

EFFECT OF SOIL CHARACTERISTICS ON THE NITROGEN BALANCE CASE OF WESTERN MIDDLE CHELIFF VALLEY - (NORTH OF ALGERIA) -

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ABSTRACT

Agriculture is the dominant activity in Western middle Cheliff valley (North of Algeria). The agricultural land surface constitutes 67% of the total of which 65% are irrigated effectively. The main cultures are arboriculture and the garden farming. The appraisal of the mineral nitrogen contributions for the year 2004 shows that 97% of these last come from N-fertilizers against 3% only result from water of irrigation. As for the organic nitrogen contributions, the breeding constitutes the dominant share compared to the municipal wastewater (5%).

The losses of nitrogen are bound to the absorption by the culture, to the volatilisation of the ammonia encouraged by the pH of soils and the temperature raised in the area study and finally to the denitrification.

The losses by leaching in depth are very low in the centre of the valley because of the fine texture of the soils that confer them a weak permeability (0.2 to 0.5 cm/h), in addition to a clayey massif of important thickness separating the soil of the aquifer. On the contrary, on the borders of the valley whose soils are very permeable (10 cm/h) receiving an intensive N-fertilization, we record the strongest nitrate concentrations in groundwater of area study.

Keywords: Soil characteristics; Nitrogen; volatilisation; denitrification

1 INTRODUCTION

Large quantities of inorganic and organic N fertilizers are applied each year in agricultural areas [1, 2, 3, 4], which increases the threat from NO_3^- contamination in groundwater. However several processes can manage these quantities of nitrogen in the nature [5]. In

this work, we try to observe the fate of the enormous quantities of nitrogen brought on the soils of western middle Cheliff valley in north of Algeria during the year 2004.

If we admit only this concentration (50 mg/l) in the water of well, we will be able to estimate the quantity of nitrogen brought by this water while using the formula below [9]:

$$X_N = \frac{[NO_3^-] \times Q_{\text{irrig}}}{4,43 \times 10^2} \quad (1)$$

Where, X_N is the yearly nitrogen quantity brought by the water of irrigation ($\text{kgN ha}^{-1} \text{yr}^{-1}$), $[NO_3^-]$ represent the nitrate concentration of the water of well (mg/l) and $Q_{\text{irrig}} =$ yearly quantity of irrigation water (mm yr^{-1}). The number 4.43 corresponds to the report of masses molar NO_3^-/N .

The total quantity of nitrogen brought by the water of irrigation represents only 3% of the one produced by the N-fertilizers (Fig. 2).

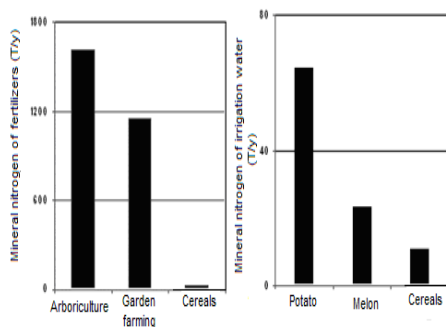


Figure 2 Annual mineral nitrogen contribution

3.1.3 Contributions from breeding

The exploitations of the breeding for the different animal species (bovines, ovine, goats and poultries) are located in the borders of the valley (in the townships of Ouled fares, Abiadh Medjadja, Sobha and Boukadir). The calculation of the yearly total quantities of organic nitrogen generated by the set of every animal category is based on the values of nitrogen produces annually by head for every species, proposed by the CORPEN [10].

3.1.4 Contributions from municipal wastewater

Organic nitrogen estimated for Individual septic tank systems constitutes only 5% of the one generated by the breeding (Fig. 3).

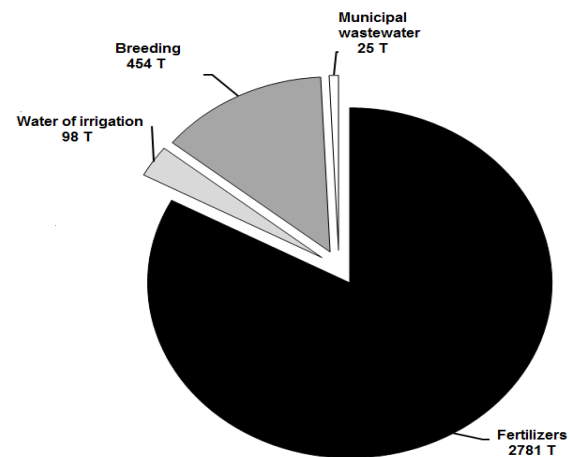


Figure 3 Annual nitrogen contribution (mineral and organic)

3.1.5 Total contributions in nitrogen

Nitrogen brought by agriculture (fertilizers and water of irrigation) constitutes 86% of the total nitrogen brought to the soils of the valley. 97% of this last (fig. 3) is attributed to nitrogenous fertilizers used extensively in garden farming, potatoes in particular. Extrapolated to the total irrigated area, this contribution is estimated at $238 \text{ kg ha}^{-1} \text{yr}^{-1}$.

3.2 Effect of soil characteristics on the nitrogen balance

The methods of the nourishing elements balances permit to develop a lasting agriculture (Parris, 1998). The nitrogenous balance method proposed by the COMIFER [11] and the CORPEN [12], detailed in Ruiz and al., [13] permits the nitrogenous excess calculation whose general formula can be given by the following equation:

$$\sum ENTRIES - \sum EXITS = \text{natural Contributions} + \text{non natural contributions} - A - V - D - L$$

With A=Absorption by the plants, V= volatilization, D=dénitrification and L = Leaching.

3.2.1 The entries

1 Natural Contributions

A - Atmospheric nitrogen contributions: The content in nitrogen of the rainwater varies of less than 1 mg/l to several mg/l, but in general, it doesn't pass the 2 mg/l [14]. Nitrate concentration of the precipitations falling on the study area doesn't pass 2 mg/l [15]. This weak concentration doesn't seem to influence the entries.

B - Contributions by mineralization: The organic matter rate is very weak on the soils of the study area (< 2%); this last will continue to decrease in the time in parallel with an increase of the speed of mineralization by effect of the semi-arid climate. The two phenomena decrease the capacity of soil to provide nitrogen by mineralization.

2 Non natural contributions

They constitute the sum of contributions from N-fertilizers, the water of irrigation, the breeding and municipal wastewater. They are valued to 3358 T yr⁻¹.

3.2.2 The exits

1 Absorption by the plants: If we keep the lower doorstep of the absorption rate (60%) of nitrogen contained in fertilizers recognized by Tremblay and al., [5], the quantities of nitrogen absorbed by the plants in study area from the different fertilizers applied would be the order of 1669 T yr⁻¹.

2 Volatilization: The losses by volatilization depend on conditions of soil (pH, capacity of exchange, porosity, humidity) and of the climatic conditions [16].

The losses by volatilization at the time of the application can reach 40 to 50% of nitrogen applied in the conditions of chalky soil, of pH > 7,5 and of elevated temperature [5, 17] However, the urea remains the fertilizer that frees the strongest quantities of ammonia in the atmosphere, producing 72% of the quantities freed by the fertilizers [18]. In the study area, the quantity of nitrogen that could be volatilized from the urea, for a doorstep of 40%, would be the order of 307 T yr⁻¹, either about 11% of the total of nitrogen (2781 T).

3 Denitrification: This process is thought to be important in agricultural soils because agriculture has been recognized as contributing nearly 70% of the anthropogenic emissions of nitrous oxides, a by-product of denitrification, to the atmosphere [19]. The fraction of nitrogen lost by denitrification given N₂O is located particularly on soils badly aired to basic pH, in the conditions of elevated temperature (> 15°C). For a middle doorstep of 20% advanced by the works of Tremblay and al. [5] the fraction of applied mineral nitrogen capable to be topic to the denitrification in the study area would be meadows of 556 T yr⁻¹.

4 Leaching: the equation of the balance gives a percentage of 9% of the total of nitrogen that could reach the aquifer. The phenomenon of leaching would be more favourable on the borders of the valley where soils are characterized by the strongest permeabilities, contrary to the center constituted by deep soils with very fine texture.

CONCLUSION

In the semi-arid regions characterised by a strong agricultural activity, it is necessary to take always into account some entries: nitrogen brought by

fertilization, nitrogen brought by the water of irrigation whatever weakly [20]. It is generally useless to include nitrogen coming from the precipitations or the mineralization.

In the same way, it is necessary to take into account some exits in the calculation of the nitrogenous balance: the quantity of nitrogen absorbed by the culture, the denitrification and the volatilization particularly for the chalky soils with a basic pH. The calculation of the quantity of nitrates leaching is not always essential since the infiltration is very weak in these regions.

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