Management Effects on Flow Processes, Erosion and Nitrate Transport in Soils under Monsoon Climate

M Ruidisch, S Arnhold, J Kettering, S Bartsch, C Bogner, S. Frei, B Huwe

University of Bayreuth

BayCEER

Contact: ruidisch@uni-bayreuth.de , sebastian.arnhold@uni-bayreuth.de, janine.kettering@flad.de

TERRECO

27

Introduction

Intense agricultural land use impacts water quality worldwide. Understanding of the associated transport of agrochemicals and of soil erosion requires information about flow processes, and how they are affected by management operations such as tillage, and in Haean Catchment with respect to plastic mulching. This is especially important in regions with extreme monsoon rain events.

Materials and Methods

Field studies in 2010

- Tensiometers and FDR sensor observations of soil water dynamics in plastic mulched ridge cultivation systems (RT_{pm})
- Brilliant Blue Tracer experiments for analyzing preferential flow paths
- Runoff collectors and flow dividers for quantifying runoff and sediment loads
- Suction lysimeter study for monitoring nitrate concentrations in seepage water

Fig. 1. Plastic mulched ridge cultivation system with potatoes (*Solanum tuberosum L.*)

Process-based numerical modelling

- Information on pressure heads was used to calibrate the water flow model Hydrus 2D
- EROSION3D was calibrated using measured data on runoff and soil loss rates
- Nitrate transport and fertilizer best management practices were estimated using HydroGeoSphere and PEST

Results

Soil water dynamics

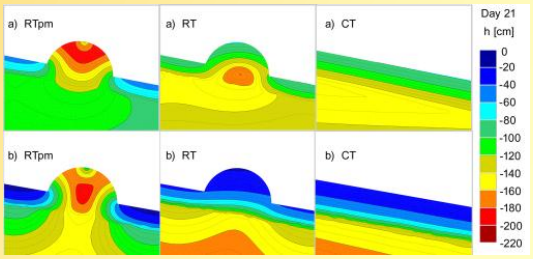

Fig. 2. Pressure head gradients

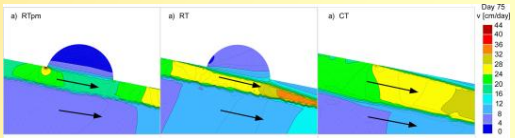

Fig. 3. Flow velocity during a monsoon event

- Lateral water movement from furrows to ridges during dry periods
- Interflow above tillage pan during monsoon
- RT_{pm} increases surface runoff up to 65%
- RT_{pm} decreases drainage water up to 16%
- RT_{pm} increases soil erosion up to 42%
- No macropore flow to deeper soil depth
- Funnel flow: redirection of water flow above the tillage pan
- The combination of plastic mulching, fertilizer placement only in ridges and split applications reduce nitrate leaching rates up to 82 %

Preferential flow

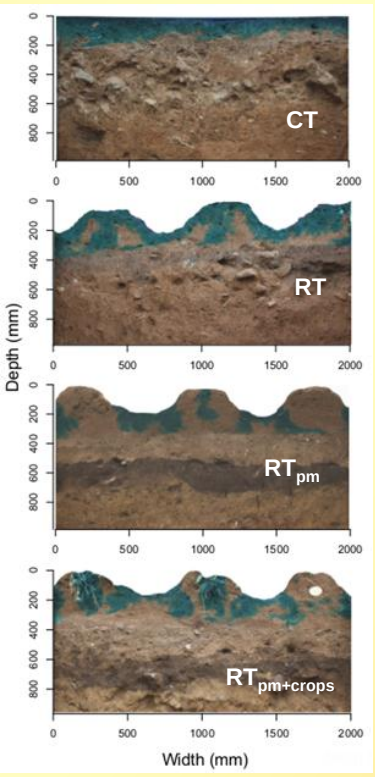

Fig. 4. Dye tracer experiments as affected by conventional tillage (CT), ridge tillage (RT), plastic mulched ridge tillage (RT_{pm}) and root systems ($RT_{pm+crops}$)

Nitrate transport & FBMPs

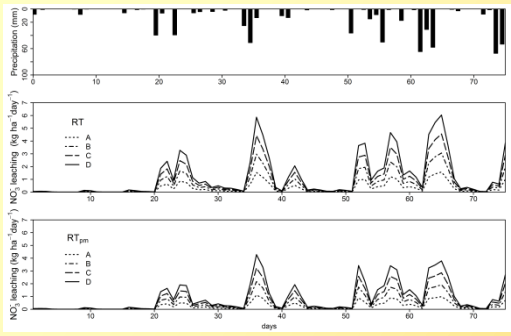

Fig. 5. Daily nitrate leaching rates below the root zone For RT and RTpm under different fertilizer rates A 50, B 150, C 250, D 350 [kg NO_3^- ha^{-1}]

		A	B	C	D
RT	R&F	24	46	68	90
RT_{pm}	R&F	18	34	51	67
RT	R	20	39	58	77
RT_{pm}	R	11	22	32	43

Table 1. Cumulative nitrate leaching rates below the root zone under different fertilizer rates A 50, B 150, C 250, D 350 [kg NO_3^- ha^{-1}] as affected by fertilizer placement in furrows and ridges (R&F) and in ridges only (R)

	App 1	App 2	App 3	LR
Scenario 1	150	x	x	22
Scenario 2a	75	75	x	14
Scenario 2b	50	100	x	12
Scenario 2c	30	120	x	10
Scenario 3a	50	50	50	11
Scenario 3b	30	60	60	9
Scenario 3c	20	80	50	8

Table 2 Split application scenarios and cumulative nitrate leaching rates (LR), all values are given in kg NO_3^- ha^{-1}

Conclusions and Recommendations

- Perforated plastic mulch should be used to reduce surface runoff and the risks at peak runoff during the monsoon on soil erosion and P transport.
- Use of impermeable plastic mulch decreases NO_3^- leaching in a flat terrain.
- Fertilizer optimal management would reduce NO_3^- leaching on agricultural fields both on hillslopes and in flat terrain.
- Establishment of buffer zones will substantially decrease the leaching of agrochemicals and sediment transport into the streams in Haean Catchment.
- Cover crop cultivation in autumn will increase N fixation, aid in avoiding soil erosion and increase soil C_{org}.