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Residue Cover versus Soil Clods for Wind Erosion Protection on Fallow

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Problem

Wind erosion is one of the major forms of soil degradation on the semi-arid Canadian prairies. Two main factors affecting wind erodibility are the amounts of crop residue and non-erodible aggregates (clods) on the soil surface. However, the contribution of each alone or the combination of both in preventing wind erosion is not known for various fallow tillage intensities representative of cropping systems on the semi-arid Canadian prairies.

Literature Review

Conventional fallow, in which most of the crop residue is buried by tillage implements, has contributed to high levels of wind erosion on the semi-arid Canadian prairies[3]. Even though large clods may be created by tillage implements which offer temporary protection from erosion, these clods are broken down by overwinter processes such as freezing-thawing, wetting-drying and freeze drying[2]. Recently, there has been a swing toward conservation tillage in the region, which leaves more crop residue on the soil surface for erosion protection.

Study Description

A long-term wheat-fallow study[1] at the Lethbridge Research Centre afforded a comparison of fallow management effects on wind erodibility. Five fallow systems were compared: two to four passes of a one-way disk, heavy-duty cultivator or wide-blade cultivator; minimum tillage (herbicides plus one pass of wide-blade cultivator in fall); and zero tillage (herbicides only, chemical fallow).

In the fall after the fallow phase (1987-91) and again before spring seeding (1988-92), about 6 kg of soil was sampled from the surface 2.5 cm, air-dried and passed through a rotary sieve to determine the erodible fraction. The erodible fraction is the weight of soil aggregates

less than 0.84 mm in diameter. It is expressed as a percentage of the total sample weight. If the erodible fraction is greater than 60%, then the erosion risk is high. Before spring seeding, surface plant residue (loose and anchored) was collected and weighed from 1 m^2 of each plot. If the amount of crop residue is less than 1.12 t/ha, then the erosion risk is high.

Major Findings

Figure 1 shows the effect of fallow management system on crop residue cover and erodible fraction (average of five years: 1987-91). Firstly, there is a very clear relationship between tillage intensity and residue conservation. As the intensity of tillage decreased from one-way disking to zero tillage, there was an increase in the amount of residue conserved. Secondly, a substantial increase in the erodible fraction from fall to spring is evident. This is due to freezing-thawing, wetting-drying and freeze drying which cause overwinter aggregate breakdown.

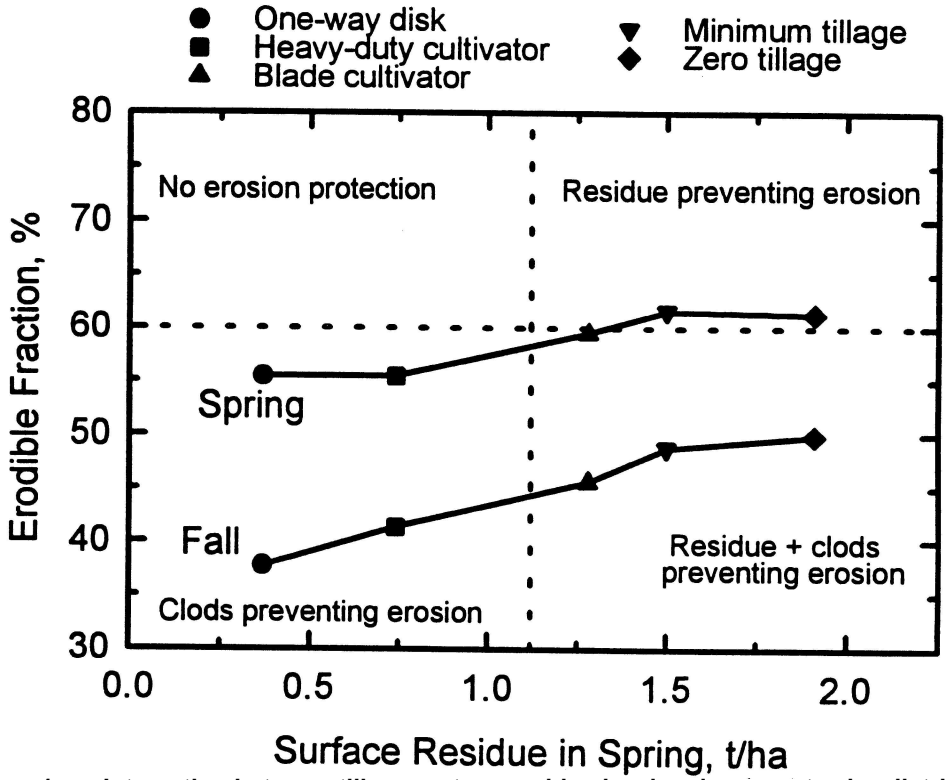

Figure 1. Interaction between tillage system, residue level and aggregate size distribution (% erodible fraction) on wind erodibility of fallow, Lethbridge, Alberta

With respect to wind erosion risk, the figure may be divided into four quadrants. In the fall, the one-way disk and heavy-duty cultivator treatments relied solely on the presence of non-erodible clods created by the working action of these implements to protect the treatments from wind erosion because they had less than the critical limit of surface residue (1.12 t/ha). However, in spring, there was a slight erosion risk as they approached the critical 60% erodible fraction value.

The blade cultivator, minimum tillage and zero tillage treatments had the best combination of residue and non-erodible clods in the fall. However, in spring, these treatments were protected solely by residue cover as the erodible fraction increased to greater than 60% due to overwinter breakdown. Since there is little or no opportunity to create large clods with these systems, severe wind erosion losses could occur if the residue cover is destroyed by drought or fire.

Figure 1 illustrates management effects on the counterbalancing nature of clods and residue cover in preventing wind erosion. In semi-arid areas, residue levels may not be sufficient to control erosion especially in drought years, and tillage to generate non-erodible clods may be required. However, it should be borne in mind that protection from large clods may be short-lived compared to residue cover, as the clods are broken down by rainfall and frost action. Therefore judicious crop residue management is the main line of defence against wind erosion.

Applied Questions

How much surface residue is needed to protect soil from wind erosion?

This is very dependent on the crop in question. With cereals, about 30% of the soil surface area should be covered with residue. This translates into about 1.12 t/ha of crop residue. In drought years, low yields and associated low straw/residue production may not generate sufficient residue cover for erosion protection. Some crops produce very little residue (e.g. canola, potatoes, sugar beets, beans), leaving soil unprotected unless a fall cover crop is established.

Which is better for erosion protection, large clods or surface residue?

Surface residue conservation is the best line of defence against wind erosion. Protection offered by large clods is very short-lived due to climatic factors which cause soil aggregate disintegration. However, in an emergency situation, where land is blowing due to lack of surface residue, an emergency tillage operation is often performed to bring large clods to the surface for temporary erosion control.

If my zero till land ever lost its surface trash mat (e.g. due to fire) would it blow?

Yes. In the absence of tillage, there is no mechanism for creating large clods, so once the surface crop residue mat is removed, zero tillage land is even more prone to erosion than cultivated land. Very small soil aggregates exist under the surface mat in long-term zero tillage fields. These aggregates are easily transported by wind. If the surface mat is lost from zero tillage fields, then application of manure or straw is recommended to prevent erosion.

References

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