SIMULATING EFFECTS OF CROP RESIDUE MULCHING ON SOIL WATER AND MAIZE GRAIN YIELD IN THE TROPICAL CERRADO REGION OF BRAZIL

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AIM

To evaluate effects of crop residue mulching on the water balance and final grain yield of maize under the humid tropical conditions of Central Brazil

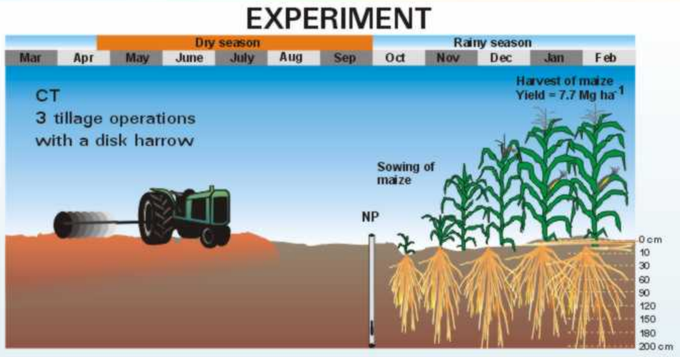
BACKGROUND

- Cropping systems with direct seeding into a mulch of plant residues (DMC) are increasingly being adopted in the Cerrado region of Brazil.
- The major drive behind the development and adoption of DMC is land degradation
- With DMC systems a soil cover of growing plants or crop residues is maintained throughout the whole year

- The principal effects of a mulch of crop residues on soil water dynamics are:
  - interception of rainfall
  - reduction of evaporation from soil through interception of radiant energy
  - reduction of surface water runoff

MATERIAL AND METHODS

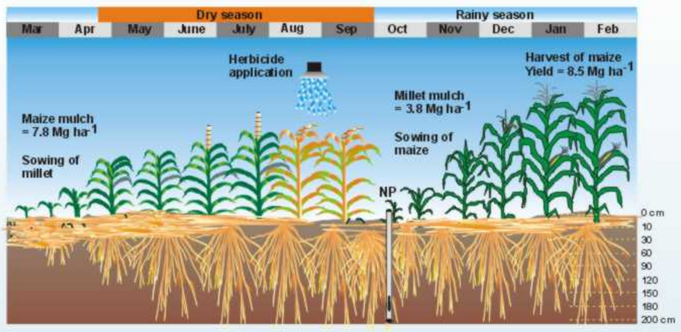
EXPERIMENT



Field experiment at the experimental farm of Embrapa Cerrados (15o35´S, 47o42´W)
Soil: Geri-Gibbsic Ferralsol (Xanthic), a widely distributed soil in the Cerrados
Mean annual rainfall is 1490 mm, with a dry season from May till September Temperature ranges from 16 to 27°C

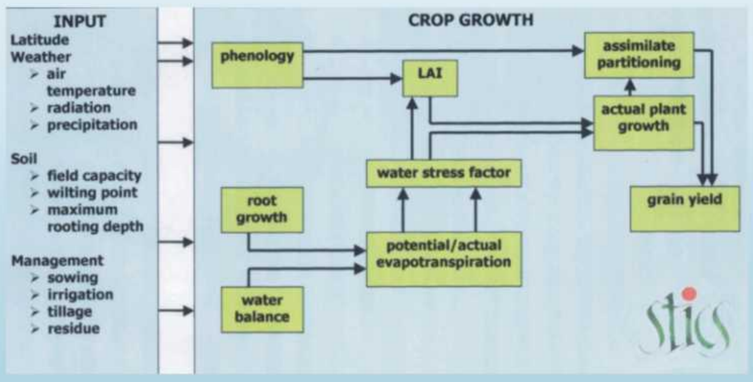
Two treatments: conventional tillage (CT) and with direct seeding into mulch (DMC) "
- CT: 3 tillage operations with a disk harrow (to about 25 cm depth) - no millet cover crop
- DMC: no-tillage and millet cover crop preceded the maize crop.

In both treatments, we monitored soil moisture using a neutron probe and LAI of maize at regular intervals. At harvest, final grain yield and above-ground dry matter of the maize crop were determined.



MODEL

Crop growth model STICS with a surface residue module (Brisson et al, 2003).



Modifications to include crop residue mulching are:

1) introduction of a pool of surface residues with first order decomposition dynamics and calculation of the corresponding soil cover.
2) rainfall interception by surface residues based on percent soil cover and the storage capacity of the residues, and evaporation of this water at potential rate.
3) reduction in evaporation from soil caused by radiation interception by surface residues.
4) reduction of surface water runoff as function of residue cover (Figure 1) and LAI.

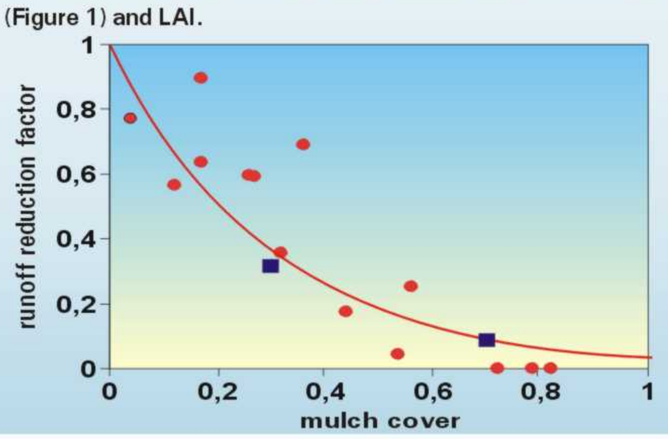


Figure 1. Relationship between surface residue cover and water runoff reduction factor. The reduction is relative to runoff from bare soil. Symbols are observed data from (●) Gilley et al. (1986) and (■) Findeling et al.(2003).

RESULTS

MODEL CALIBRATION AND PREDICTION

1) model calibration for maize growth and soil water dynamics using the data from the CT treatment

2) run the model for the DMC treatment by activating the surface residue module

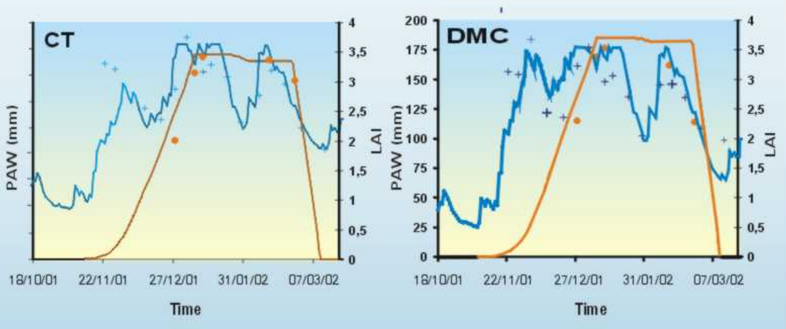
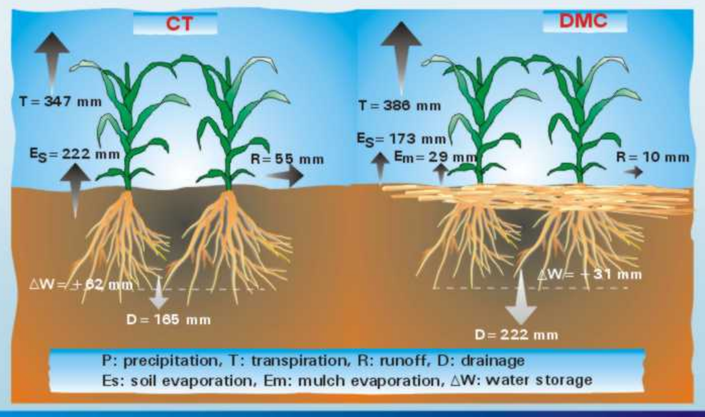


Figure 2. Observed (symbols) and simulated (line) plant available soil water (PAW) and leaf area index (LAI) during the maize growing cycle for the CT and DMC treatment.

- The model was able to simulate reasonable well the soil water dynamics, once LAI was fitted to observed data
- The simulated effect of mulching on LAI and soil water was, however, more pronounced than indicated by the observations "
- An increase of simulated grain yield (from 7300 to 8000 kg ha^{-1}), which was consistent with the slightly higher observed grain yields in the DMC treatment .

Mulching effects on water balance
Total rainfall during the growing cycle: 851 mm.



Mulch cover and water runoff effects on grain yield

- Simulations were conducted with input parameters and weather data (2001-2002) as above. "Small amounts of mulch strongly affect grain yield, especially under scenarios of high potential water run-off
- Once mulch loads exceed about 2 Mg ha^{-1}, grain yield only slightly increases with increased mulch quantity and mulching effects on surface runoff are no longer important

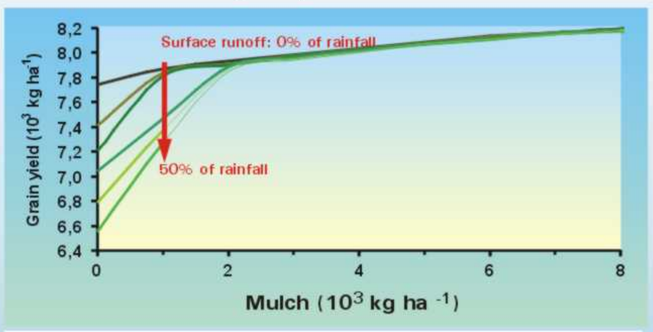


Figure 3. Simulated maize grain yield as function of mulch quantity from preceding millet crop under different scenarios of potential surface water runoff from bare soil. The potential water runoff was respectively 0, 10, 20, 30, 40 and 50% of the rainfall amount that exceeds 5 mm on a daily basis.

CONCLUSIONS

- Potential to conserve water with mulching is mainly through a decrease in surface runoff
- Gains in water conservation with mulching are partially counterbalanced by increased drainage losses
- Mulch increases the risk of deep drainage and nutrient leaching
- The net effects on growth and final grain yield are relatively small, because of limited water stress during the growing season "
- For a more complete evaluation of DMC systems also other effects on soil surface conditions need to be included, such as mulch induced changes on soil temperature and nutrient dynamics

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