Assessing the effect of soil crack dynamics on hydraulic properties of agricultural soil from reduced tillage and conventional tillage fields, Wallonia-Belgium

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BACKGROUND

Aerate soil, facilitate root and water infiltration etc.

Reduce stability of infrastructure, accelerate soil desiccation.

Soil cracks

Pathway for pesticides/pollutants

Pollute soil, ground water etc.

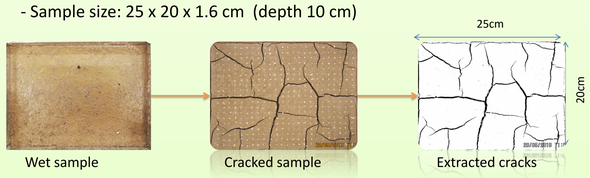
Cracks and their effect on soil hydrology are scarcely studied on agricultural soil. **Aims**: Compare crack dynamics during drying and hydrological properties of reduced tillage-residue-in **(RTRI)** and conventional tillage residue-out **(CTRO) ,** + disturbed soil **(DS)** .

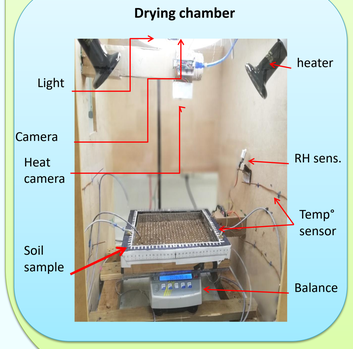
MATERIALS AND METHODS

➢ **Samples**

-10 samples : 3 Reduce tillage-residue-in ***(RTRI)***; 3 conventional tillage-residue-out ***(CTRO)***; and 4 Disturbed samples ***(DS)***.

- Sample size: 25 x 20 x 1.6 cm (depth 10 cm)





➢ **Drying chamber** :
- Temperature : 30°C
- Pressure transducer (0-2000hPa)
-Weight: balance

➢ **Image collection and analysis**:
-Digital camera: 12 Mpixel
- Image analysis : ImageJ + PCAS
- Cracks properties : crack intensity factor (CIF) = crack area/sample area

➢ **Soil hydraulic properties**:
-Evaporation rate & Soil Water Retention curve (Water content vs suction)

➢ **Treatments**
- Reduced Tillage –residue-in (***RTRI***)
- Conventional Tillage-residue-out (***CTRO***)
- Disturbed soil (***DS***)

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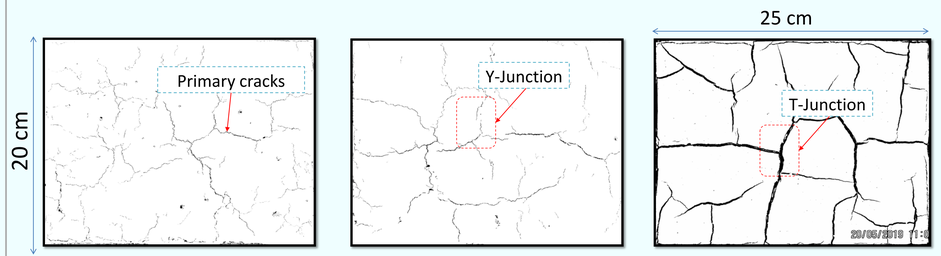
RESULTS AND INTERPRETATION



a)- Reduced tillage-residue-in (RTRI) b)-Conventional tillage-residue-out(CTRO) c)-Disturbed soil (DS)

Figure 1: Typical cracks in Conventional tillage (a), Reduced tillage (b), and Disturbed soil (c)

Crack intersection of nodes at full development :

- **Crack area, length:** *Disturbed soil (**DS**) > Reduced tillage-residue-in (**RTRI**) > Conventional tillage-residue-out(**CTRO**).*
- **Junction for primary cracks**: in “T” shape (90°) for ***DS*** and in “Y” shape (120°) for ***RTRI + CTRO***.

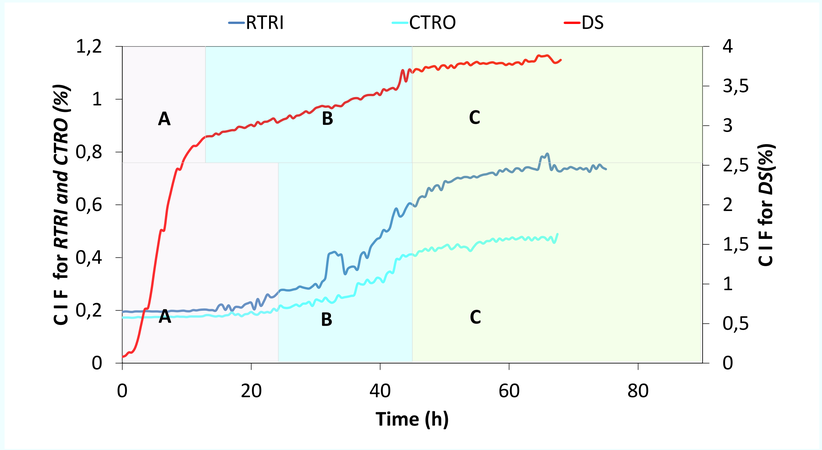
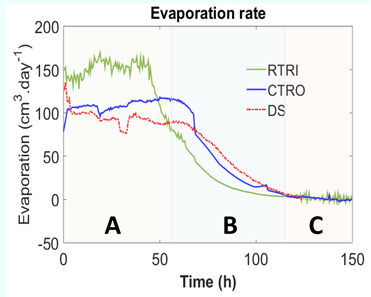


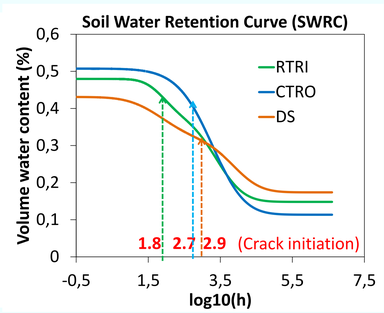
Figure 2: Evolution of Crack Intensity Factor (CIF) during desiccation time

Crack initiation and development :

- **Three cracking periods** for ***RTRI, CTRO*** : A (slow rate), B (fast increase) and C (steady)
- **Two cracking periods** for ***DS***: period A (fast increase) and steady period B
- **CIF : DS > RTRI > CTRO**



a)- Water evaporation (representative sample)



b)- SWRC + crack initiation

Figure 3: Soil evaporation Vs crack formation during drying

Water evaporation and retention during crack propagation :

- **Three evaporation periods:** A (constant rate), B (falling-1) and C (falling-2)
- **Evaporation:** ***RTRI > CTRO > DS***
- **Suction at crack initiation:** ***RTRI*** (70hPa) > ***CTRO*** (500 hPa)> ***DS*** (>800hPa)
- **SWRC:** bimodal for ***RTRI & DS***, mono-modal for ***CTRO***

Table 1: Soil physical and chemical properties

Category	Reduced tillage (RTRI)	Conventional Tillage (CTRO)	Disturbed sample (DS)
BD (g/cm³)	1,39±0,024b*	1,5±0,024a	1,56±0,021a
Clay (%)	15,85±0,112a	15,18±0,103b	16,04±0,145a
OC (mg/kg soil)	15,99±0,478a	12,74±0,436b	17,13±0,617a

Soil physical and chemical properties :

- ***RTRI***: Low Bulk density (BD), higher clay content, and high OC
- ***CTRO***: higher bulk density, lower clay content, and low OC
- ***DS:*** Bulk density similar to ***CTRO***

CONCLUSIONS

- CIF: ***DS > RTRI > CTRO*** . Probably due to loose of soil cohesion (***DS***), soil porosity (BD), soil OC, soil aggregation, and biological activities.
- Soil desiccation rate: ***RTRI > CTRO ≈ DS***.
- Crack initiation needs more suction in: ***DS> CTRO > RTRI***.
- Crack affects the SWRC and soil evaporation

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