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EFFICIENCY OF UPTAKE AND UTILIZATION OF N FROM MINERAL AND ORGANIC SOURCES BY POTATO CROP

M. A. R. Rodrigues¹, J. F. Coutinho²

¹Department of Crop Production, Escola Superior Agrária, apart. 172, 5300 Bragança, Portugal

²UTAD, 5001 Vila Real, Portugal

Introduction

This work study the relationship among N applied, N uptake and tubers yield. Several indices related to N use efficiency were also estimated and its economical aspects considered.

Methods

In 1994 and 1995, field experiments were conducted on a loamy soil in Bragança (north-east Portugal) using two varieties of potato, Stemster and Désirée, respectively. The experimental setup was a randomized complete block design with six different N doses (as urea) and four organic materials (cow manure and three types of commercial organic fertilizers). Urea treatments were 0, 50, 100, 150, 200 and 250 kg N ha⁻¹ and the Organic Fertilizers (OF) were applied at rates equivalent to 100 kg N ha⁻¹. Tubers yield, N content in tissues and the soil N-mineral were recorded during the growing season and at harvest.

The N efficiency indices are defined as: Apparent N Recovery (ANR), as a measure of the increase of the tuber N uptake per unit of N fertilizer applied; Internal Efficiency (IE), the increase of tuber yield per unit of N absorbed; External Efficiency (EE), the increase of tuber yield per unit of N applied; Economic Return for Fertilizer Investment (ERFI), the increase of yield value per monetary unit applied as fertilizer; Apparent N Lost (ANL), the N fertilizer fraction not recovered by the tubers. All efficiency parameters were calculated with reference to non fertilized plot data and estimated according to the regression curves. The Optimal Rate of Fertilizer (ORF) was analytically calculated.

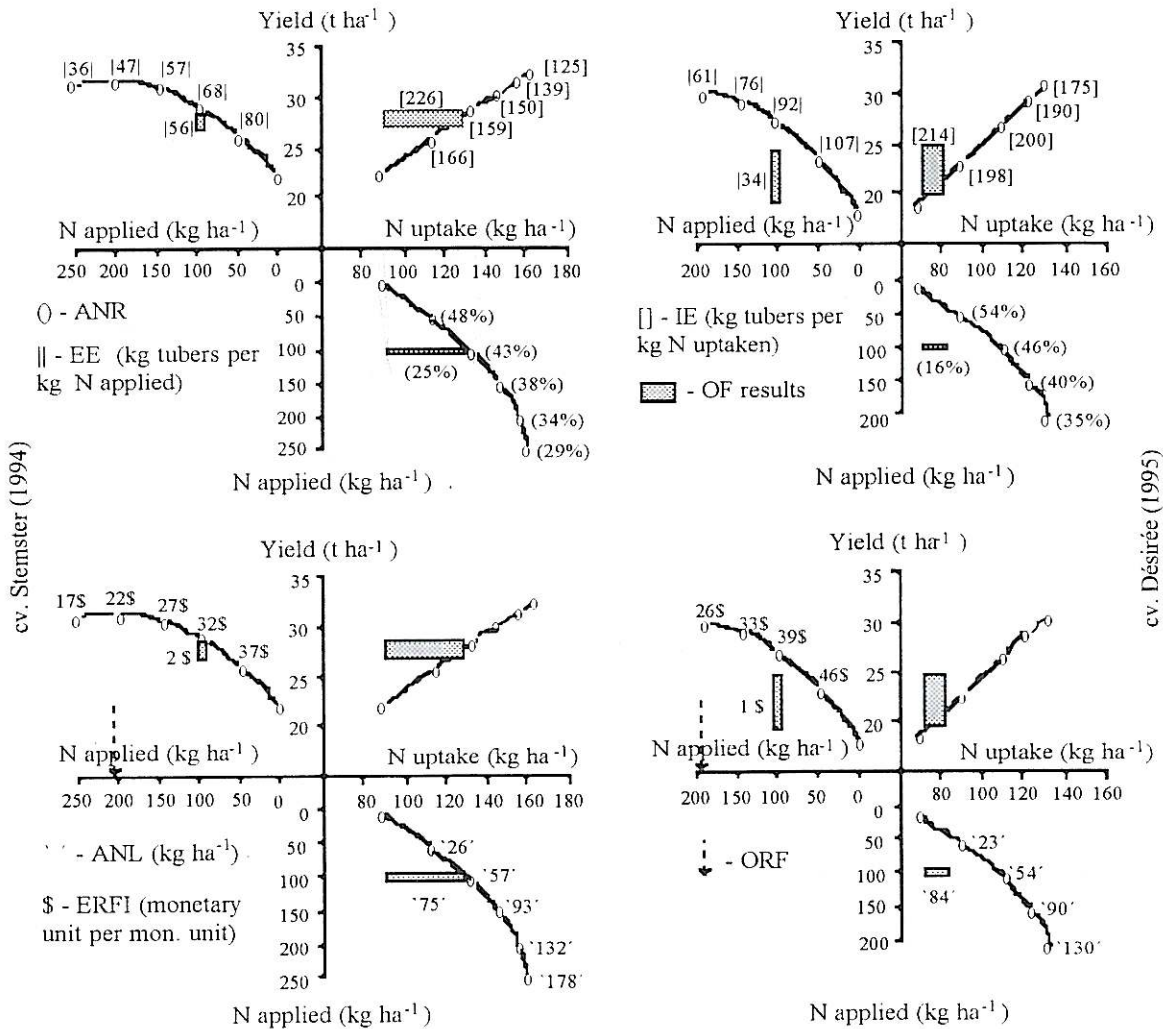
A four quadrants diagram (Dalla Costa and Giovanardi, 1994; Fotyma et al., 1994) was used to present the results. The organic fertilizers results were also presented graphically but only the mean values were plotted because no statistical differences occurred among them.

Results

The relationship among N applied, N uptake and tuber yield, as well as the various N efficiency parameters are summarized in the Figure. Either in 1994 and 1995, the data showed quadratic relations between N applied and N uptake and between N applied and yield. Between N uptake and yield, the linear regression showed the best adjustment. The mentioned quadratic equations indicate important decreases in ANR, EE and ERFI and an important increment in ANL with N dose. The expected decrease in N uptake with the N dose and the well-known law of diminishing returns justifies these results. The quadratic relation between N applied and N uptake conjugated with the linear regression among N uptake and yield suggests that the tubers are not preferential organs for N accumulation. For the above mentioned indices, the results of 1995 (cv. Désirée) were generally more favourable for inorganic N and worst for the OF than in 1994 (cv. Stemster). However, the impact of genotypic or environmental aspects is not clear.

The OF originated highest IE than any urea treatment. The observed low levels of mineral N in soil, the higher efficiency of N released late in the season and the possible favourable interactions of the organic materials in soil growth conditions can, individually or together, justify these results. The ANR and ANL values were, respectively, higher and lower than the treatment consisting of 100 kg N ha⁻¹ as urea. The low ANR value of OF, associated with the reduced

amounts of soil mineral N during the season (data not shown) suggested that the high value of ANL is due to the fact that N is not actually released through mineralization from OF along the crop cycle. The optimal rate of applied N was 204 and 195 kg ha⁻¹ in 1994 and 1995, respectively. The OF originated a poor economic return, in some cases inferior to unit, due to their high commercial prices.



Relationship among N applied, tubers yield and N uptake. Summary of the N efficiency indices

Conclusions

The results showed for all indices a decrease in N use efficiency with the increase of urea rates. The slope of N response curve and the relatively low cost of N mineral lead to an high value of ORF. Notwithstanding, this value represents a low N efficiency with high N loss potential. Regarding OF, the potential risk of environmental damage during the growing season is reduced due to the lower levels of soil N mineral. Posterior effects of the OF utilization are not discussed here. On account of their commercial prices, the OF turned out to be, in our conditions, a poor economic fertilization strategy.

References

Dalla Costa, L. and Giovanardi, R., 1994. Proc. of 3rd ESA Congress, Abano-Padova, 98-99.
 Fotyma, E. et al., 1994. Proc. of 3rd ESA Congress, Abano-Padova, 482-483.