STEEP

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INFORMATION FOR LEADERS IN LAND MANAGEMENT

Research and Extension in land management technology for farm profits and conservation of soil and water.

STUBBLE MANAGEMENT INFLUENCES SOIL FREEZING

THE PROBLEM

Erosion of soil from frozen land is a substantial portion of the total erosion occurring from the dryland wheat area of Oregon's north-central counties. Water cannot infiltrate into frozen soil, so rainfall, snow melt, and condensation moisture flow over the surface on sloping land and can cause severe erosion. Any management practice that reduces freezing, therefore, reduces erosion.

THE RESEARCH

Measurements of winter soil temperatures and the development of ice layers in the soil were carried out at several locations and under a variety of soil surface conditions during the winter of 1980 by research scientists at the USDA-ARS Columbia Plateau Conservation Research Center at Pendleton. Not all of the results, which are available elsewhere, will be presented in this report. The present discussion will be confined to describing the effects of standing stubble.

The researchers decided to compare soil temperatures and ice formation under nearly bare, tilled, planted soil against temperatures at the same depths in undisturbed, settled soil under standing stubble.

RESULTS

Research at the Columbia Plateau Conservation Research Center in Pendleton has demonstrated that standing stubble on undisturbed ground can prevent soil freezing. Measurements show that during the winter months there is less ice formation and warmer soil temperatures prevail under standing stubble than in a tilled and seeded field.

Soil temperatures were recorded in January and February of 1980 at the one-half inch depth in plots where wheat had been no-till drilled through four to six tons of standing stubble residue. At the same time and at the same depth, soil temperatures were recorded in plots which had been conventionally tilled and planted and whose surface residue cover was estimated to be from one-fourth to one-half ton per acre. In the no-till plots, the temperature ranged from 31.5 to 40.5°F. On the other hand, soil temperatures in the conventionally tilled, nearly bare plots fluctuated between 29.0 and 42°F. The bare soil was warmer at times and colder at times than the soil under standing stubble; it experienced a greater fluctuation in temperature while the temperature of the residue covered soil changed less.

More importantly, while the temperature of the covered soil in the no-till plots was below 32°F (freezing) for only a few hours on each of two occasions, in the conventionally planted soil temperatures below freezing persisted for 2 days early in January, 4 or 5 days in mid-January, and for 4 days in late January. These long intervals of low temperature allowed formation of thick layers of solidly frozen soil with very few voids open for infiltration and percolation of water.

In the conventionally tilled plots with low levels of surface residues, the

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surface soil was frozen solid at least two inches deep continuously from January 5 to February 10. Such severe and continuous frozen soil conditions provide a high probability of surface runoff and soil erosion. On the other hand, under the four to five tons of surface residues on the no-till drilled plots there was no soil freezing detected.

How it works. Joe Pikul's research data and his analyses are useful in explaining these effects of standing stubble. Anything that reduces the long wave radiation from the soil has an influence on soil freezing. Standing stubble shuts the long wave window by reflecting radiant heat, which is escaping from the soil, back to the soil. By controlling the net long wave radiation losses, the stubble reduces nocturnal cooling of the soil. When this cooling rate is reduced, the soil stays too warm to freeze during the night. Second, the undisturbed, stubble-covered soil is wetter near the surface. Because moist soil has a larger heat capacity than a dry soil, more heat must be lost to bring about a sufficient temperature drop and to initiate and sustain freezing. Third, the standing stubble reduces the air movement near the soil surface by a "windbreak" effect, reducing heat losses. Finally, the standing stubble can prevent blow-off of snow cover when present, providing additional insulating effect.

Warmer soil. Don Baldwin, district conservationist for the Wallowa SWCD, has observed that the soil temperature in fields with standing stubble fluctuates far less than that in black fallow fields. The minimum temperatures were higher by several degrees and the maximum temperatures were lower in non-tilled stubble fields.

CONCLUSIONS

Standing stubble is a powerful tool for preventing soil freezing. By reducing the frequency and severity of frozen soil conditions, it can reduce runoff. By reducing runoff, leaving the stubble standing over winter can reduce soil losses from erosion and also increase moisture storage for the succeeding crop. It can increase conservation AND profits.

There are some prerequisites for leaving the stubble standing over winter successfully. Planting should be on the contour so the drill furrows will not channel water downhill. Also, a good job of chaff and straw spreading out of the combine during harvest helps to use the standing stubble more effectively, especially if the winter season is to be followed by no-till or minimum till planting.

Freezing may occur even under standing stubble under conditions of an extended severe cold snap. The important effect is that the probability of soil freezing causing serious runoff and erosion is reduced.

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