k-state extension
Agronomy e-Updates

Number 235
March 12, 2010

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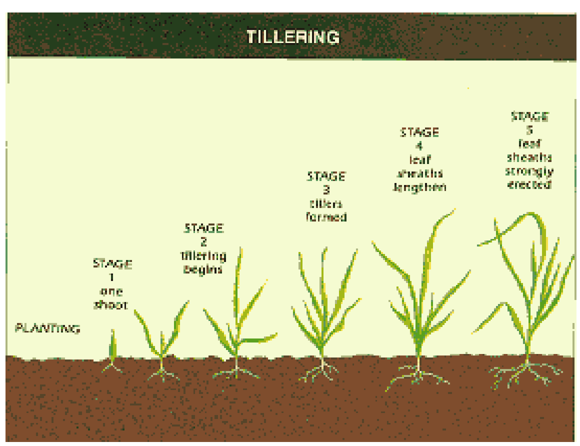
1. Late winter stages of wheat growth and development

From now through April, wheat in Kansas will go through some important stages of growth. As the weather warms up and nighttime temperatures remain above freezing for several consecutive days, wheat leaves will change from their prostrate position of winter dormancy to an upright growth habit. On the widely-used Feekes scale of wheat development, Feekes 4 is the stage when leaves begin to become erect in the spring. In some southern areas of the state, wheat is now in this stage. In other areas of the state, this stage of growth is rapidly approaching. Feekes 5 is when the leaves are strongly erect. On a practical basis, this can be hard to distinguish from stage 4.



Wheat at Feekes 4, as leaves begin to become erect.
Photos by Jim Shroyer, K-State Research and Extension.

At Feekes 4, in the photo above, the plants are losing the prostrate growth that they had during winter dormancy. The plants will continue to tiller (produce more stems) for about another month, as long as there's good soil moisture and the temperatures are not too hot.

At Feekes stage 5, the leaves are strongly erect.

At Feekes stage 5, the leaves are becoming even more erect. During this stage, stems are formed and the growing point or head moves up inside the stem. As the plants emerge from the cold period of winter, the plants switch from the vegetative stage (leaves and tillers are developed) to the reproductive stage (the head is formed and grain is produced). This cold requirement or process is called vernalization. The soil temperature has to be below 48 degrees for several weeks in order for the plant to become fully vernalized. Some wheat varieties have a short vernalization requirement and they need only a week or two, while other varieties need four to six weeks for vernalization.

Wheat that was planted last fall and germinated will all have vernalized by now, even if the seedlings didn't emerge until recently, or even if they haven't yet emerged at all. With normal planting dates and average fall weather conditions, the wheat will have vernalized by Christmas time.

During Feekes stages 4 and 5, producers should apply topdress fertilizer if necessary. Producers should also scout fields for winter annual broadleaf weeds and insects such as greenbugs, bird cherry oat aphids, army cutworms, and others. It's a little early at this stage to be concerned about leaf diseases, although powdery mildew and speckled leaf blotch can start to become active in late winter.

In about two or three weeks, we'll have another article in the e-Update on wheat growth stages as the plants begin to joint.

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2. Brownfield sites: Soil quality issues in urban agriculture

Urban agriculture in the U.S. consists primarily of small garden areas within cities. The kinds of land used for this includes not only backyard gardens, but also vacant lots, parks, greenhouses, roof tops, balconies, window sills, and land adjacent to ponds, rivers, and estuaries.

Increasingly, urban agriculture is being done on a community basis rather than an individual basis. There are now more than 18,000 community gardens in the U.S. and Canada, according to the American Community Gardening Association.

Soil quality issues often associated with urban soils include:

- Contamination
- Compaction
- Stone content
- Poor drainage
- Poor soil chemical properties
  - Nutrient concentrations and availability
  - pH

These soils may pose health risks for community gardens if the soils are contaminated with heavy metals, metalloids, and/or organic compounds. Urban soils have sometimes been found to contain toxic levels of heavy metals including lead (Pb), arsenic (As), cadmium (Cd), mercury (Hg), zinc (Zn), nickel (Ni), and copper (Cu). Contamination may have come from paint, gas or oil, waste incineration, lead pipes, specific industries, and so forth.

Brownfield sites

Abandoned, contaminated urban soils can also be called "Brownfield" sites. According to the U.S. Environmental Protection Agency, Brownfield sites are defined as vacant, abandoned property, the reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant.

There are an estimated 450,000 to 1 million Brownfield sites in the U.S., according to the U.S. Department of Housing and Urban Development. There are about 5 million acres of abandoned industrial sites in U.S. cities – roughly the same amount of land occupied by 60 of the largest U.S. cities.

Examples of Brownfield sites are:

- Vacant residential lots
- Abandoned residential properties next to industrial facilities
- Abandoned properties next to rail lines
- Abandoned gas stations
- Abandoned grain elevators
- Former manufacturing facilities
- Former school buildings

Brownfield sites are also sometimes contaminated with organic compounds, in addition to heavy metals and metalloids. The most common organic contaminants in the U.S. are chlordane, DDT, and PCBs. Chlordane was used for homes to control termites; protecting farms. The EPA banned all uses of chlordane in 1988. DDT was an insecticide used at one time to control mosquitoes. It was banned in the US in 1972. PCBs (polychlorinated biphenyls) were used in electrical transformers, capacitors, and other electrical components. PCB production was banned by the US Congress in 1979.

In addition, Brownfield sites can be contaminated from air pollution. Polycyclic aromatic hydrocarbons (PAHs), a known carcinogen, have been found in urban soils. PAHs are residues from incomplete combustion. They may exist in gardens and other urban soils due to vehicle pollution (roads and railways), past wood or coal burning on or near the site, or use of creosote railroad ties as garden plot dividers.

K-State project: Gardening Initiatives at Brownfield Sites

At K-State, we are working on an EPA-funded project titled “Gardening Initiatives at Brownfield Sites.” The goals of this project include:

- Enhance the capabilities of gardening/farming initiatives to produce crops locally without potentially adverse health effects to the grower or the end consumer
- Contribute to the meaningful revitalization of Brownfield sites in a sustainable manner
- Increase confidence in urban food production quality
- Provide resources for producers, urban land managers, local and state government, and extension agents to implement proposed BMPs for the detection and mitigation of potentially harmful substances in soils on Brownfield sites.

To do this, we first establish the Brownfield site history. Then we screen and collect soil samples from the site, and recommend Best Management Practices (adding soil amendments, raised beds) that the community gardeners should be using on the site.

We provide continuous monitoring and analysis of the soil and produce raised by the gardeners. We also provide training and technical assistance to participating community organizations (sample collection, site evaluation, etc.) throughout the term of the project. The soils and produce from the site are analyzed in labs in the Agronomy Department at K-State. The Brownfield sites involved in the project are from throughout the nation.

Local example

An example of one of the sites in the project is from the Washington Wheatley area of Kansas City. Three houses had been present on this site, but had been torn down and cleared away, leaving a vacant lot adjacent to a house that was still standing. This is what the site looked like before the project began and before the area was utilized as a community garden. The photo below is from March 2009.

Brownfield site in the Washington Wheatley area of Kansas City.
(This photo and those below are by K-State Research and Extension.)

The first thing we did on this site was to conduct an in situ soil screening using handheld X-ray fluorescence (XRF). We then did soil sampling for laboratory verification.

Blasé Leven, K-State's Center for Hazardous Substance Research, doing preliminary in situ soil screening at the Kansas City site using handheld X-ray fluorescence.

The soil tests found:

- No detectable chlordane
- Detectable levels of DDT and DDE (daughter product of DDT breakdown)
- Mildly to moderately elevated lead (Pb) levels
- All other parameters were within normal ranges

To deal with elevated levels of Pb, we recommend that those who participate in the community garden wash their hands after working at the site, and that all produce from the site be thoroughly washed before consumption. All general exposure to a site with high Pb levels should be limited, and organic soil amendments could be applied to reduce the bioavailability of Pb in the soil. The pH of the soil at this site was about 7.0 and P levels were high, so no lime or P fertilizer was needed. Our recommendation for this site was addition of compost (good soil amendment, with non-acidulating effects) at about ¼ by volume into the top 15 cm of soil.

After applying compost, we then established test plots and grew swiss chard, sweet potato, and tomato plants. The photo below shows the site after the garden had been established in the summer of 2009. We analyzed samples of the plants for nutrients, and Pb, comparing the results using standard kitchen washing and a more thorough laboratory washing method. Neither DDT nor DDE levels in the soil were high enough that we needed to be concerned about their plant uptake.

The Kansas City Brownfield site after being converted to a community garden.

We found that the levels of Pb in all three plant types were well below the maximum permissible limits, as established by the Food & Agriculture Organization/World Health Organization. Compost lowered the Pb concentrations in the swiss chard, but had no consistent effect on the sweet potatoes and tomatoes. The level of washing had no consistent effect on Pb concentrations in produce materials. We suspect that no consistent effect was seen because soil Pb concentrations were not high enough to cause significant uptake of Pb.

K-State personnel discussing soil test results with community gardeners at the Kansas City Brownfields site.

Summary

The Brownfield example above from Kansas City is part of a large, ongoing project to determine whether selected urban Brownfield sites across the nation can be utilized as community garden areas. Most sites tested so far have been okay for use as a garden area with soil amendments -- but not all sites are suitable.

Other faculty involved in this project at K-State include Sabine Martin and Blasé Leven, Center for Hazardous Substance Research; Larry Erickson, Department of Chemical Engineering; Gary Pierzynski and DeAnn Presley, Department of Agronomy; and Rhonda Janke and Ted Carey, Department of Horticulture, Forestry, and Recreational Resources.

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3. Intensive crop rotations can minimize some risks of near-surface soil compaction

Little is known about the effects of increased cropping intensity and soil organic carbon (C) concentration on soil compactibility, particularly in semiarid regions. Some studies have compared differences in soil compactibility between plow-till and no-till practices, but not among cropping systems within the same tillage system -- such as no-till. Intensified cropping systems under no-till may provide some buffer against excessive compaction by increasing soil organic C concentration.

It has been shown that more intensive crop rotations result in improved soil and water conservation, improved soil properties, and higher soil organic C concentration, all while improving crop production. The greater annual residue return from diverse and intensified crop rotations protects the soil surface from water and wind erosion, reduces surface sealing and crusting, reduces water evaporation, and enhances soil organic C accumulation.

But what about the effect different cropping systems within no-till – a tillage system that also produces many of those same benefits? Is there an additive effect? In particular, can more intensive cropping rotations help reduce soil compactibility within a no-till system? To find out, we studied three long-term no-till cropping system experiments, as described below.

Description of Long-term Cropping System Experiments

Location	Soil type	No. of years	Cropping systems
Hays, KS	Silty clay loam	33	1. Grain sorghum/fallow 2. Continuous sorghum 3. Wheat/sorghum/fallow 4. Wheat/fallow 5. Continuous wheat
Tribune, KS	Silt loam	11	1. Wheat/sorghum/sorghum/fallow 2. Wheat/wheat/sorghum/fallow 3. Continuous wheat
Akron, CO	Loam	19	1. Wheat/fallow 2. Wheat/corn/fallow 3. Wheat/corn/millet 4. Perennial grass

Maximum bulk density

Results from this regional study showed that intensive cropping systems in these no-till experiments reduced soil compaction in the top 2 inches (as measured by bulk density taken at soil water contents below the "critical water content" – which is the soil water content at which the maximum soil compaction occurs). The bulk density was measured by the Proctor test where the higher the reading, in terms of weight per unit of volume, the more compact the soil.

* At Hays, surface compaction was reduced by 5 to 15% when continuous sorghum or continuous wheat was grown instead of sorghum-fallow or wheat-fallow.
* At Akron, surface compaction was reduced by 8% in wheat/corn/millet and perennial grass as compared to wheat-fallow and wheat/corn/fallow.
* There were no statistical differences in maximum soil compaction among the three cropping systems at Tribune.

At Hays and Akron, the maximum bulk density was lower in intensive cropping systems than in systems which included fallow, meaning the compactibility was lower in the intensive cropping systems. Frequent fallowing appeared to increase risks of soil compaction due to the reduced annual input of residues. The more frequent the fallow periods, such as those at Hays and Akron, the greater the risks of soil compaction.

Relationship between maximum bulk density and soil organic C

The reduction in the maximum soil compaction by intensive cropping systems is largely attributed to the near-surface accumulation of soil organic C, which differed among cropping systems, except at Tribune (Fig. 1A-1C). On the silty clay loam at Hays, soil organic C concentration under continuous wheat was 1.5 times greater than the average across other rotations at the 0- to 2-inch depth. On the loam at Akron, soil organic C concentration under grass was greater by 1.4 times while that under wheat-corn-millet was greater by 2 times than the average across wheat-corn-fallow and wheat-fallow at the 0- to 2-inch depth. Compactibility, as measured by maximum bulk density, decreased with an increase in soil organic C concentration.

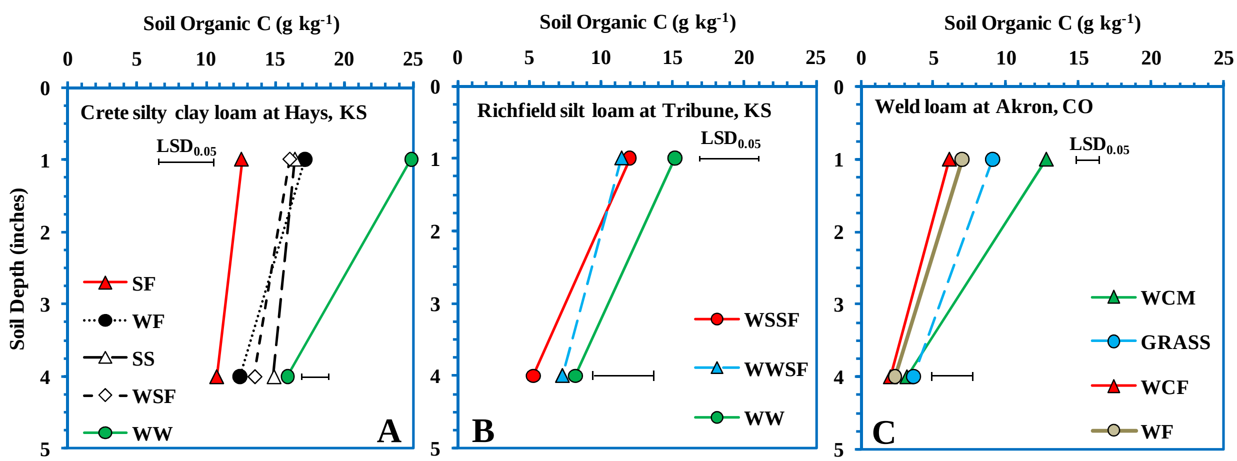

Fig. 1. Soil organic C concentration by depth for three soils under (A): wheat-fallow (WF), sorghum-fallow (SF), wheat-sorghum-fallow (WSF), continuous sorghum (SS), and continuous wheat (WW); (B): wheat-sorghum-sorghum-fallow (WSSF), wheat-wheat-sorghum-fallow (WWSF), and WW; and (C): wheat-fallow (WF), wheat-corn-fallow (WCF), wheat-corn-millet (WCM), and perennial grass (GRASS).

Correlating the compactibility readings with soil organic C readings, we found that crop-fallow systems were more prone to compaction than more intensive cropping systems because they had lower soil organic C concentration. In technical terms, soil organic C reduces the soil's susceptibility to compaction because it increases the soil's resistance to deformation, improves the elasticity and rebounding capacity of the soil matrix, and lowers the bulk density of the whole soil by the "dilution effect."

Results suggest that near-surface compaction can be somewhat reduced in no-till by adopting intensive cropping systems, which increase soil organic C concentration. Why do we say only "near-surface" compaction? Because of the stratification of soil organic C concentration in no-till soils. Improved management strategies such as growing deep-rooted plant species (e.g., forage grass) can increase soil organic C concentration at lower depths and reduce soil organic C stratification.

Summary

This regional study across three contrasting soils in the central Great Plains showed that long-term intensive cropping systems can help reduce near-surface soil compaction over crop-fallow systems in no-till systems. Soils in intensive cropping systems can be trafficked at greater soil water contents than those in crop-fallow systems without causing excessive compaction.

Results of this study indicate that the maximum compactive force that these soils can resist without being compacted depends on soil organic C concentration. Intensive cropping systems increased soil organic C concentration over crop-fallow systems, and the maximum bulk density decreased and critical water content increased with an increase in soil organic C concentration in all soils. Increasing soil organic C concentration through appropriate management practices such as intensive cropping systems may be a potential means for managing near-surface soil compaction.

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These e-Updates are a regular weekly item from K-State Extension Agronomy and Steve Watson, Agronomy e-Update Editor. All of the Research and Extension faculty in Agronomy will be involved as sources from time to time. If you have any questions or suggestions for topics you'd like to have us address in this weekly update, contact Steve Watson, 785-532-7105 swatson@ksu.edu, or Jim Shroyer, Research and Extension Crop Production Specialist and State Extension Agronomy Leader 785-532-0397 jshroyer@ksu.edu