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SOURCE OF SEDIMENT AND SOIL REDISTRIBUTION AFTER RAINFALL EVENTS IN A FURROW-SHOULDERS SYSTEM

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Introduction

Sediment tracers have been used as a complementary tool to understand soil movement by water erosion under different conditions. **Simulation models** are also used to understand and extrapolate the dynamics of water erosion in agricultural systems under different scenarios.

In this communication we combine several iron oxides, **magnetite** (*Guzmán et al., 2010*), **hematite** and **goethite**, during rainfall simulation experiments at different scales with model analysis using **EUROSEM**, to characterize the erosion dynamics in a furrow-bed system under different scenarios.

Material and Methods

The sediment source tracking tests were performed in a plot cultivated with cotton in Southern Spain with a slope of 0.8% formed by **conventional tilled beds** with two soil managements: with (**+T**) and without traffic (**-T**) (*Boulal et al., 2010*).

Fig.1.- Rainfall simulations at small scale

Rainfall events of 60 mm·h^{-1} and 1h duration were simulated with a portable rainfall simulator at **micro-plot scale** in furrows tagged with magnetite (**Fig.1**). Source of sediment (bed planting or furrows) was identify at two different ground covers (bare beds or with standing residues).

An rainfall simulation test of 8.5 h and an intensity of 18 mm·h^{-1} was performed at **field scale**. Three areas of furrows surface were tagged with magnetite, hematite and goethite. Runoff, soil losses and tagged areas contribution to sediment were determined (**Fig.2**).

Fig.2.- Rainfall simulation at field scale

The erosion model **EUROSEM** was calibrated and validated using the experimental information obtained from these simulations, and field and crop description. Once calibrated, it was used to study **sediment and sedimentation dynamics** in a broader range of conditions: slope, length and ground cover.

Results

The validation of iron oxides concentrations in soil using magnetic susceptibility and optical properties resulted in a r^2= 0.99, 0.93, 0.91 and a RMSE=0.10, 0.51, 0.44 % in weight for magnetite, hematite and goethite respectively.

Source of sediment was identify at **small scale** measuring tracer concentration in soil and sediment after correcting them by selectivity in transport and tracer distribution in soil profile, **Fig.3**. Deposition of soil from beds (untagged) to furrows (tagged) was observed in all the cases, **Fig.4**.

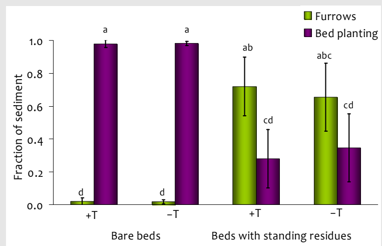

Fig.3.- Source of sediment at small scale in furrows +T and –T (Tukey HSD p<0.05)

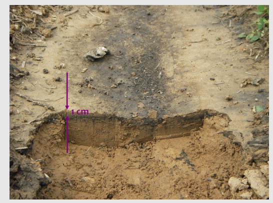

Fig.4.- Soil redistribution after the simulations

At **field scale**, furrows +T presented higher runoff and soil losses for the same sediment concentration because runoff started later and the amount was smaller, **Table 1**.

Furrows management	Runoff (mm)	Soil losses (g/m^2)	Time to runoff (min)	Sed. Conc. (g/l)
+T	63.5 ± 22.6 (a)	84.9 ± 39.3 (a)	113.0 ± 5.7 (b)	1.4 ± 0.2 (a)
-T	24.4 ± 6.8 (b)	39.3 ± 8.7 (b)	282.0 ± 51.1 (a)	1.3 ± 0.2 (a)

Table 1.- Cumulative runoff, soil losses, time to runoff and sediment concentration in all conventional tilled bed furrows +T and –T (Tukey HSD p<0.05)

After the rainfall simulation at field scale, soil sedimentation was observed along furrows length (**Fig. 5**). Tagged areas contribution to total sediment was determined analyzing its tracer concentration, **Fig. 6**.

Fig.5.- Tagged soil movement

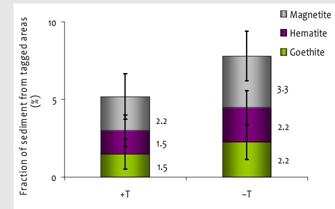

Fig.6.- Sediment composition of furrows

Analysis of the system using **EUROSEM** for different physical plot conditions, such as slope, provided information about soil erosion/deposition along furrows. **Fig.7** shows how net erosion happens in the upper part of the furrow with net deposition after 50 m. Non linear relationships of runoff and, specially, soil losses with slope is clear, albeit maintaining a deposition area lower in the furrow (**Fig.8**).

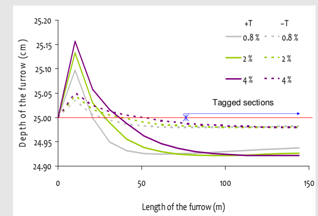

Fig. 7.- Soil deposition along furrows +T and –T under different slopes

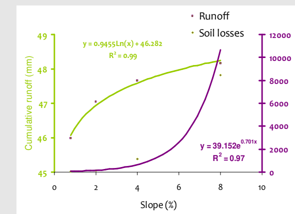

Fig. 8.- Variation of cumulative runoff and soil losses for different slopes

Conclusions

The combination of sediment tracers and model analysis allowed interpretation of sediment dynamic in a furrow-should system. Once the crop is standing, furrows and shoulders (specially furrows) deliver significantly sediment at small (1-m) scale. At larger scale the furrow system has net erosion in the upper part of the furrow and deposition in the lower sections. There is a significant fraction of sediment coming from tagged furrow areas were sedimentation was observed and predicted indicating simultaneous detachment and deposition within these areas. There is an exponential increase of net erosion with increasing slope, albeit the furrow maintains a large deposition area in its lower sections.

References

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Acknowledgments

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