**AGRO2010** 29 AUGUST- 3 SEPTEMBER MONTPELLIER

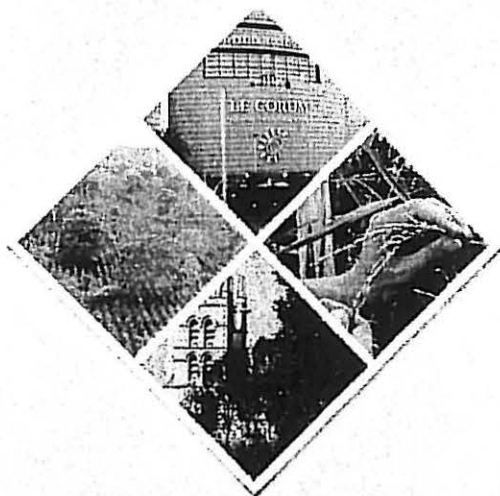**ESA** European Society for Agronomy

# PROCEEDINGS OF
# Agro2010
## the XIth ESA Congress

August 29th - September 3rd, 2010
Montpellier, France

## Chair

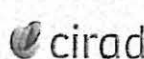- J. Wery, Montpellier SupAgro, France
  ESA President

## Scientific Committee

- S. Asseng, CSIRO, Australia
- J.M. Barbier, INRA Montpellier,
  UMR Innovation, France
- M. Benoit, INRA Mirecourt, dpt SAD, France
- J.E Bergez, INRA Toulouse, UMR Agir, France
- J. Boiffin, INRA Angers, AFA, France
- P. Carberry, CSIRO, Australia
- J.L. Chotte, IRD Montpellier, UMR EcoSol, France
- O. Christen, Martin Luther University,
  Halle-Wittenberg, Germany
- M. Donatelli, ESA secretary, JRC and CRA, Italy
- T. Dore, AgroParisTech-INRA/EA, France
- C. Gary, INRA Montpellier, UMR System, France
- M. Genard, INRA Avignon, UR PSH, France
- P. Gregory, SCRI, United Kingdom
- D. Habash, Rothamsted Research,
  United Kingdom
- G. Hammer, APSRU, Australia
- P. Hinsinger, INRA Montpellier,
  UMR EcoSol, France
- B.Hubert, Agropolis International, France
- J. Jones, University of Florida,USA
- J.D. Lebreton, CNRS Montpellier,
  IFR MEB, France

- F. Lescouret, INRA Avignon, UR PSH, France
- R. Lifran, INRA Montpellier, UMR Lameta, France
- E. Malezieux, CIRAD Montpellier, France
- F. Maraux, CIRAD Montpellier, France
- M. Morison, INRA Grignon, France
- N. Munier-Jollain, INRA Dijon-INRA/EA, France
- M.L. Navas, Montpellier SupAgro,
  UMR CEFE, France
- B. Ney, AgroParisTech & Académie de
  l'Agriculture, Paris, France
- J. Porter, University of Copenhagen, Denmark
- F. Tardieu, INRA Montpellier, IFR Daphne, France
- M. Van Ittersum, WUR and Seamless,
  The Netherlands

## Organizing Committee

- I. Bastie, Montpellier SupAgro
- B. Cabantous, Agropolis International
- C. Jacquet, CIRAD
- F. Lavat, Montpellier SupAgro
- E. Mignard, INRA
- A. Perrin, Montpellier SupAgro
- C. Picard, INRA
- P. Prevost, Montpellier SupAgro - AFA
- S. Renoir, CIRAD
- M. Salas, Agropolis International
- I. Shili-Touzi , Montpellier SupAgro
- N. Villemejeanne, Agropolis International

# Optimising the time of incubation of an anion exchange membrane inserted into the soil to use in studies of monitoring soil nitrate levels

Ângelo Rodrigues M. ,Arrobas M.

Mountain Research Center - ESA, Instituto Politécnico de Bragança
Campus de Sta Apolónia, ap. 1172, 5301-855 Bragança, Portugal; email: angelor@ipb.pt

An anion exchange membrane (AEM) is a solid organic polymer that has a positive electrostatic charge, which is saturated by the addition of a counter ion, such as bicarbonate ($HCO_3^-$), before use. In the presence of an anion, such as $NO_3^-$, $HCO_3^-$ will be exchanged for a stoichiometrically equivalent amount of that anion. By placing the AEM in a concentrated acid solution (hydrochloric acid, for instance), $NO_3^-$ ions are displaced by $Cl^-$ and then determined in the extracts by appropriate analytical methods (Pare et al., 1995). Pare et al. (1995) compared the $NO_3$-N extracted by AEM buried at 15 cm soil depth for a 2-wk period in a soil cropped with corn subjected to different fertilization treatments with $NO_3$-N extracted with $2M$ KCl. They found a highly significant correlation ($r^2 = 0.78$) between the two $NO_3$-N extraction procedures. Qian and Schoenau (1995) used AEM buried in the soil in a Lab incubation experiment to measure the $NO_3$-N released from organic matter. They compared the results of the AEM method and those of a chemical extraction technique using 0.001 $M$ $CaCl_2$ solution with plant N uptake in the field. Rodrigues et al. (2006) compared $NO_3$-N adsorbed in AEM with plant N uptake when the AEM were inserted into the soil in a pot experiment with maize subjected to the application of different organic manures permitted in organic farming. Rodrigues et al. (2010) used AEM in a similar pot experiment with tall cabbage and ryegrass subjected to N fertilisers with different slow-release mechanisms. From all the cited experiments it was clear that there is a great potential for the use of AEM to provide reliable information on time and rate of N released from organic matter and fertilisers. Despite positive results having been obtained, the technology of placing the membranes directly into the soil can be improved if the most appropriate time could be established for the duration of the incubations. Thus, there is a need to test if the initial soil disturbance influences the flux of nitrates to the AEM and if there is any risk of the saturation of the adsorption capacity of the membrane due to a prolonged exposure in the soil and a high soil nitrate level. This paper relates the effect of the incubation time on the amount of nitrate ion recovered by AEM in a pot experiment where different N rates were previously applied.

## Materials and Methods
Pots of 15 kg dried and sieved (6-mm) soil were amended with 0, 2.74, 5.49 and 10.98 g N applied as ammonium nitrate in three replications. The soil was kept bare during the period of the experiment. The pots were incubated under a temperature between 10 to 15 °C for a month. After this period 5 strips of 1x2 cm AEM per pot were buried 10 cm in the soil. The AEM were tied with a line allowing for an easy removal from the soil. After 48, 72, 96, 120 and 240 hours the membranes were recovered, rinsed with distilled water and the nitrate ions eluted in hydrochloric acid as previous described (Rodrigues et al., 2010). Nitrate concentration in the extracts was determined by UV-vis. spectrophotometry. The use of an agricultural soil and a common N fertiliser, which was homogenously distributed in the soil, was intended to test the AEM in as similar conditions as possible to those that the AEM would find in a pot or even in a field experiment. Thus, the many aspects that can influence the performance of the AEM, including the saturation of its exchange capacity by anions other than $NO_3^-$, can then be taken into account.

## Results and discussions
In the higher N rate (10.92 g N pot$^{-1}$) the adsorption capacity of the AEM was saturated after 72 h of incubation (figure 1). When 5.49 g N pot$^{-1}$ were used the adsorption capacity of the AEM was saturated after 120 h (5 days) of incubation. In the treatment consisting of the application of 2.74 g N

pot[-1] an in the control the soil available nitrate ions were not high enough to saturate the adsorption capacity of the AEM.
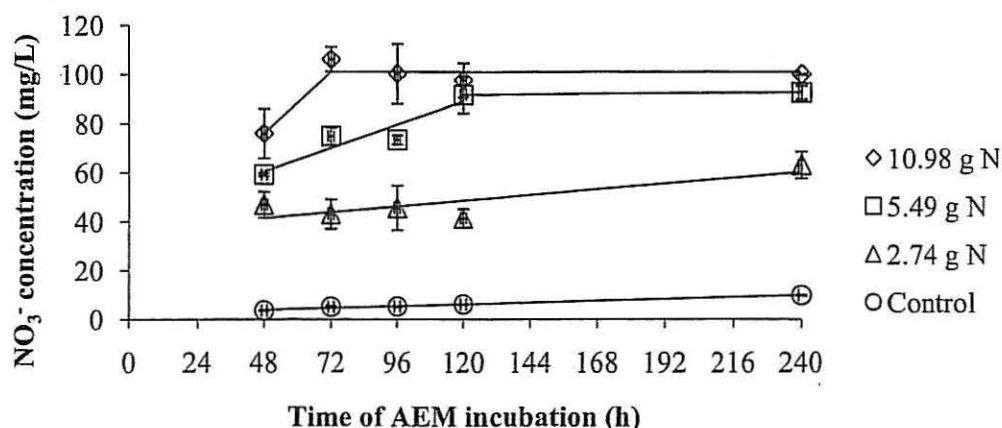


**Figure 1.** Nitrate concentration in AEM extracts from different N application rates and from different incubation times. Vertical lines represent the mean standard deviations.

The application of 10.92 g N pot[-1] lead to soil nitrate levels that will be difficult to find in a soil after the application of a usual N rate. Such a high N rate was precisely used with the expectation that it would saturate the adsorption capacity of the AEM. The experiment also showed that the adsorption capacity of the AEM was reached with the use of 5.49 g N pot[-1], a value of N fertilisation that lead to a soil nitrate level that can easily be found in a cultivated field. This may mean that caution should be taken when using AEM in heavily fertilised crops. From the 5.49 g N pot[-1] treatment, it was also clear that the saturation of the adsorption capacity of the AEM was a continuous process. In pots which were not irrigated during the incubation period and where the evaporation of water would be minimal, no movement of $NO_3^-$ would occur through mass flow. Diffusion would be the major process leading to the movement of $NO_3^-$ from the soil solution to the AEM. Thus, this study also showed that the time of incubation may be an important aspect that must be taken into account in the use of the AEM methodology. In the treatment where 5.49 g N pot[-1] were applied, the highest N concentration in the AEM extracts never reached the values found in the pots where 10.92 g N pot[-1] were applied, even after 10 days of incubation. The low soil nitrate levels in the 5.49 g N pot[-1] treatment would allow that other anions such as Cl^{-} to have increased their position at the exchanging sites of the membrane.

A high soil nitrate level may saturate the adsorption capacity of the AEM, which could limit the use of AEM in environments with high $NO_3$-N levels. Since the saturation of the adsorption capacity of the AEM is a continuous process, the time of incubation must be carefully selected to increase the useful potential of AEM in monitoring nitrate dynamic in the soil.

**References**
Pare, T., Gregorich, E.G., Ellert, B.H. 1995. Comparison of soil nitrate extracted by potassium chloride and adsorbed on an Exchange membrane in situ. Commun. Soil Sci. Plant Anal. 26: 883-898.
Qian, P., and Schoenau, J.J. 1995. Assessing nitrogen mineralization from soil organic matter using anion exchange membranes. Fert. Res. 40: 143-148.
Rodrigues, M.A., Pereira, A., Cabanas, J.E., Dias, L., Pires, J. and Arrobas, M. 2006. Crops use-efficiency of nitrogen from manures allowed for organic farming. Eur. J. Agron. 25: 328-335.
Rodrigues, M.A., Santos, H., Ruívo, S., and Arrobas, M. 2010. Slow release N fertilisers are not an alternative to urea for fertilisation of autumn-grown tall cabbage. Eur. J. Agron. 32: 137-143.