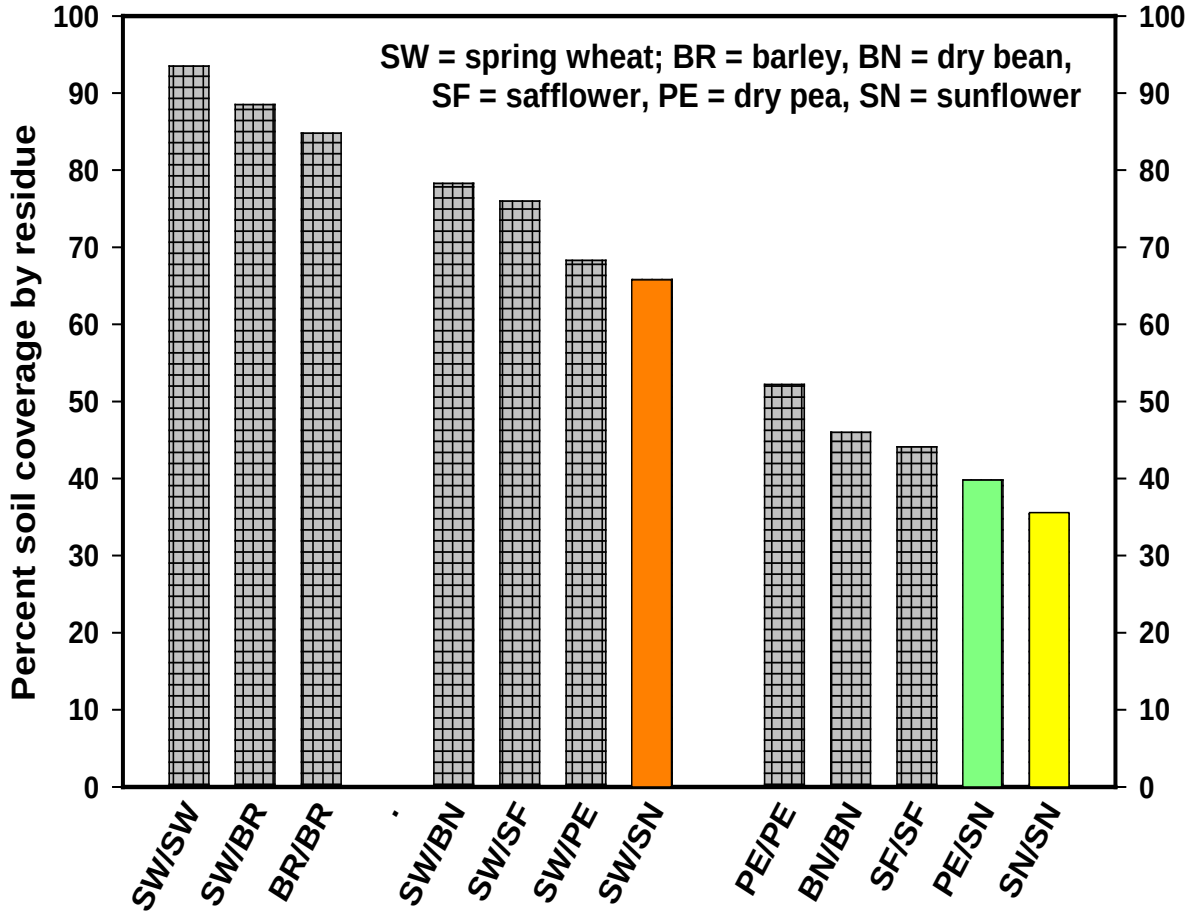
Wind Erosion, Diverse Cropping Systems, and Soil Conservation Management

An Active Measurement Wind Erosion Study

Soil coverage by residue in spring 2001 after seeding spring wheat after various 2-year sequences of crops. From Phase II crop sequence experiment.



Our work with cropping-systems has been carried out with no-till management, and as the selected measurements of residue coverage in spring shown here indicate, residue coverage levels are all over 30%, providing at least a modest level of soil protection. The problem is that lower residue-providing crops, notably sunflower and dry pea, will not provide sufficient soil protection if they are subsequently disturbed by tillage, or if drought reduces crop growth so that soil coverage by residue becomes inadequate, falling below 30%.

yellow = SN/SN
orange = SW/SN
green = PE/SN

Agronomic scenario for northern Great Plains active measurement wind erosion experiment:

Producer has no-till managed land that is covered with sunflower stubble this spring; land was in spring wheat the prior year, thus residue coverage is adequate;

Pre-plant tillage is carried out in April;

Because of unfavorable weather or economics, the decision is subsequently made to not crop the land and to summer-fallow with glyphosate.

NO-TILL

Tillage was carried out in early April with results as shown here. The soil was Temvik-Wilton silt loams. All weed control following the initial tillage was by application of glyphosate

<u>Tillage Treatments</u>:

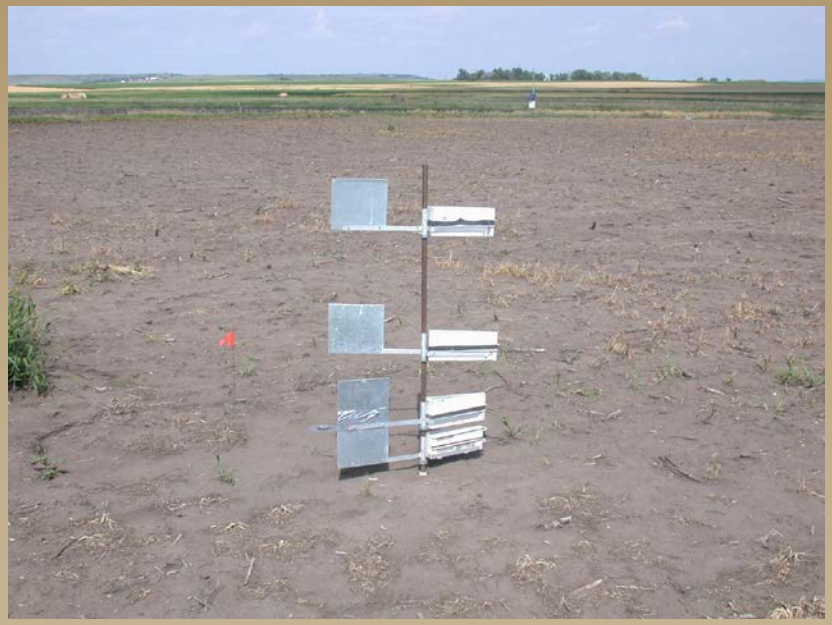
No-Till
Med-Till - single pass with tandem disk
Max-Till - double passage with offset disk followed by single pass with rotary harrow

MAXIMUM-TILL

MEDIUM-TILL

Shown here are the instruments used to measure soil losses in an active measurement wind erosion experiment. The most important of the instruments were the sediment samples, which were at a height of 4 inches above the surface.

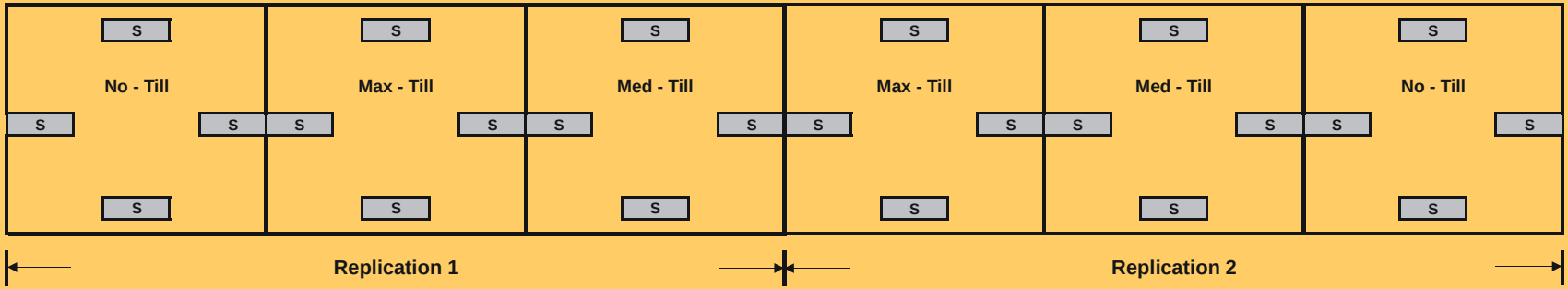
Sediment sampler



Stacked sediment samplers

Sensit – piezoelectric flying particles sensor

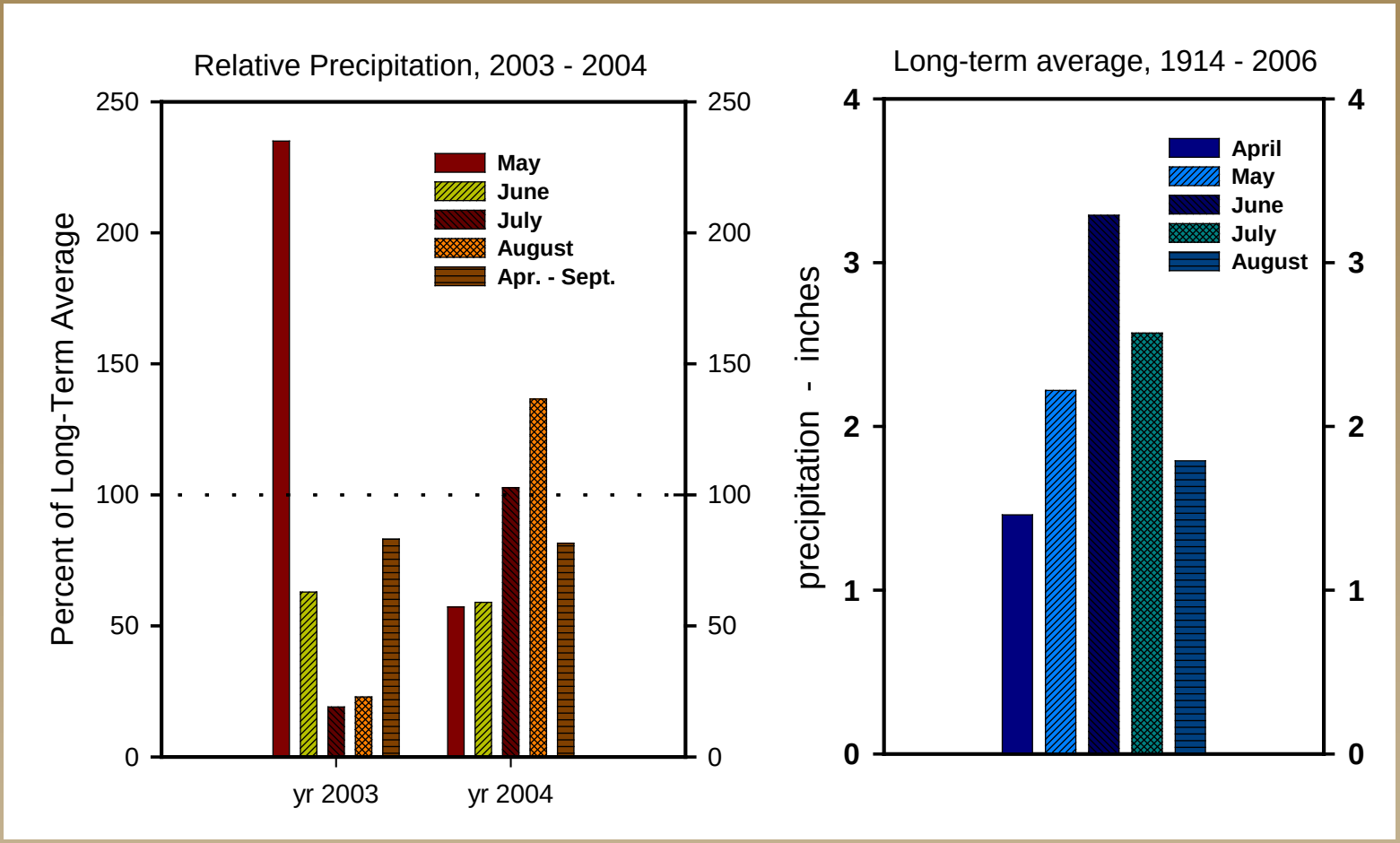
Fig. 1. Layout of Erosion Plots in 2004



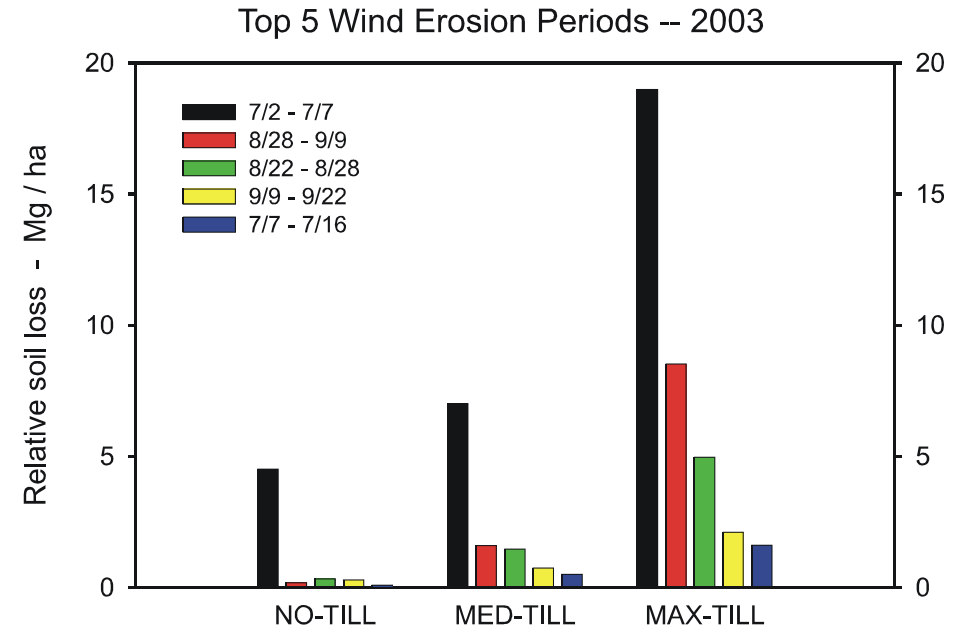
S = location of sediment sampler

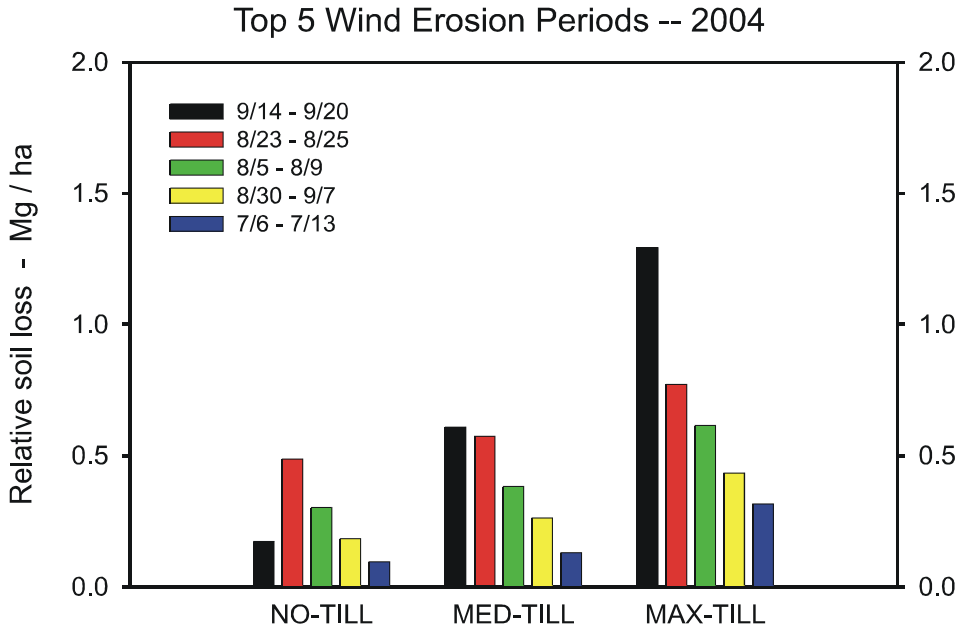
The experiment was conducted in 2003 and 2004. The 3 tillage treatments were replicated. Each erosion plot was approx. 3.7 acres and was surrounded by non-erodible strips that had been tilled and seeded to wheat. Sediment samplers were placed near plot boundaries.

Precipitation during 2003 and 2004 Seasons



Precipitation during both 2003 and 2004 seasons was below average, but the distribution was considerably better in 2004 than in 2003, which had very high rain in May and quite low rain in July and August.



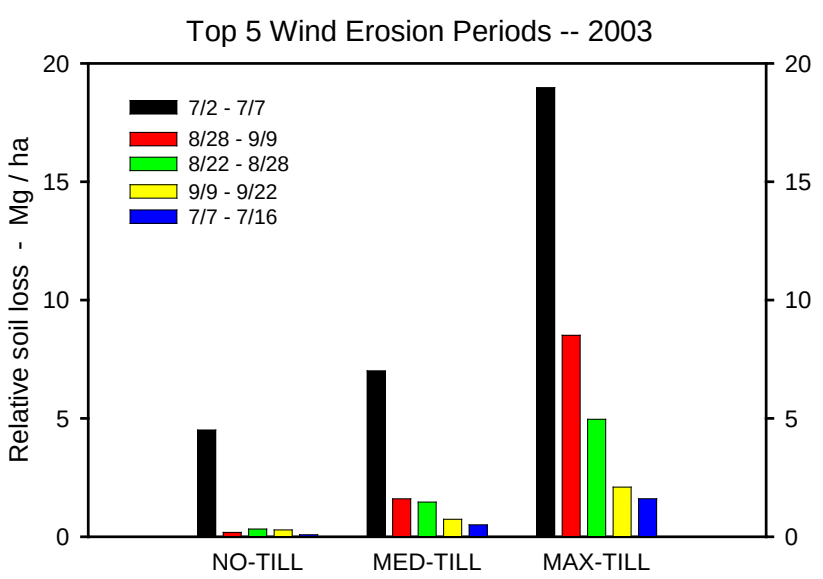


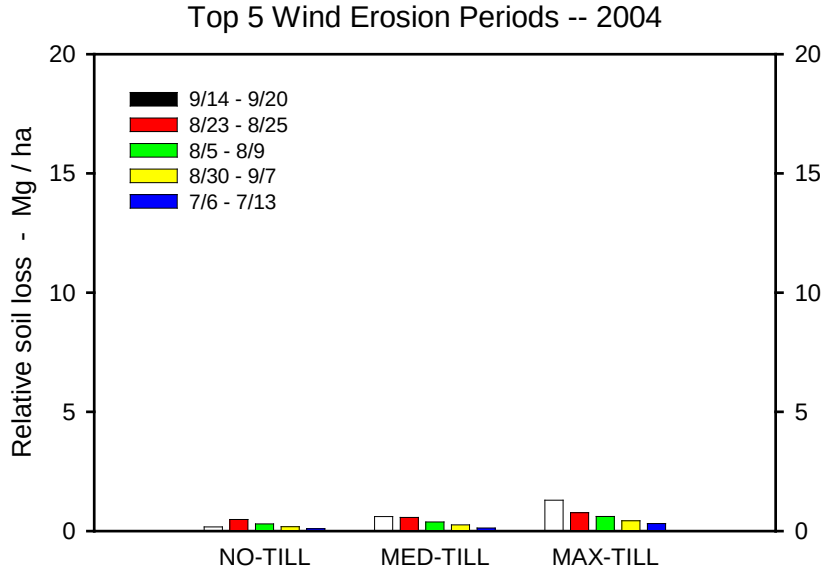
Shown here are the principal results of our wind erosion experiment. There was much more wind erosion in 2003 with its dry summer than in 2004 (note the change in vertical scale).

Soil losses for the Max-till treatment with its high level of tillage and low soil roughness were typically many times greater than for No-till. However, significant soil losses were observed for No-till during a violent wind-storm in July, 2003 (peak windspeeds above 60 mph). Sunflower stubble is a relatively non-durable form of crop residue.

1 Mg/ha = 0.446 ton/acre.

Principal results comparing 2003 and 2004 soil losses graphed on the same vertical scale.





SUMMARY

Soil losses in 2003 were approximately 10 times higher than in 2004 due to more weed growth and better summertime rainfall distribution in 2004 compared with dry summertime conditions in 2003.

The greatest soil loss under Max-till for a storm period in the significantly dry year, 2003, approached an estimated 20 Mg/ha (9 ton/acre) and cumulative summertime losses were approximately 40 Mg/ha (18 ton/acre). This is a potentially damaging, unsustainable level of soil loss which has been quantitatively documented here as having occurred on a soil that is normally considered to be of higher quality and non-erodible.

The value of Max-till to No-till and Med-till to No-till average soil loss ratios for the top five windstorm periods in 2003 were 13 to 1 and 4 to 1, respectively.

The ultimate soil-crop management, soil conservation management lesson from this experiment:

Even with no-till management, lands with fragile, non-durable crop residues such as sunflower can become subjected to potentially damaging levels of wind erosion in semi-arid/subhumid areas when seasonal drought interacts with aggressive chemical weed control and/or tillage disturbance.

Is serial monoculture managed by chemical weed control sustainable over the long term?

Additional Information: Appearance of Wind-Driven Rain Erosion

During rainstorms with higher winds, significant amounts of soil can be moved quickly as the high kinetic energy of wind-driven raindrops lofts soil particles into the windstream, overcoming standing residue and soil roughness. Thus, wind-driven rain erosion (WDRE) is Mother Nature's equalizer, overcoming weakened residue protection of no-till, and tending to equalize soil loss among tillage treatments, as seen in the figure here. Although WDRE is self-limiting, it moves and transforms surface soil from more aggregated, non-erodible conditions and places into erodible positions and conditions so that such soil becomes erodible by subsequent wind- and rain-storms.