NUTRIENT DYNAMICS IN LOW AND HIGH INPUT SYSTEMS UNDER IRRIGATION WITH RECLAIMED AND DESALINATED WATERS. CASE STUDIES IN THE CANARY ISLANDS

José Manuel Hernández Moreno

Universidad de La Laguna, Dept. Edafología y Geología, Ave. Astrofísico F. Sánchez, s/n 38204 La Laguna. jhmoreno@ull.es

In arid and semiarid lands, water scarcity is one of the constraints for agricultural activity. In such a context, non-conventional water resources, as reclaimed municipal wastewater and desalinated water, can play a key role in sustainable agriculture. Besides, irrigation water quality influences nutrient management. Municipal reclaimed wastewater (RW) provides nutrients while desalinated water (DW) may induce nutrient deficiency [4] These peculiarities should be taken into account for a proper fertilization and nutrient management. In this paper we present three case studies from the Canary Islands of low and high input agricultural systems irrigated with DW and/or RW.

System-1: Valle San Lorenzo,Tenerife. High input, export crops, mainly bananas. Five field plots were studied [1].

System-2: Northern coast Gran of Canaria, Arucas. Project aimed to rehabilitation of abandoned marginal soils, former cultivated, obtaining high forage yields and environmental benefits (e.g. erosion reduction). No fertilizers. Two field plots were studied, each receiving different water qualities [2]

System-3: Irrigated “arenados” in Lanzarote (traditional rainfed farming system, based on the soil mulching with basaltic tephra) in which irrigation water percolates through the mulch. The impact of irrigation in six field plots were evaluated in comparison with the adjacent rainfed mulched soils [3].

Table 1.- Relevant characteristics of these systems are reported below

	System-1	**System-2**	**System-3**
Soils/Initial conditions	“Sorriba”,Andic/acid, slightly acid	Torriarents/ saline, sodic	Haplocambids-Haplocalcids
Soil Fertility modifiers FCC[1]	***x*** (amorphous), ***i*** (P fixation cap. Al, Fe)	***b*** (Calcareous)	***b*** (calcareous)
Irrigation water(IW)	RW[2], GW[3]	RW, DW[4]	RW (origin DW)
Irrigation system	Drip	Subsurface drip	Drip in the mulch
IW hazards	EC (1000μScm^{-1}), SAR (), B (1-2 mgL^{-1})	**RW**: EC (1000μScm^{-1}), SAR (15), B (1-2 mgL^{-1}) **DW:** EC (1000 μScm^{-1}), SAR (), B (1-2 mgL^{-1})	EC (1000 μScm^{-1}), SAR (), B (1-2 mgL^{-1})
Fertilizer input	high	none	low
Organic matter input	High (forest residues, compost)	none	low
Crops	bananas	Alfalfa (RW, DW), Sudan grass (RW)	Sweet potato
Years cultivation	10-12	2.5	8-10

1: Fertility Capability System, 2: Reclaimed municipal water; 3: Groundwater; 4: Desalinated water

Comparative Summary

The soils in all the systems are loamy to clayey. Modifiers ***x*** and ***i*** in System-1 implies high binding capacity for anions (P, B, organic) and cations (Ca, microelements) as well as excellent and stable structure.

Salinity: The management of the two water qualities has permitted the salinity control in the case of System-1. In System-2, at the end of the experiment, the RW-irrigated soil (with local water irrigation frequency and 70% of ETc) reached high salinity levels between the irrigation lines, above the threshold of salinity damage even for alfalfa. However, a yield of 84 t ha^{-1} of fresh matter was obtained. In the DW-irrigated soil, salt leaching occurred and EC values decreased to non-saline values, especially in the bulb. In System-3, an increase of salinity was observed in the irrigated soils (2.5-4 dSm^{-1}), but to a lesser extent than expected (mulch effect).

Nitrate: In System-1, the amounts provided by RW are not taken into account by the growers in the N fertilization, hence high levels of nitrate are found in soil solutions. In System-2, adequate nitrate levels remained throughout the experiment, both in RW-irrigated plots and in alfalfa DW-irrigated ones (legume influence). In System-3, nitrate levels in irrigated soils increased in relation to rainfed ones (possible nitrification within the mulch layer) and values over 1 $mmol_c$/L were frequent.

Phosphorus: In System-1, available P (Olsen) exceeded 100 mg/kg, which is a target value generally accepted for high P-retention soils. In spite of the heavy fertilization (+P input from RW), the P retention capacity remains about 60%. In System-2, high levels of microbial P were observed. Mobilization of residual P seemed to occur in DW-irrigated soils (See poster by Palacios *et al*. in this Symposium). In System-3, a significant increase of available P was observed in the irrigated soils, especially in the soil layer in contact with the mulch. Phosphorus in plant tissues also increased significantly.

Boron: In System-1, the binding capacity of the soils is manifested by a high buffer capacity for B. Values of hot water soluble B (availability index) can exceed 5 mg/Kg with relatively low concentrations of soluble B. In spite of the continuous input of B by RW, B applications are frequently needed. In System-2, B was monitored in soil solutions and did not reach harmful values for the plants. Some buffer capacity is also to be expected (Clayey, carbonated soil). In System 3, both sorbed and soluble B increased significantly in irrigated soils and reached or surpassed critical values for sweet potatoes, however, no effect on plants were observed.

Conclusions

The possibility of conjunctive use of waters of different qualities, which is frequent in the islands, can help to mitigate the negative aspects of RW, such as salinity and B. More research is needed on nutrient management in order to get benefits from nutrient RW and avoid side-effects of their excess. The results also show that soil properties are a key factor in site-specific aspects of water management.

References

[1] Departamento de Edafología y Geología (1994-2008). Informes Proyecto con BALTEN (Balsas de Tenerife) para seguimiento impacto del riego con aguas depuradas de S/C de Tenerife en e¡l Valle de San Lorenzo.

[2] Palacios, M.P., V. Mendoza-Grimón, F. Fernández, J.R. Fernandez-Vera and J.M. Hernandez-Moreno (2008). *Water Practice & Technology*, volume 3, issue 2**,** doi:10.2166

[3] Tejedor, M.L.; Jiménez, C.; Hernandez-Moreno, J.M., Diaz, F. (2008). *Agricultural Water Manag*. (in press)

[4] Yermiyahu, U.; Tal, A., Ben-Gal, A., Tarchitzky, J., Lahav, O. (2007). *Science*, 318:920-21