Two-year On-farm Study of Crop Residue Removal on Soil Erodibility

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Introduction

Concerns over rising energy costs, dwindling crude oil supplies, increasing energy demand from developing economies, and increasing levels of greenhouse gas emissions are generating a strong interest in producing biofuel from renewable energy sources. Corn (*Zea mays L.*), wheat (*Triticum aestivum L.*) and sorghum (*Sorghum bicolor (L.) Moench*) residues are being considered as potential feedstocks for energy production because of their high abundance. Residue removal for bioenergy production and livestock at large scales may degrade soil productivity and properties.

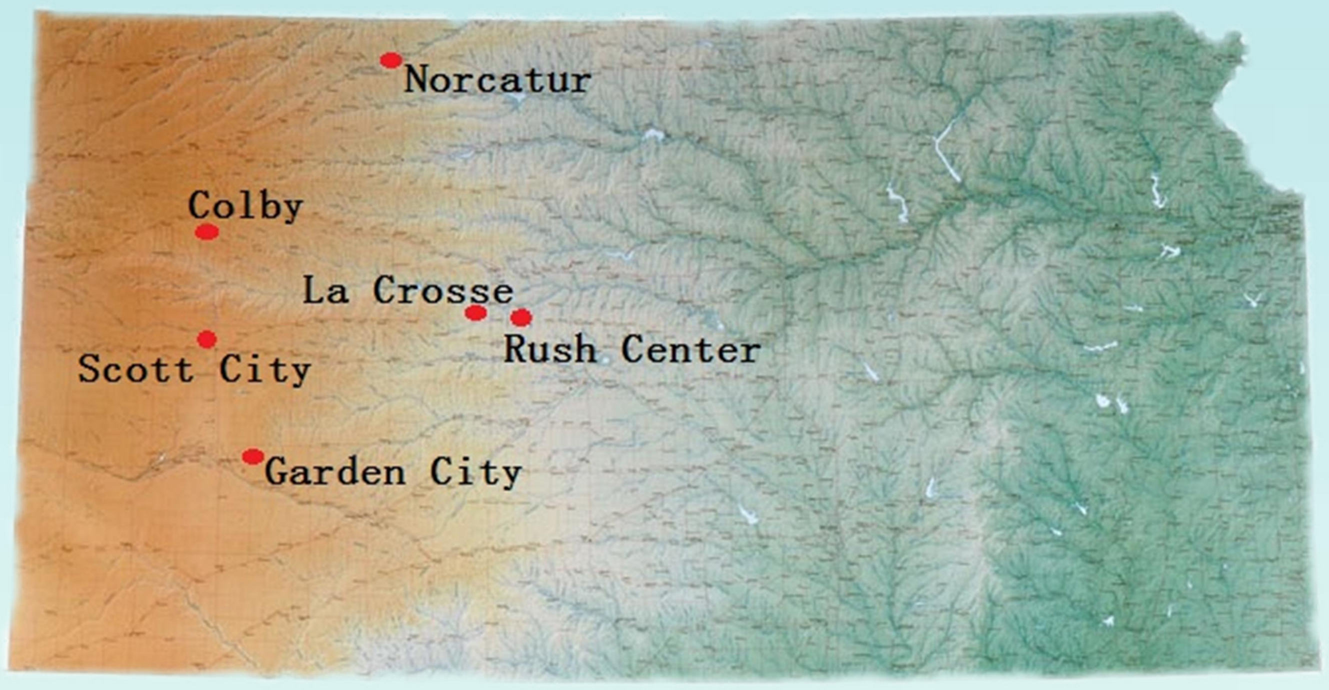
Wind erosion is one of the most important soil degradation processes happening worldwide, particularly in arid and semi-arid area, where precipitation is limited and sparse (Lal, 1990; Rajot et al; 2003). We conducted an on-farm study by removing crop residue at five levels (0, 25, 50, 75, and 100%) at six sites in western Kansas to determine the impacts of crop residue removal on soil wind erosion properties such as soil wind erodible fraction (EF <0.84 mm aggregates), soil surface roughness, and dry aggregate stability.

Objectives

- To measure EF, dry aggregate stability (DAS) and surface random roughness (RR) under different crop residue removal levels under on-farm conditions
- To determine if there are negative impacts of residues removal on soil properties
- To establish the preliminary threshold levels of residue removal for the representative no-till soils in this region

Methods and Materials

Figure 1. Map of Kansas showing the location of six on-farm study sites

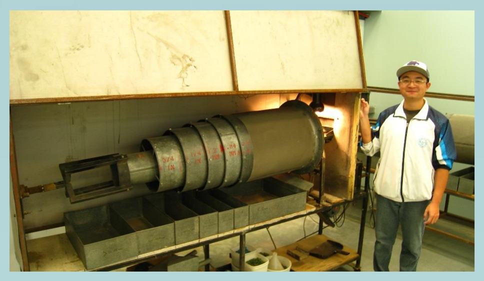


- Five treatments with four replications were arranged in a randomized complete block design. Each plot size was 9.1 m × 9.1 m.

Table 1. Soil and Crop Management Information for Each On-farm Site in Kansas

Research Site	Soil series	Classification	Cropping system 2011-2012-2013	Management history
La Cross	Harney silt loam	Fine, smectitic, mesic Typic Argiustolls	Wheat-wheat-sorghum-fallow	11 years No-till
Rush Center	Bridgeport silt loam	Fine-silty, mixed, superactive, mesic Fluventic Haplustolls	Wheat-wheat-fallow	8 years No-till
Colby	Richfield silt loam	Fine, smectitic, mesic Aridic Argiustolls	Wheat-corn-fallow	15 years No-till
Norcatur	Ulysses silt loam	Fine-silty, mixed, superactive, mesic Aridic Haplustolls	Wheat-corn-wheat	20 years No-till
Garden City	Ulysses silt loam	Fine-silty, mixed, superactive, mesic Aridic Haplustolls	Wheat-fallow-wheat	5 years No-till
Scott City	Richfield silt loam	Fine, smectitic, mesic Aridic Argiustolls	Wheat-sorghum-sorghum	17 years No-till

- First wheat stubble was removed at five different levels (0, 25, 50, 75 and 100%) at each site in July 2011 (Fig. 2). Following crop residue removals were applied based on the cropping system at each site.
- Undisturbed surface soil (0 – 5 cm) was collected from each plot in September, 2011, March 2012, October, 2012, and April, 2013, respectively.
- No less than 2 kg soil from each plot was oven dried at 60 °C for 72 hours to pass a rotary sieve for measuring EF.
- Thirty aggregates from each plot were used to determine dry aggregate stability (DAS) by using soil aggregate crushing energy meter (SACEM).
- Pin meter was used to determine soil surface roughness. One digital picture was taken from center of each research plot. Pictures were analyzed by using SigmaScan Pro 5 software.



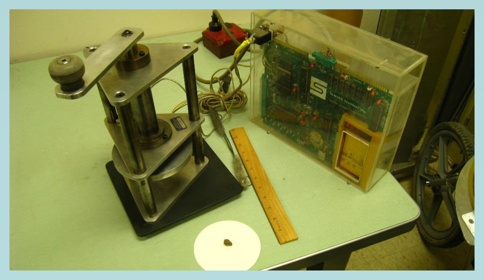
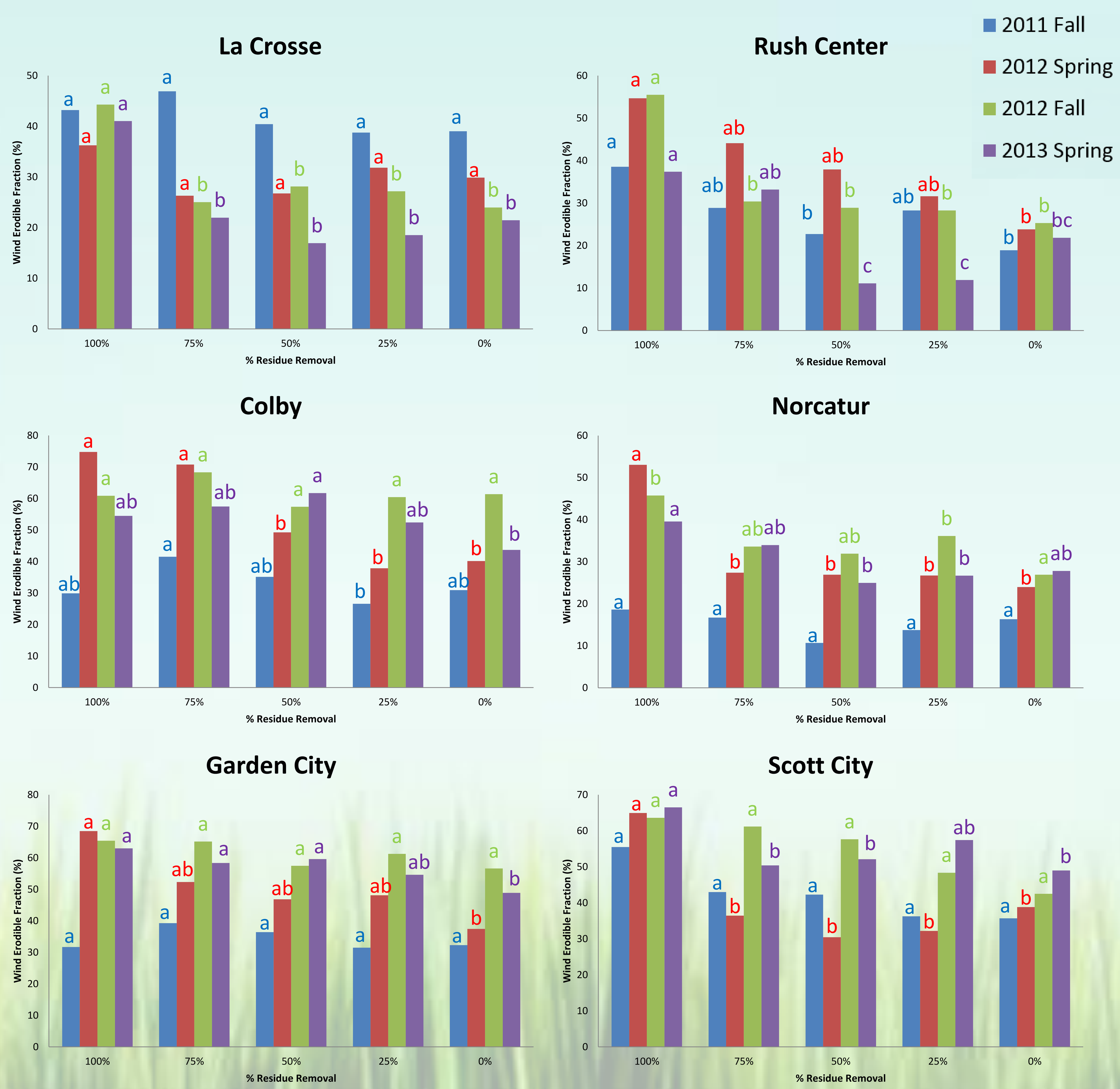


Figure 2. Plots with 50 and 100% removal rates after treatment establishment

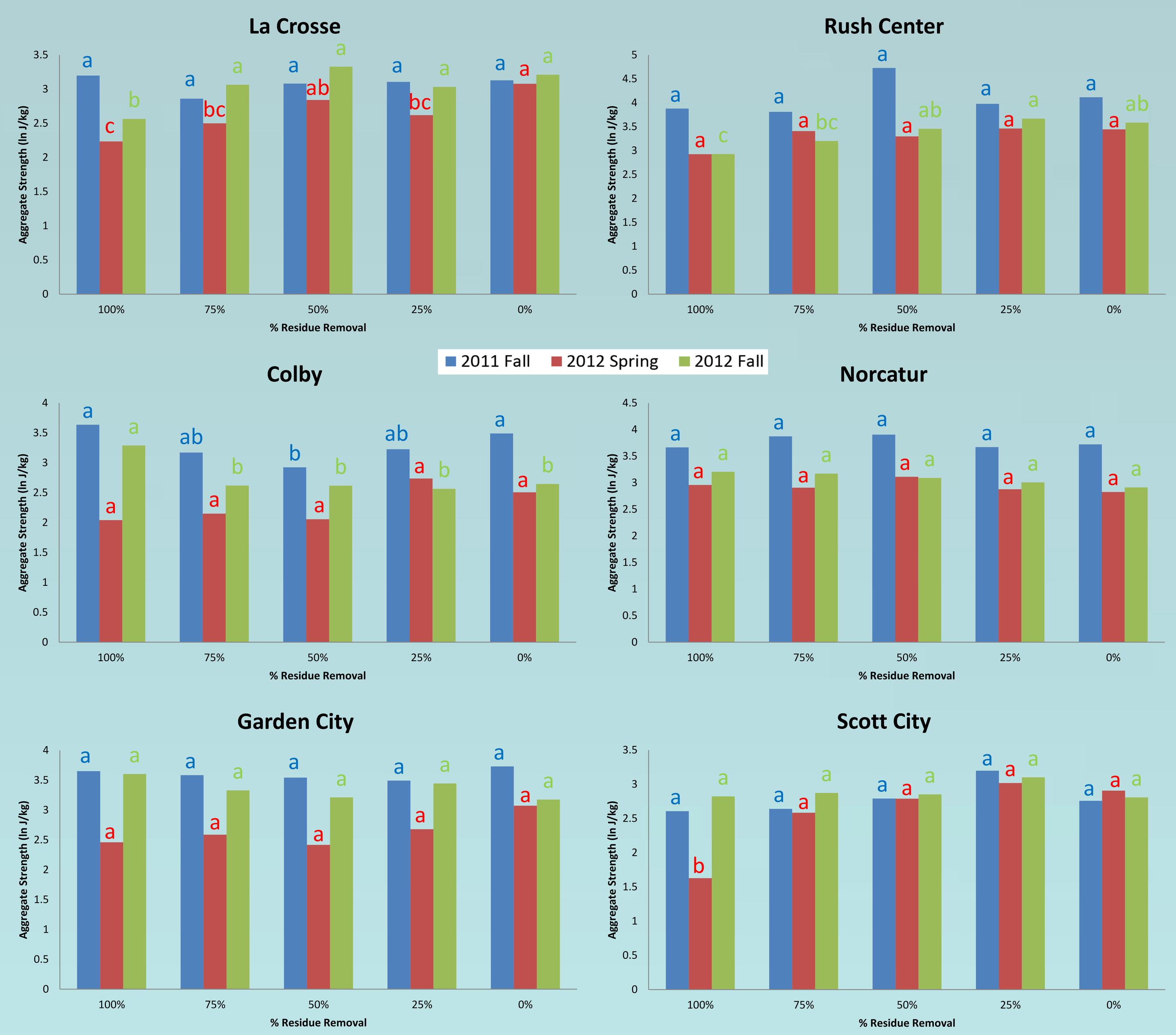
Results and Discussion

Figure 3. Wind erodible fraction (EF)



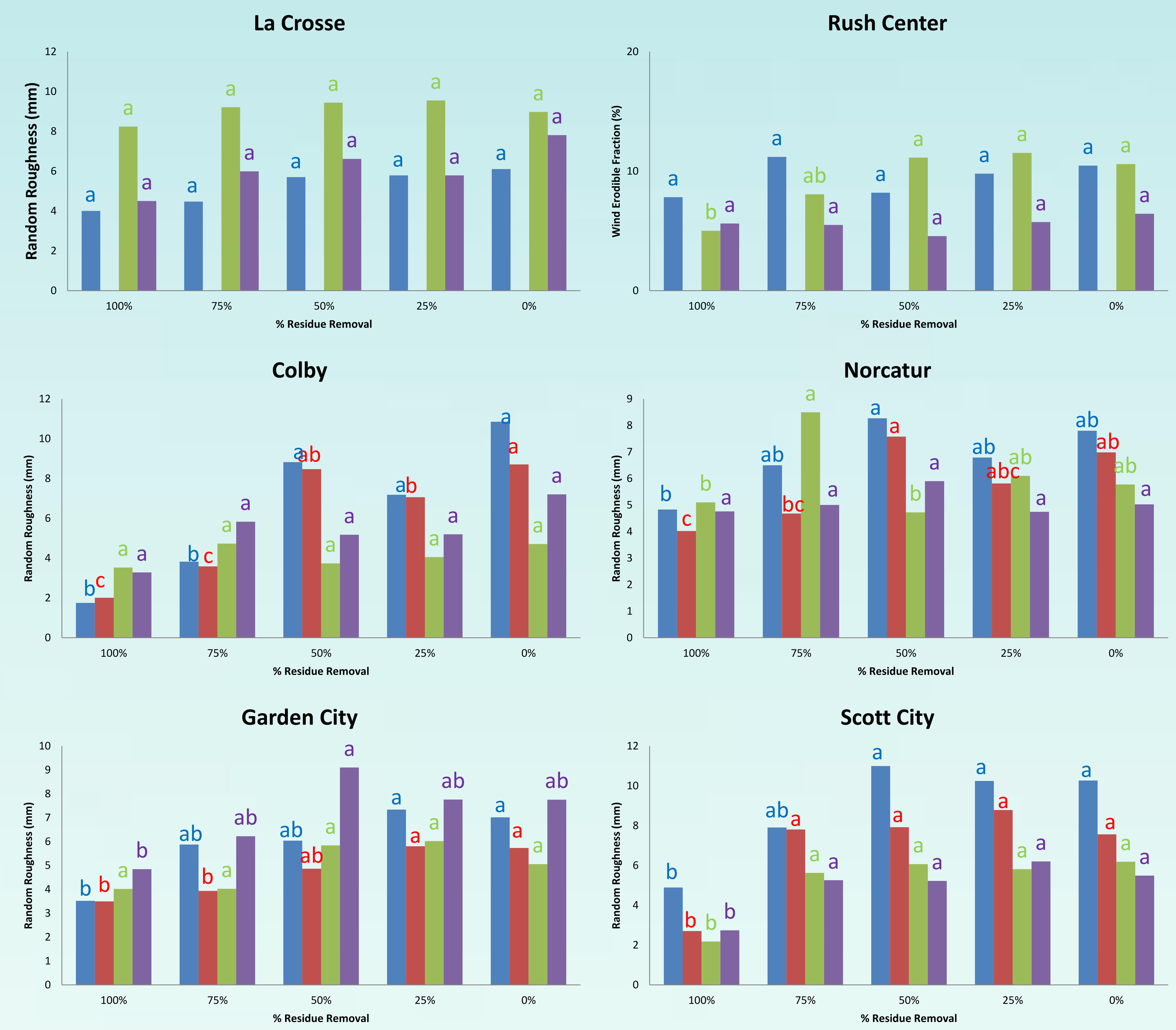
- Results show a general trend of increase in EF with an increasing in crop residue removal rates in each sampling time.
- Four months after the first residue removal, the EF increased between 5 and 10% after 100% residue removal rate in four of the six sites. In spring 2012, the EF increased between 7 and 37% after 100% residue removal rate in all six sites.
- Reduced EF was detected under each treatment at Rush Center and La Crosse in Spring 2013 was attributed to the post-cultivation sampling time.

Figure 4. Dry aggregate stability



- DAS was not affected by residue removal considerately in a short term.
- Eight moths after the first residue removal, DAS decreased significantly under 100% residue removal plots at two sites out of six.
- Generally, the DAS decreased as time went by since the residue removal treatment was established.
- Soil surface crusting and sealing could result in high DAS to soil in these treatments at different sites and different time, such as Colby.

Figure 5 Random roughness results across six sites



- Overall, soil surface random roughness decreased with an increasing in crop residue removal.
- Roughness at three sites out of six has continuous decreasing trend since the treatments were established.
- Roughness is also affected by the cropping system. The roughness at La Crosse site increased in fall 2012 under each treatment could be attributed to the cultivation of winter wheat in fall 2011. Similar pattern has been detected at Rush Center site in fall 2012 and Garden City site in spring 2013.

Conclusions

- Crop residue removal increased soil wind erodibility by increasing wind erodible fraction, decreasing aggregate stability and soil surface random roughness.
- Excessive (> 75%) crop residue removal can rapidly increase soil's susceptibility to wind erosion in some soils.

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Reference

Lal, R. 1990. Soil Erosion in the tropics: Principles and Management. Mc Graw– Hill, New York.

Rajot, J.L., Alfaro, S.C., Gaudichet, A. 2003. Soil crusting on sandy soils and its influence on wind erosion. Catena 53, pp. 1-16.