Macroclimatic Indices to Define Potential Soil Organic Carbon Storage with No Tillage

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BACKGROUND

Conservation tillage causes a change in ecological conditions

- reduces mixing of soil
- crop residues are concentrated at the soil surface
- microclimate and some soil properties change

Drivers of change in tillage

- socio-economic
  - philosophy, community perception, cost/benefit, risk, availability of equipment, regulations, policies
- environmental
  - natural resource base, temperature, precipitation

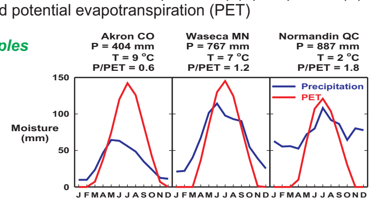
Hypothesis

- macroclimate will affect the "potential" of soil to accumulate soil organic C during conversion of conventionally tilled cropland to no-tillage cropland

Macroclimate

- influences biological activity
  - plant production, soil microbial activity
- main features include temperature (T), precipitation (P), and potential evapotranspiration (PET)

Examples



APPROACH

Peer-reviewed publications

- compilation of data on soil organic C (SOC) under no tillage (NT) and conventional tillage (CT)
- calculated on volume basis to at least the depth of tillage in CT (10-25 cm)
- calculated as change in SOC = $[SOC_{NT} - SOC_{CT}]$ / years
- 46 locations in USA and Canada with 136 comparisons varying in time, fertilization, and cropping intensity

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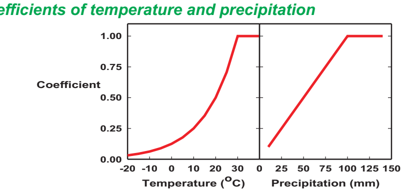
Climate descriptions

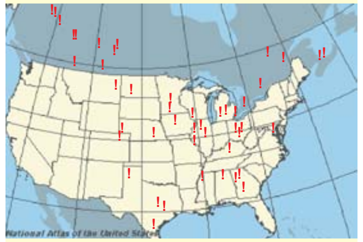
- long-term mean monthly temperature and precipitation from Global Historical Climatology Network website: ftp://ftp.ncdc.noaa.gov/pub/data/ghcn
- expressions of "decomposition potential" calculated from (a) monthly means and (b) yearly means
  - ratio of precipitation-to-potential evapotranspiration
  - temperature x precipitation coefficients
  - most limiting temperature or precipitation coefficient

Coefficients of temperature and precipitation

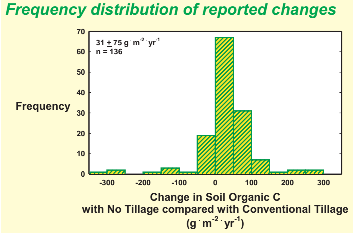


RESULTS

Distribution of locations

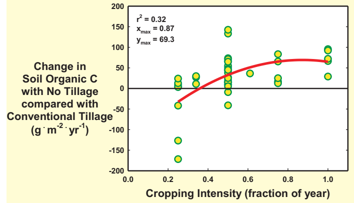


Frequency distribution of reported changes



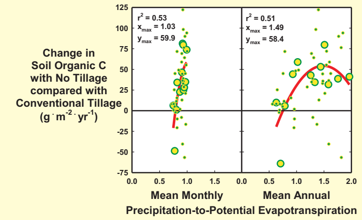
81% of comparisons had greater SOC with NT than with CT. The middle 25% of comparisons averaged 25 ± 7 g m^{-2} yr^{-1}.

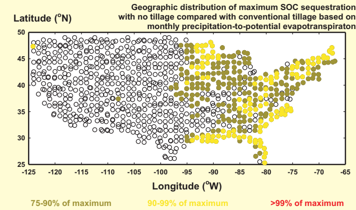
Effect of cropping intensity on tillage-induced changes

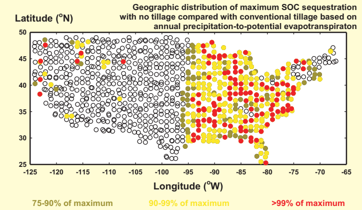


Greater SOC can be sequestered with NT compared with CT with higher cropping intensity.

Precipitation-to-potential evapotranspiration

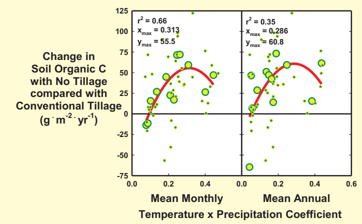


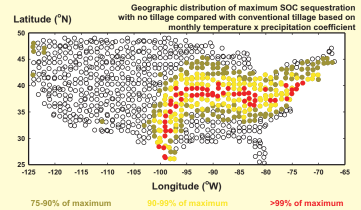


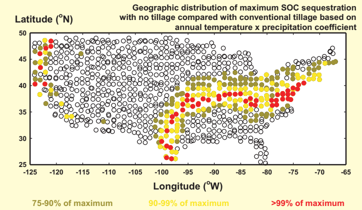


Whether P/PET was from monthly means or from annual means had little effect on the strength of regressions. Monthly P/PET had a lower range than annual P/PET, which may reduce sensitivity.

Temperature x precipitation coefficient

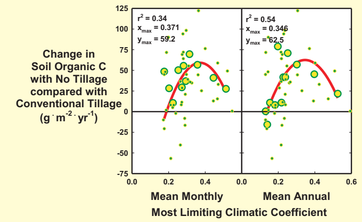


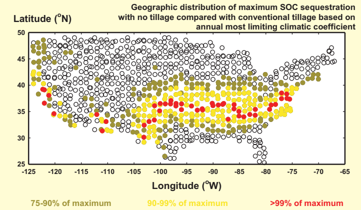




Mean monthly T x P coefficient was a stronger predictor of changes in SOC than mean annual T x P. Both predictors produced a similar geographical distribution that was more restricted than P/PET.

Most limiting climatic coefficient





Most limiting climatic coefficient was almost always due to temperature.

Geographical distribution of maximum potential SOC sequestration with no tillage compared with conventional tillage based on overlap of 3 annual climatic indices.