Introduction

The application of high rates of nitrogen to fertilize potato constitutes an economic constraint for the Tunisian farmer with a more and more elevated price of nitrogenous manures. It also constitutes an environmental constraint because of the risk of leaching of nitrates which pollute the groundwater. So, it is important to adjust, as precisely as possible, nitrogen supply to the crop by the use of the nitrogen balance and diagnostic tools: Nitrogen Nutrition Index (N.N.I.) and Hydro-N-Tester (H.N.T.) which help to decide the dates and amounts of nitrogen fertilizer applications (Justes et al., 1997; Chambenoit et al., 2002; Goffart et al., 2005). Consequently, the first objective of this study is to optimise the nitrogen fertilisation of potato using the critical dilution curve, and the second objective is to validate the H.N.T. method based on a strong correlation between H.N.T. and N.N.I.

Method and Materials

Field experiment and treatments
The experimentation was conducted in 2008 in the Technical Center of Potato situated in the north of Tunisia (37 north, 10 east, Altitude 238m). On a clay loam soil, we used the Spunta variety that was drip irrigated. Five rates of urea (46%N): 0, 50, 150, 200 and 300 kg N.ha-1 were applied. To provide to the nutritional crop demand, phosphoric acid (50% P2O5) and potassium sulphate (K2SO4) were applied at a rate of 150 kg.ha-1 of P2O5 and 360 kg.ha-1 of K2O. Nitrogen management treatments were arranged in a completely randomized block with 4 replications. Statistical analyses were conducted with the STATISTIX 8 software.

Measurements
The measured parameters were:

- Refractive chlorophyll index: determined by the H.N.T.
- NNI and critical dilution curve: Plants were sampled in order to determine the evolution of total dry matter (tubers + shoot) expressed in t.ha-1 depending on the time and the organic nitrogen content determined by the Kjeldahl method (Bremner, 1965). The N.N.I. which was derived from organic nitrogen content is defined as a quotient between the observed nitrogen content and the critical nitrogen content which was defined from the critical curve dilution of Duchenne et al. (1997).

- Yield: it is estimated from the fresh matter of tubers by unit of surface.
- Coefficient of nitrogen use: The evaluation of the fertilizer nitrogen use efficiency of potato is deducted from the calculation of the coefficient of nitrogen use which is defined as: C.N.U. (%) = (N - N0)/X with Ns = quantity of N appropriated by the culture in the dose D (kg.ha-1), N0 = quantity of N appropriated by the culture to the hopeless dose (kg.ha-1), D = dose of N brought (kg.ha-1) (Schvartz et al., 2005).

- Evaluation of losses: N mineral losses in the soil have been estimated from the method of the nitrogen balance between 0-20 cm and 20-40 cm of depth of the soil: Rf-Ri=Mn+X-(P+B), so P=(Ri-Rf)+Mn+X-B with P: Quantity of nitrogen lost, Ri: Quantity of initial mineral N in soil (kg.ha-1), Rf: Quantity of final mineral N in soil (kg.ha-1), Mn: N Mineralization (kg.ha-1), X: Quantity of mineral N brought by the fertilizer (kg.ha-1), B: N exported by the plant (kg.ha-1) (Meynard et al., 1996).

Results and Discussion
**Critical dilution curve:** The curves corresponding to the nitrogen treatments are situated below the curve of Duchenne *et al.* (1997) and showed a deficient nitrogen status (Fig. 1). This phenomenon has been interpreted as a nitrogen dilution (Justes *et al.*, 1994). Statistically, the effect of the nitrogen was not significant (Fig. 1).

**Nitrogen Nutrition Index:** In the beginning of the cycle of development of potato, only plants fertilized by 200 and 300 kg N.ha⁻¹ were in situation of non-limiting nitrogen supply because the values of NNI were included between 0.8 and 1 (Chambenoit *et al.*, 2002). The provision of nitrogen rates superior to 200 kg N.ha⁻¹ doesn’t have any positive effect on the nitrogen status of potato. Statistically, the effect of the nitrogen was significant, only, for 50 and 200 kg N.ha⁻¹ (Fig. 2).

![Fig. 1: Critical dilution curve](image1)

![Fig. 2: Nitrogen nutrition index](image2)

**Correlation HNT-NNI**

The correlations between H.N.T. and N.N.I. showed linear relations with coefficients of correlation included between 0.1 and 0.7 (Fig. 3).
The comparison of the relative averages to the 4 N treatments showed the independence of the yield of potato to the N rate. The statistical analysis indicated the absence of the effect of the nitrogen (Fig. 4).

The coefficient of nitrogen use calculated didn’t reveal the effect of the nitrogen between the various treatments and the values differences were very slight by comparison with an average of 50% for the culture of potato recorded by Goffart et al. (2005) (Fig.5).

- Nitrogen losses
The calculation of nitrogen losses according to the method of the nitrogen balance indicated very important values varying between 72.9 and 299.5 kg N.ha\(^{-1}\). Statistically, the effect of the nitrogen is noted for the 4 nitrogen fertilizer rates 50, 150, 200 and 300 kg N.ha\(^{-1}\) (Fig. 6).

![Graph showing Coefficients of Nitrogen Use](image1)

**Fig.5:** Coefficients of Nitrogen Use

The values having the same letter are not meaningfully different to the doorstep 5%

![Graph showing Nitrogen losses](image2)

**Fig.6:** Nitrogen losses

The values having the same letter are not meaningfully different to the doorstep 5%

**Conclusion**

The nitrogen status and the productivity of potato are two factors related to the effects of the nitrogen supply and its repartition during the development of potato. In order to have a good relation between these two factors, we have followed some parameters through which we have observed a lower correlation HNT-NNI in Tunisian conditions, a deficient nitrogen status of plants and a difficulty of establishment of the critical dilution curve for potato. The calculation of the coefficient of nitrogen use suggested lowers values which showed a non-availability of nitrogen to plants. This hypothesis was confirmed by the very elevated nitrogen losses by leaching or denitrification.

**References**


