Plant Contribution to the Nitrogen Budget under Irrigation in the Cukurova Region of Southern Turkey

Hayriye Ibrikci[A], Mahmut Cetin[B], Ebru Karnez[A], Sevilay Topcu[B], Cevat Kirda, John Ryan[C], Hacer Oguz[A], Eren Oztekin and Mahmut Dingil

[A]Soil Sci. Dept. Cukurova University, Adana, Turkey Email hibrikci@cu.edu.tr
[B]Agricultural Structures and Irrigation Dept., Adana, Turkey
[C]International Center for Agricultural Research in Dry Area, Aleppo, Syria

Abstract
Nitrogen (N) is the major plant nutrient intensively used in agriculture in most of the world, including the Mediterranean region. While some of the added N is taken up by the plants, the remainder is lost by mechanisms such as volatilization, leaching and immobilization; such losses have health, environmental and economical implications. In this research, the contribution of locally grown crops to the N budget in the Akarsu Irrigation District (AID) (9,495 ha) in the Cukurova region of Turkey was determined during 2007 and 2008 irrigation seasons. The N budget parameters, i.e., inputs and outputs, including added N fertilizer amount and plant uptake, were determined and used in the budget equation. Our results indicated that plant N uptake and the amount of N added to the soil are the main parameters affecting the N budget of the District under irrigated conditions.

Key Words
Nitrogen budget, plant parameters, irrigation district

Introduction

With a growing world population, there is need to ensure crop production and food quality (Borlaug, 2003). Nitrogen is one of the major plant nutrient extensively used in irrigated and dryland agriculture (Aulakh and Mahli, 2005; Ryan *et al*., 2009). Its availability is very closely related to soil, plant and climatic conditions, especially the rainfall and irrigation water. These factors intimately affect the N fertilizer use efficiency that is generally low in the most agricultural systems (Ma *et al*., 2009). Therefore, management practices are vitally important for improved N use efficiency.

Determination of N budget in a regional basis could be a very important tool for the best N management. Measurements of the site- specific input and output parameters result in better success of the budget (Ammann *et al*., 2009). However, the most budget and modeled-budget parameters are drawn from the literature (Ross *et al*., 2008; Ammann *et al*., 2009). In recent research, detailed N input and output parameters have been determined and used in the calculation of the N budget (Liu *et al*., 2003; Ju *et al*., 2006), with the conclusion that added N fertilizer is the main input (Ventura *et al*., 2008), while the plant uptake is the output in the budget calculations.

Therefore, the contribution of the locally grown crop parameters to N budget of the District was assessed in this study.

Materials and Methods

Location and Soils

The study was conducted in one of the most intensively cropped area of the Mediterranean coastal region of Turkey. It involved the Akarsu Irrigation District within the Lower Seyhan Plain (LSP) (Fig. 1). The Akarsu Irrigation District covers an area of 9,495 ha within the LSP and lies between 36° 57′ 32″ and 36° 50′ 43″ N latitude and 35° 40′ 22″ and 35° 28′ 42″ E longitudes. The area has a Mediterranean-type climate, typically with hot and dry summers and mild and rainy winters. Annual averages of mean, maximum and minimum temperatures are 18.9, 31.0 and 9.0 ºC, respectively.

The soils are mainly alluvial, being formed in the Ceyhan River floodplain, a number of district soil series are recognized. Most soils are deep and high in clay and calcium carbonate, and deep cracks are common during the dry season, but differ in other minor futures.

© 2010 19th World Congress of Soil Science, Soil Solutions for a Changing World
1 – 6 August 2010, Brisbane, Australia. Published on DVD.

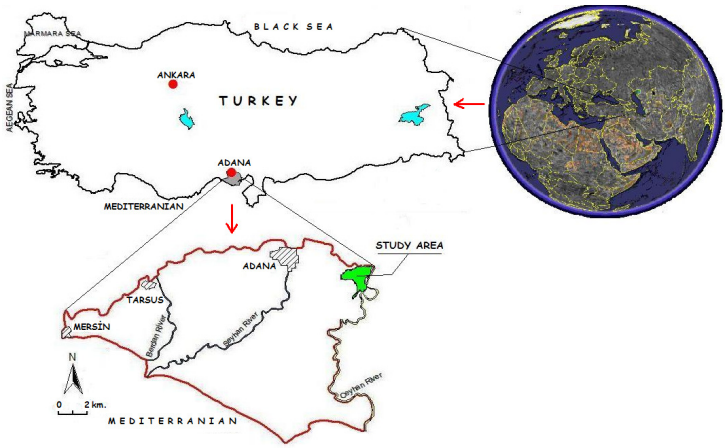

Figure 1. The location of the study area.

Cropping pattern
Currently, maize (*Zea mays*) as first and second crop is the major crop, followed by citrus orchards and wheat (*Triticum aestivum*) in the area. Cultivation of wheat and citrus has shown considerable increases in the recent years, caused mainly by fluctuating crop prices and market demands. Melon (*Citrullus vulgaris*) and some vegetables are the other crops exist in the location.

Hydrologic observations
October 1st is the starting date of the hydrological year in Turkey, and in the District. Therefore, water sampling and all other relevant data were collected and processed in the hydrological years 2007 and 2008. Five sets of groundwater samples from 107 shallow groundwater observation wells were collected. In addition, in order to determine irrigation and drainage in-and outflows, gauging stations with automatic water level recorders were installed on appropriate locations of the canals. Nitrate concentrations of all collected water samples were determined.

Measurements
Preplant and post harvest soil N in the profile, amount of added fertilizer to each crop, N load in rainfall, irrigation and drainage water, fluctuated N load in the groundwater, N uptake by the plants were calculated using the site specific measured data of these parameters. Then, these parameters were used in the below given N budget equation.

$$\Delta N = N_I + N_P + N_{LSF} + N_F - N_C - N_D$$

where N_I is N coming from irrigation, N_P from precipitation, N_{LSF} from lateral subterranean flow, N_F from fertilizer and N loss by crop uptake, N_C and drainage, N_D.

Results
The budget parameters in 2007 and 2008 are given in Table 1, the specific calculations were made as the load of N for each unit area (kg N ha^{-1}). There were some differences between two irrigation seasons.

The N input from irrigation water and precipitation are only a small proportion of the total budget as sum of 13.4 and 15.1 kg N ha^{-1}. Since the irrigation water is fresh water diverted from the dam, its N concentration and thus the N load to the District is very small.

There is hardly any contribution of subterranean lateral flow to the N budget in the District. Added fertilizer N is the biggest input parameter of the budget (Ventura *et al*., 2008), the average N rate over the cropped area and plant types was 240.0 and 246.6 kg N ha^{-1} in the both years. The main crops of the area are wheat, corn, citrus, cotton and various vegetables which are extensively fertilized with minimum expert recommendations.

Table 1. Nitrogen input and output parameters used in the N budget in 2007 and 2008.

Budget Parameters*	Hydrologic Year	
	2007	2008
	----------kg N ha^{-1}----------	
Irrigation (N_I)	5.4	6.0
Precipitation (N_P)	8.0	9.1
Fertilizer (N_F)	240.0	246.6
Subterranean Lateral Flow (N_{SLF})	-0.008	0.01
Crop Uptake (N_C)	151.0	183.4
Drainage (N_D)	41.2	29.3
Nitrogen Budget	61.2	49.0

* The sources of N inputs and outputs

The main N loss from the system is the one by the plant uptake, 151.0 and 183.4 kg N/ha in 2007 and 2008. Loss to the drainage is also in substantial amount compare to some input parameters. There is a considerable seasonal difference in the load of N by drainage due to the rainfall and irrigation.

Conclusion

Two year's data show that amount of added N fertilizer and plant N uptake are the main factors effecting the N budget of irrigated agriculture in southern Turkey. Since the area has potential to grow two crops in a year, an optimized fertilization program is imperative for economic, health and environmental implications.

Acknowledgements

Authors gratefully acknowledge that this work was funded by the European Union in the context of FP6 with project acronym QUALIWATER (Project #: INCO-CT-2005-015031) and partial support was received from Cukurova University Academic Research Projects Unit (Project #: ZF2006KAP1 and ZF2008BAP8).

References

Ammann C, Spirig C, Leifeld J, Neftel A (2009) Assessment of the nitrogen and carbon budget of two managed temperate grassland fields. *Agriculture, Ecosystems and Environment* **133,** 150-162.

Aulakh MS, Malhi SS (2005) Interactions of nitrogen with other nutrients and water: effect on crop yield and quality, nutrient use efficiency, carbon sequestration, and environmental pollution. *Advances in Agronomy* **86,** 342-410.

Borlaug N (2003) Feeding a World of 10 Billion people: The TVA/IDC legacy. Travis P. Hignett Memorial Lecture, March 14, Muscle Schoals. Alabama, USA.

Ju XT, Kou CL, Zhang FS, Christie P (2006) Nitrate balance and groundwater nitrate contamination: Comparison among three intensive cropping systems on the North China Plain. *Environmental Pollution* **143,** 117-125.

Liu X, Ju X, Zhang FS, Pan J, Christie P (2003) Nitrogen dynamics and budgets in a winter wheat-maize cropping system in the North China Plain. *Field Crops Research* **83,** 111-124.

Ma W, Li J, Ma L, Wang F, Sisak I, Cushman G, Zhang F (2009) Nitrogen flow and use efficiency in production and utilization of wheat, rice, and maize in China. *Agricultural Systems* **99,** 53-63.

Ross SM, Izaurralde RC, Janzen HH, Robertson JA, McGill WB (2008) The nitrogen balance of three long-term agroecosystems on a boreal soil in western Canada. *Agriculture, Ecosystems and Environment* **127,** 241-250.

Ryan J, Ibrikci H, Sommer R, McNeil A (2009) Nitrogen in Rainfed and Irrigated Cropping Systems in the Mediterranean Region. *Advances in Agronomy* **104,** 53-136.

Ventura M, Scandellari F, Ventura F, Guzzon B, Pisa PR, Tagliavini M (2008) Nitrogen Balance and loasses through trainage waters in an agricultural watershed of the Po Valley (Italy). *European Journal of Agronomy* **29,** 108-115.