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Institut für Pflanzenproduktion und Agrarökologie in den Tropen und Subtropen (380)

Linking stable isotope methods and electrical resistivity tomography imaging: Improving our understanding of competition in poly-culture systems

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Introduction

- Poly-cultures diversify agricultural production and contribute to reconciliation ecology.
- Coupled with soil conservation measures, they contribute to erosion control and resource protection in fragile areas.
- Their acceptance by farmers depends on their performance under local cropping conditions.

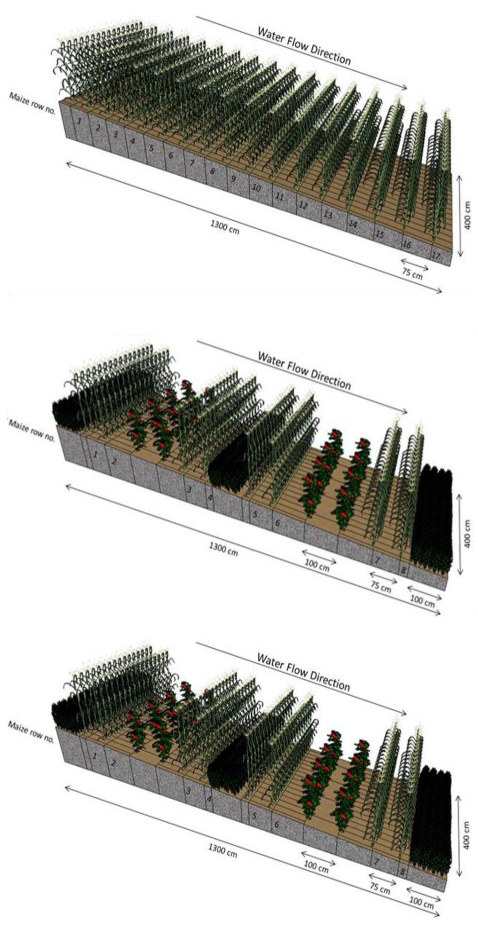
Objectives

- Assess the maize growth and development in poly-cultural systems under limited resource conditions.
- Test novel approaches to better understand competition at the crop-hedge-soil interface under tropical conditions.

Materials and methods

Location and experimental design

- Ratchaburi province of Thailand (13°28´ N and 99°15´ E)
- Hilly terrain with slope gradients up to 25%
- Tropical savanna climate (Total rainfall in 2010 = 1149 mm)
- loamy-skeletal, siliceous, isohyperthermic, kanhaplic Haplustult, Oxisols (Siriwong et al. 2012)
- Fertilizer @ 62-11-36 NPK
- Grain samples were used for isotopic analysis
- $\delta^{13}C_{sample}$ (‰) = {(R_{sample} / R_{PDB})-1} x 10^3
- Electrical resistivity tomography (ERT) ten channels Syscal Pro resistivity meter (IRIS, France)



Schematic representation and photos of the experimental plots

For complete ERT procedure, calibration and conversion of EC to WC refer to Garré et al. (2013)

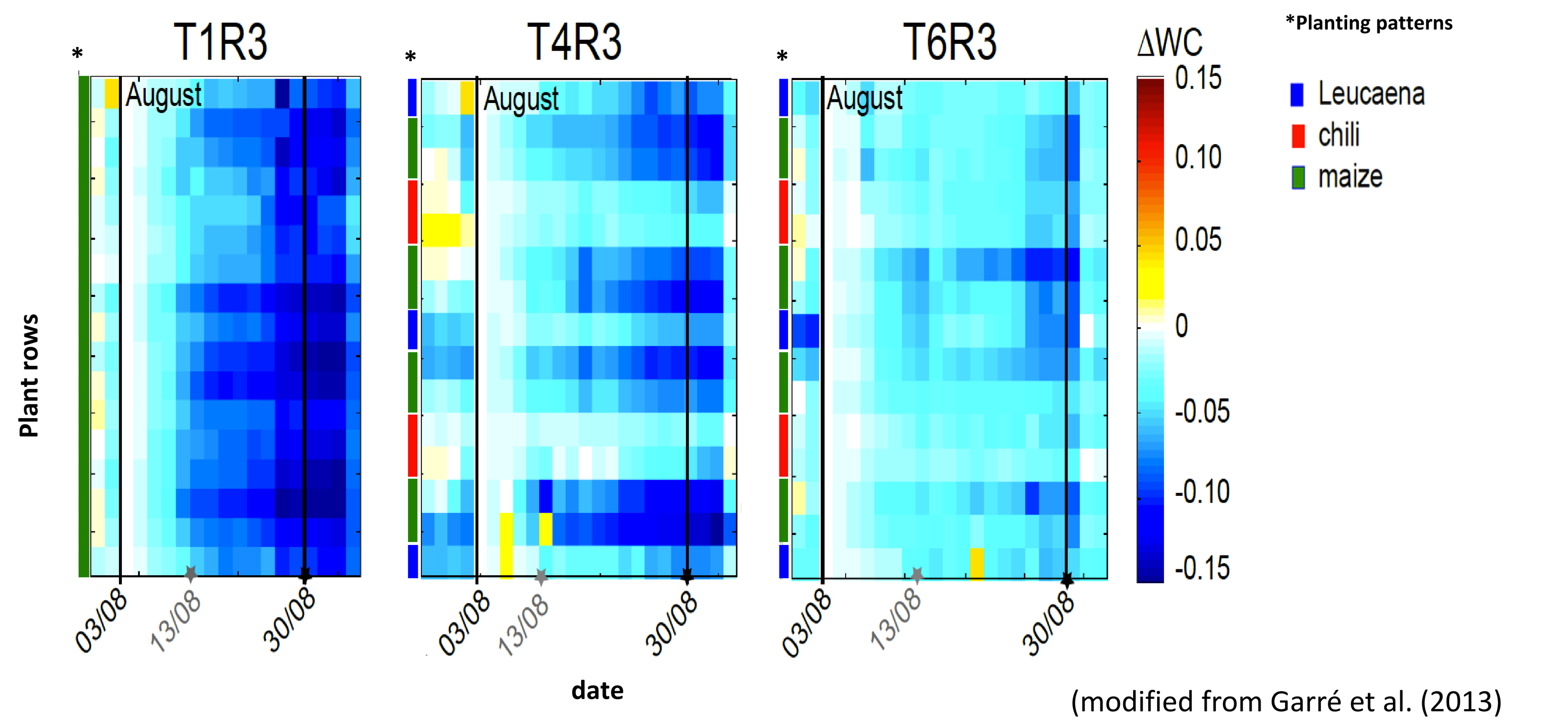
Results

Maize rows total dry matter (TDM), plant height and $\delta^{13}C$ signals

TDM (g m^{-2})		T1R3 (Control)	T4R3	T6R3
Position	Close to hedge (n=4)	1372	1074 *b*	752 *b*
	Distant from hedge (n=4)	1170	*1530 a*	1268 *a*
	t-test	*ns*	<0.004**	<0.006**
	Average row TDM (n=8)	*1271 A*	1303 *A*	1010 *B*
	t-test	<0.001***		
Plant height (cm)				
Position	Close to hedge (n=4)	147	132	121
	Distant from hedge (n=4)	155	*141*	137
	t-test	*ns*	*ns*	*ns*
	Average row plant height (n=8)	*151 A*	136 *B*	129 *B*
	t-test	<0.002**		
$\delta^{13}C$ (‰)				
Position	Close to hedge (n=4)	-10.53	-10.03 *a*	-9.28
	Distant from hedge (n=4)	-10.50	*-10.35 b*	-9.47
	t-test	*ns*	<0.004**	*ns*
	Average row $\delta^{13}C$ (n=8)	*-10.52 C*	-10.20 *B*	-9.38 *A*
	t-test	<0.001***		

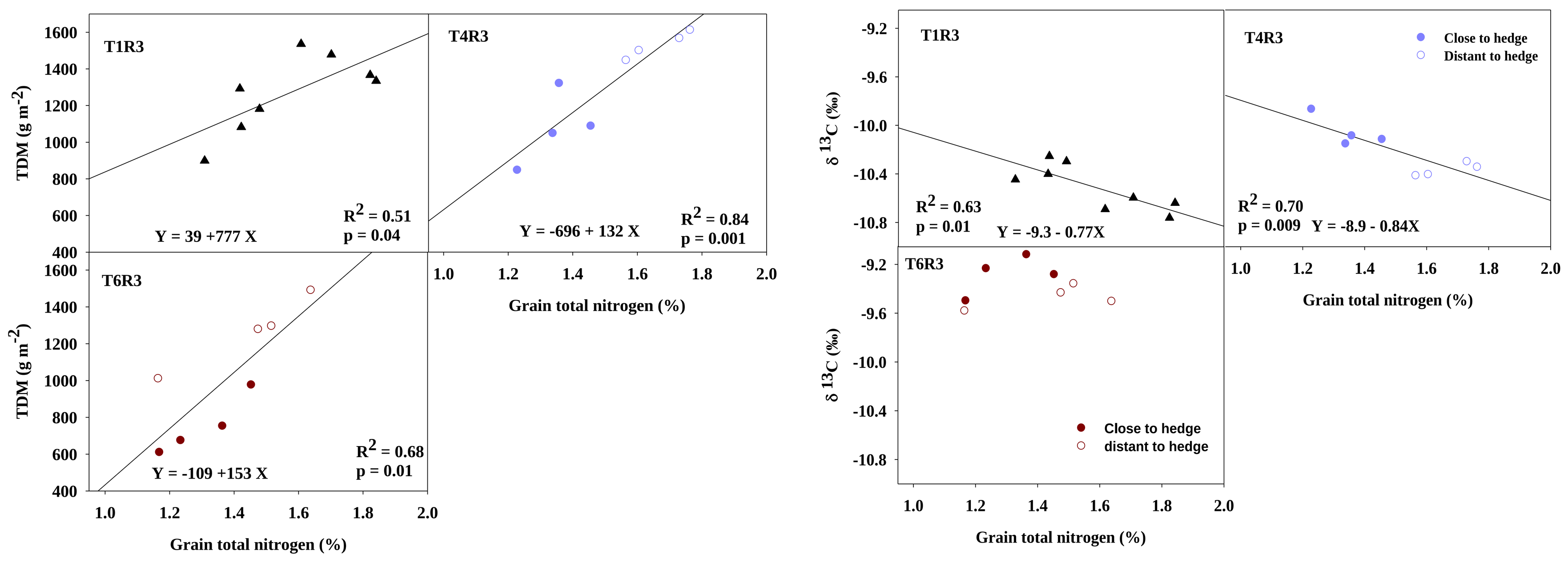
, * are significant at p≤0.01 and 0.001, respectively. Small letters indicate significant differences within the treatment while capital letters show significant differences between treatments

Electrical resistivity tomography soil moisture depletion imaging

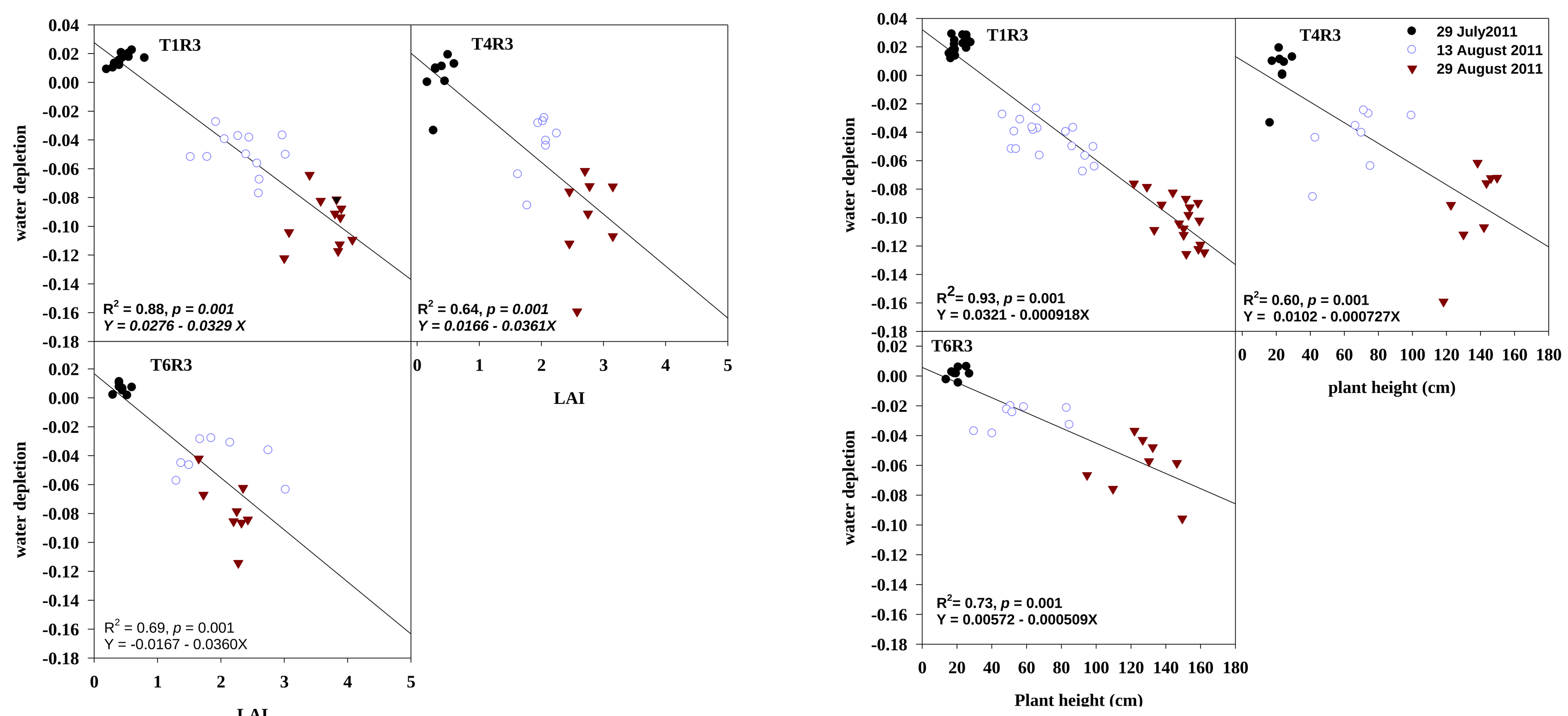


(modified from Garré et al. (2013)

Relationships between TDM, $\delta^{13}C$ and grain total nitrogen



Relationships between water depletion, LAI and plant height



Conclusions

- Electrical resistivity tomography imaging and stable isotopic methods were helpful in improving the understandings of competition at the crop-hedge-soil interface
- Combining both methods allowed distinguishing between competition for water or nitrogen.

References

Garré, S., I. Coteur, C. Wongleecharoen, T. Kongkaew, J. Diels and J. Vanderborght. 2013. Non-invasive monitoring of soil water dynamics in mixed cropping systems A case-study in Ratchaburi province, Thailand. Vadose Zone J. 12(2)

Siriwong, S., T. Kongkaew, G. Cadisch and T. Hilger. 2012. Nitrogen and water uptake on sloping land of Thailand. Adv. Mater. Res. 356-360:2484-2496

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