Ammonium absorption and cations leaching from the canopy of a sugarcane agro ecosystem under acid rains precipitation

Danilo López-Hernández, Diego Sequera, Oswaldo Vallejo and Carmen Infante

Laboratorio de Estudios Ambientales – Instituto de Zoología y Ecología Tropical (IZET). Universidad Central de Venezuela (UCV). POB 47058 Caracas 1041-A - Venezuela.

E-mail: danilo.lopez@ciens.ucv.ve

1.- Introduction

Acidic rains heavily loaded in ammonium are characteristic of Central Northern Venezuela, a region currently cropped with sugarcane plantations. Nitrogen inputs (ammonium and nitrate) in precipitation waters are considered of great importance in the N economy of natural ecosystems; on the contrary in agro systems those inputs are of lesser importance when compared with the N requirements to crop production (Stevenson 1982; Thorburn et al. 2005). However, in some areas atmospheric deposition highly loaded in N as a consequence of industrial and agricultural activities can contribute in a significant proportion to crop nutrition. The nitrogen and other nutrients dissolved in rainwater might be retained by the crop-canopy (mainly in leaves), in this case a natural fertilisation occurs, whereas a reverse process take place when ions and compounds are leached from the canopy to the throughfall waters (Tukey 1970). The magnitude of the foliar leaching depends on plant conditions such as plant age, physiological state, plant composition and morphology, but also in frequency, duration, and intensity and chemical composition of the rainwater. In this contribution we analyzed the chemical changes in acid rains heavily loaded in N after passing through the canopy of a sugarcane field.

2.- Materials and methods

2.1 The study site was located in a sugarcane farm near San Felipe, Yaracuy state, Venezuela (10°29´44´´N and 68°31´44´´W). (Fig.1).

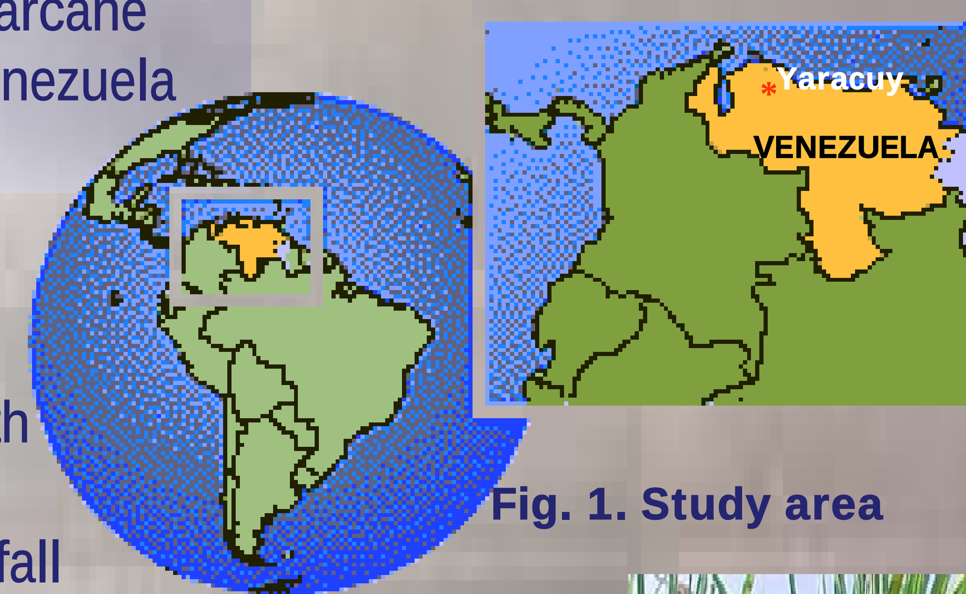
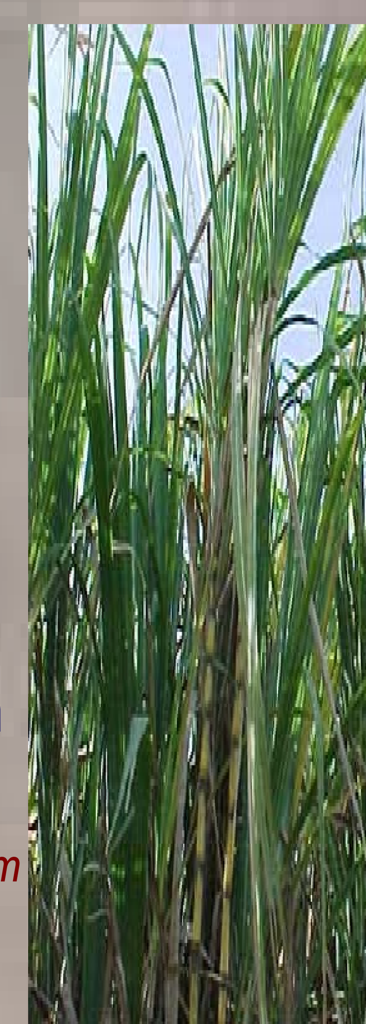


Fig. 1. Study area

2.2.- Four plots of 300 m^2 within an experimental area of 4.5 ha cropped with *Saccharum officinarum* were selected to install the collectors of rain, throughfall and leaching waters. The study corresponds to the analysis of the second and third ratoons of two sugarcane varieties. The soil is a Mollisols, Haplaquoll (fine loam, isohiperthermic, muscovite, montmorillonitic, kaolinitic) with a pH of 7.4, moderate to high CICE and N content 0.1-0.2 %. Details of the collectors for precipitation, throughfall and leaching waters are presented in Infante et al 1993 and López-Hernández et al. 2005. pH was determined in a soil: solution ratio 1:5. Nitrate and ammonium in the waters were analysed in a Technicon Auto Analyzer II (1973). Magnesium was analysed by atomic absorption in a Varian Techtron AA6.



Saccharum officinarum

3.- Results and discussion

3.1.- All the rainwaters collected were acid (3.54-4.52, Fig. 2). The pH of the acid rain increased after the passage through the canopy (Fig. 2), which is in accordance with the significant amount of cations leaching from the leaves. Data in Fig. 2 includes Mg (µg L^{-1}), also information was obtained for K, Ca, Mg and Na.

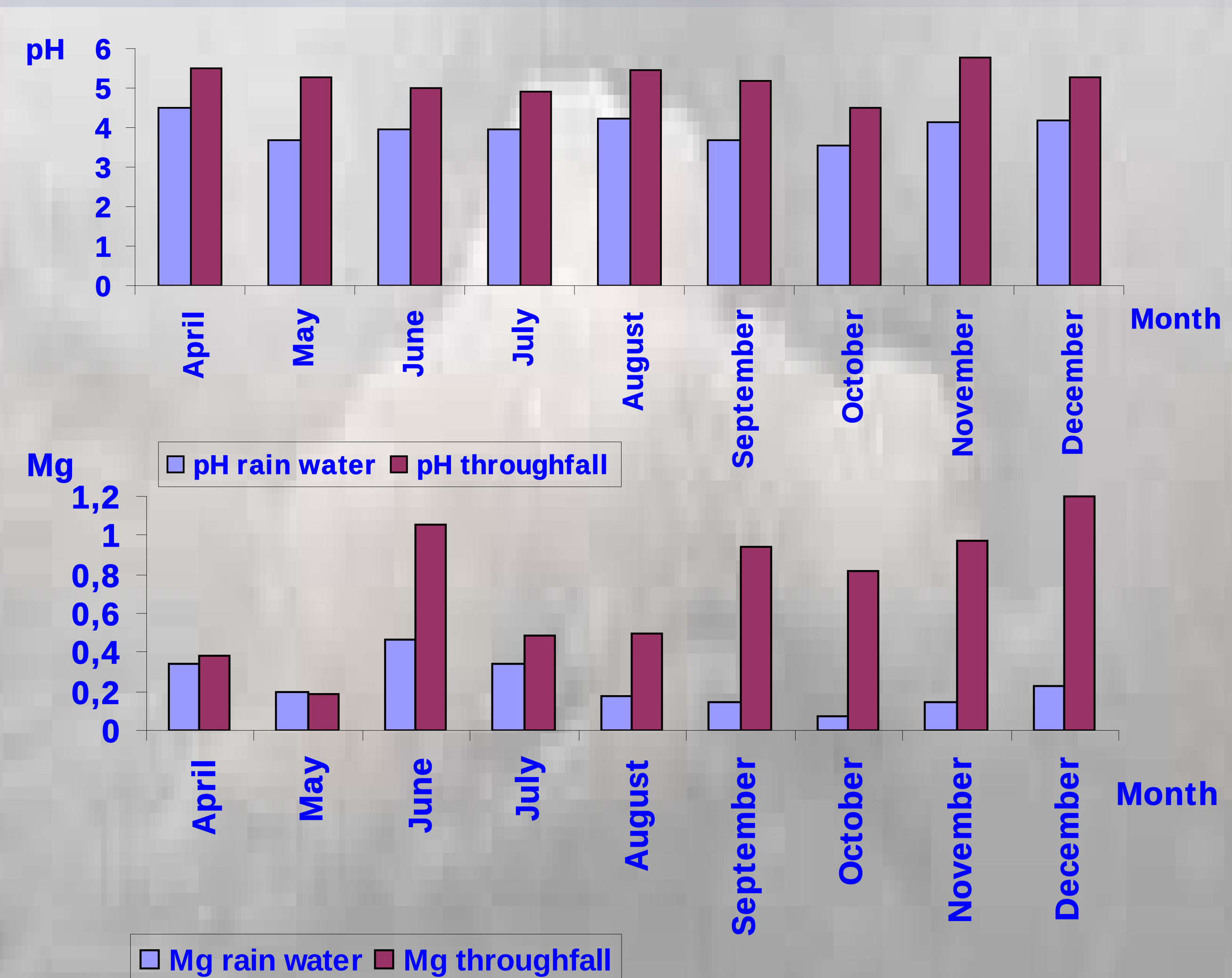


Fig. 2.- . Monthly average pH and magnesium (µg L^{-1}) in rain and throughfall waters

3.2.- Ammonium was the predominant N form in the precipitation water with a mean value of 1.29 µg L^{-1} (Fig.3), N-nitrate forms in most of the analysed months were no detectable. The nitrogen inputs for wet and dry deposition in the agro system were high compared with other ecosystems (26.3 kg ha $^{-1}$ yr^{-1}, mostly in the ammonium form). This is probably due to the high agricultural activity in the area, the local burning of the sugarcane before cropping, and the location of the experimental area nearby petrochemical industrial activities and fertiliser producer industries.

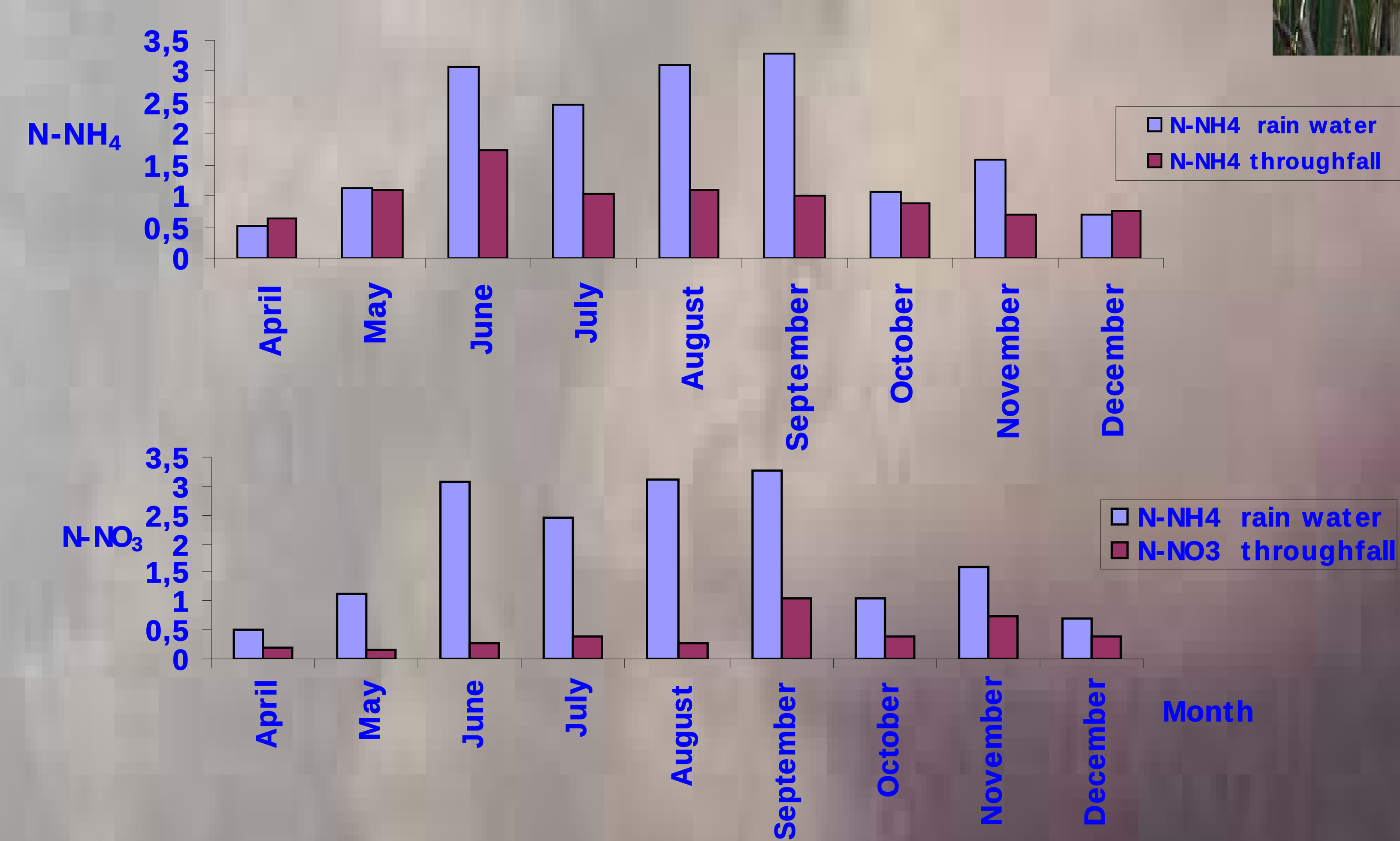


Fig. 3.- . Monthly average N-ammonium and N-nitrate (µg L^{-1}) in rain and throughfall waters

3.3.- Although nitrates were leached in throughfall waters (Fig. 3), the balance accounted for important N fertilisation of the leave canopy through ammonium absorption. On the contrary, throughfall waters were enriched in bases compared with precipitation waters meaning a significant cations lessivage from leaves particularly of magnesium due to the acidic water leaching of the canopy (Fig 2). Desorption from the sugarcane canopy for other cations also occurred (data to be presented elsewhere).

4.- Conclusions

There was an important N fertilisation of the sugarcane leaves through ammonium absorption. On the contrary, throughfall waters were enriched in bases compared with precipitation waters meaning a significant cations lessivage from leaves particularly of magnesium due to the acidic water leaching from the canopy. The N (NH_4) input of rain water represents around 10 per cent of the N requirement for biomass production of the sugarcane plantation.

5.- References

- Infante C., D. López-Hernández, E. Medina y G. Escalante. 1993. Distribución de las formas inorgánicas del nitrógeno en los flujos hídricos de un agroecosistema tropical. Ecotropicos: 6 (2): 13-23.
- López -Hernández D., C. Infante y E. Medina 2005. Balance de elementos en un agroecosistema de caña de azúcar: I. Balance de nitrógeno. Tropicultura 23: 212-219.
- Stevenson F.J. 1982. Origin and distribution of nitrogen in soil. p. 1-39. In Stevenson et al. (Eds.). Nitrogen in agricultural soils. Agronomy Series 22. ASA, Wisconsin, USA.
- Thorburn P.J., E.A.M. Meier and M.E. Probert. 2005. Modelling nitrogen dynamics in sugarcane systems: Recent advances and applications. Field Crops Research 92: 337-351
- Tukey H.B. 1970. The leaching of substances from plants. Annual Review Plant Physiology 21: 305-322