B22

Netherlands Journal of Agricultural Science 40 (1992) 51-72

Effects of spatial variability of nitrogen supply on environmentally acceptable nitrogen fertilizer application rates to arable crops

M. VAN NOORDWIJK & W.P. WADMAN

DLO-Institute for Soil Fertility Research (IB-DLO), P.O. Box 30003, NL 9750 RA Haren, Netherlands

Received: 24 September 1991; accepted: 13 December 1991

Abstract

Current N recommendation schemes are based on the Maximum Economic Yield (MEY), as obtained at 'economic optimum' fertilizer application rates. Environmental standards for the amount of mineral N left in the soil at harvest time will soon restrict fertilizer rates to obtain an Environmentally Acceptable Production (EAP). For MEY, but especially for EAP, spatial variability of N supply in a field which is managed as if it were a homogeneous unit should be taken into account. A model is presented here, based on a four-quadrant representation of N fertilizer experiments. Effects of spatial variability of various terms of the N-balance were investigated in the model. Calculations showed that spatial variability of mineral-N supply in the soil leads to higher 'economic optimum' fertilizer rates, while the rates which are allowed for EAP decrease. For a standard set of parameters, but without spatial variability, a positive difference of 13 kg per ha exists between the N fertilizer rates for EAP and MEY, even if the strictest environmental standard is applied (soil mineral N content at harvest is not allowed to exceed 34 kg ha^{-1}). At standard levels of variability a negative difference of 26 kg ha^{-1} was calculated and at doubled variability this difference was 156 kg ha^{-1}. An N residue at harvest of 45 kg ha^{-1} can be met at standard variability, but not at doubled variability. The model shows that higher degrees of 'luxury consumption' and improved synchronization of mineralization and crop demand have a positive effect on the difference between EAP and MEY. The choice for relatively homogeneous sites for field experiments has introduced a bias in existing quantitative data on environmental effects and crop response to fertilizer application. We conclude that the degree of spatial variability in N supply should be explicitly taken into account in future discussions of the conflict between environmental and production targets.

Keywords: crop yield, fertilizer nitrogen, nitrogen fertilizer recommendation, price ratio, residual soil mineral nitrogen, simulation model, spatial variability

Introduction

Conventionally, N recommendation schemes have been based on the Maximum Economic Yield (MEY), as obtained at 'economic optimum' fertilizer application rates (Neeteson, 1990). Environmental standards will soon restrict fertilizer rates to obtain an Environmentally Acceptable Production (EAP). For the present