Knott, Extension Grain Crops Specialist

The Ins and Outs to Soil Carbon Sequestration

Dr. John Grove—Soil Science Research & Extension

As we head towards winter, there's been more talk about soil carbon sequestration (storage) as soil organic carbon, brought on in part by a recent announcement proposing a value of $15 per "metric ton carbon dioxide equivalent". This has stimulated some questions, and as a member of a science advisory committee to the now defunct Chicago Climate Exchange, I guess I deserve these. They are a combination of both chemistry and mathematics, fun topics for us all.

First question: What is a "metric ton carbon dioxide equivalent (mt CO_2eq) ", in terms of soil organic matter? To answer that, we need some other facts/conversions: A metric ton = 1000 kg = 2200 lb. A lb-mole of carbon dioxide (CO_2) = 44 lb and contains 12 lb of carbon (C). So, 1 mt CO_2eq = 2200 lb CO_2eq. Converting that to C, we get 2200 lb CO_2eq x 12/44 = 600 lb C, which is stored/sequestered in the soil as soil organic carbon (SOC). Soil organic matter (SOM) contains 58% SOC, so 2000 lb SOM x 0.58 = 1160 lb SOC. This means that 1 mt CO_2eq is the same as 600/1160 = 0.52 ton SOM.

Second question: The payment assumes the grower executes one or more management practices. How does the grower know that the level of carbon sequestration paid for was achieved? The short answer is – the grower can't make that guarantee. The payment also assumes, using published field research data and modeling/forecasting, that the practice or combination of practices will bring about the carbon sequestration that was paid for. Changes in SOM are hard to measure. For example, an average topsoil weight is assumed to be two million pounds per acre (2,000,000 lb/A). If the topsoil contains 2.5% SOM, then we have: 2,000,000 x 0.025 = 50,000 lb SOM/A = 25 ton SOM/A. An annual sequestration rate of 1 mt CO_2eq/year = 0.52 ton SOM/year, which is only 2.1% of the total SOM or 0.05% of the whole soil weight. To measure such a change – small each year – we need a lot of years. Long-term field research sites were used to get these data, and then modeling is used to "cover the gaps" and estimate values for other spaces and for future seasons.

Third question: I grow no-till corn and long-term trials involving corn are out there. What do those studies show? UK and Purdue research (studies that I know) has found that about 10% of above-ground stover (AGS) carbon and 20% of the below-ground root/root exudate residue (BGR) carbon are sequestered, yearly. I use these numbers knowing that the UK study site was warmer (encourages residue mineralization) and no-till (discourages mineralization) while the Purdue site was colder (discourages residue mineralization) and fall plowed (encourages mineralization). If you grow 200 bushel corn, estimated corn residue levels are: 200 bu x 56 lb grain/bu x 0.845 lb grain dry matter/lb grain = 9464 lb grain dry matter = 9464 lb AGS dry matter (I'm assuming corn's harvest index is 0.5). This gives a corn total above-ground biomass (grain plus stover) of 9464 x 2 = 18928 lb grain plus stover biomass.

I need this number because the BGR dry matter estimate is about 17% of total biomass, and 18928 x 0.17 = 3218 lb BGR dry matter. Corn residues (both AGS and BGR) contain 40% C, so we have 9464 lb AGS x 0.4 lb C/lb AGS x 0.1 lb SOC/lb C = 379 lb SOC sequestered from AGS and 3218 lb BGR x 0.4 lb C/lb BGR x 0.2 lb SOC/lb C = 257 lb SOC sequestered from BGR. Total SOC sequestration would be 636 lb SOC. The sequestered SOM would be 636 lb SOC x 100 lb SOM/58 lb SOC = 1097 lb SOM = 0.55 ton SOM.

While SOM is being added to the soil via the crops/cover crops being grown, there is mineralization of indigenous SOM going on (the soil microbes are at work) at a rate of about 1% per year. For our soil with 2.5% SOM (25 ton SOM/A), that means a loss: 25 ton SOM/A x 0.01 ton SOM/yr = 0.25 ton SOM/A/yr. So, with 200 bu corn per acre, the net sequestration is 0.55 - 0.25 = 0.3 ton SOM/A. Comparing 0.3 ton SOM/A to the 0.52 ton SOM/A value I calculated above, we wouldn't net 1 mt CO_2eq/A in sequestered C with 200 bu corn.

Fourth (and last) question: Are there other factors that we need to consider? The short answer is yes. For me, the most important of these other factors is that C sequestration is accompanied by nitrogen (N), phosphorus (P) and sulfur (S) sequestration. The SOM contains all these elements (and others) and these are subject to the same rules – sequestration means that these nutrient elements remain generally unavailable. As in the example given above, there will be some SOM turnover every year, but the 'net' impact is supposed to be sequestration – soil storage of C and associated organic N, P and S.

Let's look at the 1 mt CO_2eq = 0.52 ton SOM. Remember that SOM is 58% SOC and add that the average soil science textbook C:N:P:S weight ratio in SOM is around 120:10:1.3:1.3, we find that we have 0.52 ton SOM x 2000 lb SOM/ton SOM x 58 lb SOC/100 lb SOM x 10 lb N/120 lb SOC = 50 lb N. Similar calculations give 6.5 lb S and 6.5 lb P x 142 lb P_2O_5/62 lb P = 15 lb P_2O_5. Replacing these nutrients with dry fertilizer; ammonium sulfate (AS, 21-0-0-24S) at $270/ton for the S and part of the N, diammonium phosphate (DAP, 18-46-0) at $430/ton for the P_2O_5 and another portion of the N, and urea (U, 46-0-0) for all the remaining N, we will need to buy:

6.5 lb S x 100 lb AS/24 lb S x 1 ton AS/2000 lb AS x $270/ton AS = $3.66 (27.1 lb AS) and 27.1 lb AS contains 5.7 lb N = (27.1 lb AS x 21 lb N/100 lb AS); 15 lb P_2O_5 x 100 lb DAP/46 lb P_2O_5 x 1 ton DAP/2000 lb DAP x $430/ton DAP = $7.01 (32.6 lb DAP) and 32.6 lb DAP contains 5.9 lb N = (32.6 lb DAP x 18 lb N/100 lb DAP); (50 - 5.7 - 5.9) lb N = 38.4 lb N x 100 lb U/46 lb N x 1 ton U/2000 lb U x $360/ton U = $15.02 (83.5 lb U).

So, each 1 mt CO_2eq = 0.52 ton SOM also contains $(3.66+7.01+15.02) = $25.69 in S, P and N, respectively. At $15 per mt CO_2eq, we recover about 100 x ($15/$25.69) ≈ 60% of that value.

In summary, and as a soil scientist, I think recommendations that increase soil carbon sequestration are generally positive, improving soil health and productivity. Those practices that are beneficial to the producer and to SOM levels, like no-tillage, are win-win practices. For other recommendations, I think that all costs associated with these need to be transparent and well considered. Studies on soil formation tell us that SOM tends towards an equilibrium value for each soil/environment and that larger inputs are required to bring about those last small increments that give the highest SOM values. The law of diminishing returns eventually applies.

USEFUL RESOURCES

KyGRAINS.info

Kentucky Pest News
Entomology · Plant Pathology · Weed Science
http://kentuckypestnews.wordpress.com/

College of Agriculture, Food and Environment
WHEAT SCIENCE GROUP
http://wheatscience.ca.uky.edu/home

Crops Marketing and Management Update
http://www.uky.edu/Ag/AgEcon/extcmmu.php

KATS
Kentucky Agriculture Training School

VIRTUAL
WINTER WHEAT MEETING

UK Grain and Forage Center of Excellence

DAY 1

JANUARY
05
2021

8:30—10:30
central time

- CROP CONDITION
- ECONOMICS OF WHEAT IN 2021
- THINGS ARE CHANGING: AN OVERVIEW OF KENTUCKY'S CLIMATE FROM 1895 TO 2020
- MAXIMIZING WHEAT YIELD POTENTIAL DESPITE MOTHER NATURE
- IS COMPACTION LIMITING YIELD AND HOW CAN IT BE MANAGED?

https://uky.zoom.us/j/86253972713

DAY 2

JANUARY
08
2021

8:30—10:30
central time

- CROP CONDITION
- WHEAT VARIETAL DIFFERENCES IN METRIBUZIN TOLERANCE
- INSECTS IN STORED WINTER WHEAT & MANAGEMENT TO REDUCE POPULATIONS
- PUTTING IT ALL TOGETHER: INTEGRATED MANAGEMENT OF HEAD SCAB IN WHEAT
- ANNUAL RYEGRASS CONTROL IN WHEAT

https://uky.zoom.us/j/85093871632

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RETURN SERVICE REQUESTED

Upcoming Events

January 5, 2021 ***January 8, 2021***	***Virtual Winter Wheat Meeting—Day 1*** ***Virtual Winter Wheat Meeting—Day 2***
January 14, 2021	***KY Commodity Conference***
May 11, 2021	***Wheat Field Day***
July 29, 2021	***2021 High School Scouting Competition***