Carbon Source Quality and Placement Effects On Soil Organic Carbon Status

Brian Wienhold, USDA-Agricultural Research Service, Lincoln, NE
Gary Varvel, USDA-Agricultural Research Service, Lincoln, NE
Jane M-F Johnson, USDA-Agricultural Research Service, Morris, MN

Background

Crop residue and perennial grasses have been identified as potential feedstocks for biofuel production. Residue protects soils from potential wind and water erosion, serves as a boundary layer reducing evaporation, and serves as a substrate for soil biota. The objective of this study was to measure changes in soil organic matter components after five annual additions of carbon sources varying in quality.

Methods & Materials

Treatments were applied to a silty clay loam soil in eastern Nebraska. The experimental design was a randomized complete blocks with four replications.

Carbon sources listed in table 1 varying in availability as an energy source for soil biota were applied at a rate similar to the long-term wheat yield. Annual and perennial grass treatments included: WR+ = Wheat grown and residue returned after harvest; WR- = Wheat grown and residue removed after harvest; FWR+ = fallow plots with wheat residue added at harvest; SR+ = Switchgrass grown and residue returned at harvest; SR- = Switchgrass grown and residue removed at harvest; FSR+ = fallow plots with switchgrass residue added at harvest.

Soil samples were collected each fall prior to applying the carbon sources.

Results

- **Total particulate organic matter decreased in the alfalfa , sucrose, control, and FR+ treatments (Table 1).**
- **Labile C increased in all annual and perennial plant treatments (Table 1).**
- **Total organic C increased in the wood, WR+, SR+, and SR- treatments (Table 1).**
- **Mean aggregate diameter was maintained in WR+ and all perennial grass treatments (Fig. 1).**
- **Soil respiration was temporally dynamic but greatest in annual and perennial grass treatments (Fig. 2).**

Table 1. Changes in soil organic matter components as a function of carbon source in eastern Nebraska.

	Total particulate organic matter ($Mg\ ha^{-1}$)		Total labile carbon ($Mg\ ha^{-1}$)		Total organic carbon ($Mg\ ha^{-1}$)	
Treatment¥	2002	2007	2002	2007	2002	2007
Wood	6.3 ± 1.0	5.4 ± 1.0	3.0 ± 0.2	3.8 ± 0.2	13.1 ± 1.4	16.4 ± 1.4
Alfalfa	7.2 ± 1.0	3.0 ± 1.0	3.0 ± 0.2	3.3 ± 0.2	13.3 ± 1.4	10.7 ± 1.4
Flour	6.3 ± 1.0	3.7 ± 1.0	3.0 ± 0.2	3.3 ± 0.2	13.4 ± 1.4	15.1 ± 1.4
Paper	7.1 ± 1.0	4.7 ± 0.8	3.2 ± 0.2	3.5 ± 0.2	14.5 ± 1.4	16.1 ± 1.4
Sucrose	5.8 ± 1.0	2.8 ± 1.0	2.8 ± 0.2	2.9 ± 0.2	12.5 ± 1.4	13.6 ± 1.4
Control	7.7 ± 1.0	4.0 ± 1.0	3.2 ± 0.2	3.4 ± 0.2	15.0 ± 1.4	15.7 ± 1.4
WR+	6.8 ± 1.0	7.6 ± 1.0	3.0 ± 0.2	4.1 ± 0.2	14.0 ± 1.4	19.2 ± 1.4
WR-	6.3 ± 1.0	4.9 ± 1.0	3.0 ± 0.2	3.7 ± 0.2	12.9 ± 1.4	14.6 ± 1.4
FWR+	6.5 ± 1.0	3.2 ± 1.0	3.0 ± 0.2	3.7 ± 0.2	14.2 ± 1.4	14.3 ± 1.4
SR+	6.7 ± 1.0	9.1 ± 1.0	3.1 ± 0.2	4.4 ± 0.2	13.3 ± 1.4	17.5 ± 1.4
SR-	8.1 ± 1.0	8.0 ± 1.0	3.2 ± 0.2	4.4 ± 0.2	14.7 ± 1.4	20.1 ± 1.4
FSR+	6.4 ± 1.0	5.2 ± 1.0	2.9 ± 0.2	4.2 ± 0.2	12.9 ± 1.4	16.7 ± 1.4

Pairs of values shaded yellow are different at $P < 0.05$.

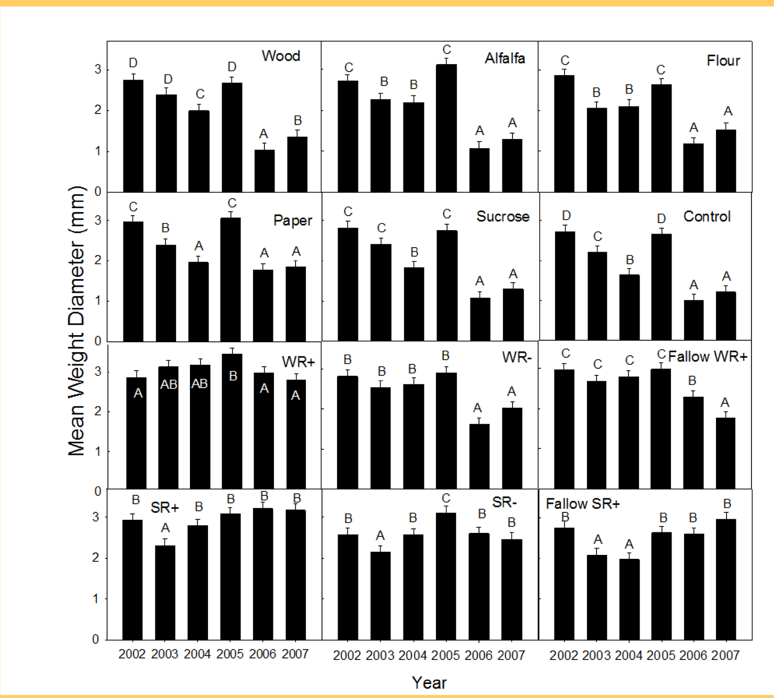

Fig. 1.

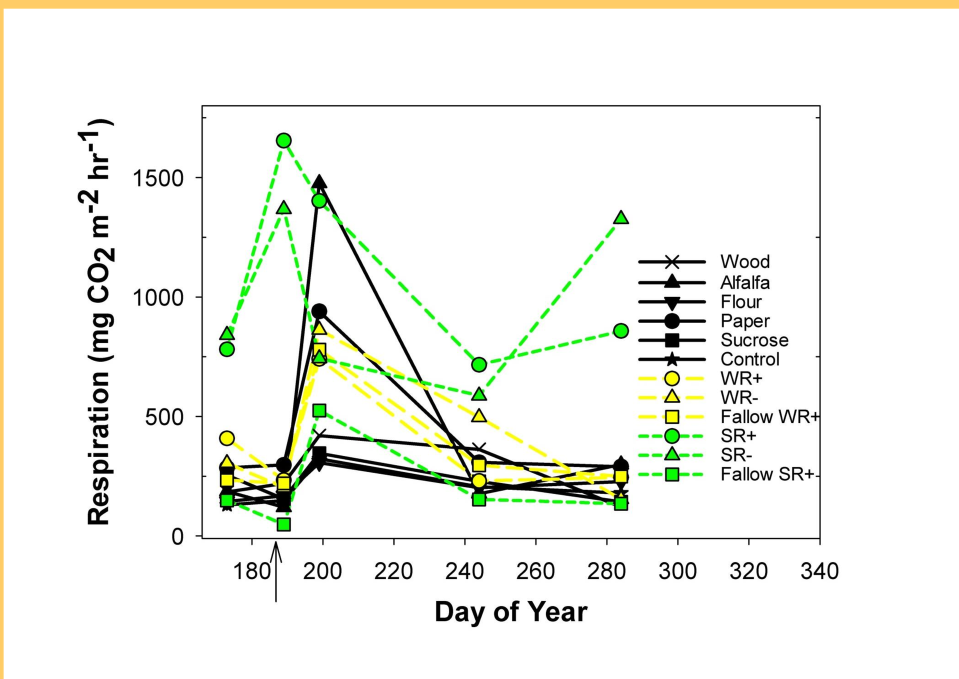

Fig. 2

Conclusion

Surface plant residue protected the soil against raindrop impacts and reduced the intensity of wetting and drying cycles allowing the development of larger more stable aggregates resulting in C accrual.