SOIL TILLAGE AND CROP ESTABLISHMENT PRACTICES TO DECREASE NUTRIENT LOSSES TO WATER – INTRODUCTION

2011 Authors: B. Ulén, M. Bechmann, T. Krogstad

Soil tillage affects nitrogen (N) mineralisation and phosphorus (P) mobilisation in variable and site-specific ways depending on inherent soil susceptibility to structural management and weather [1]. Thus, a number of factors with an impact on soil management interact with nutrient transfer. Erosion and leaching are both processes related to P and N. However, leaching is the most important process described for N. Soil tillage affects both erosion [2] and leaching of nutrients. In addition, a pre-condition for low nutrient leaching is a well-developed crop, which means improved nutrient uptake [3]. In turn, root and hence crop development depend on soil tillage. However, the combined effects of crop and soil management are difficult to estimate for arable fields.

In general, especially during warm and moist soil conditions, soil tillage encourages high rates of mineralisation. It is well known that in the absence of an actively growing crop, there is little N uptake and therefore much nitrate can leach. However, there is generally a lack of knowledge on how individual crops affect N leaching in relation to the entire crop rotation. Without the presence of a crop no efficient root filter is established, which has an impact on P leaching. Similarly to N, there is a lack of knowledge on how individual crops affect P leaching in relation to the entire crop rotation. There is also a lack of knowledge on the extent to which P can be released from plants damaged by frost and on whether there are decisive differences between newly germinated fresh plant material and plant regrowth and how plants translocate P down to their roots as they mature.

In general, the effect of reduced tillage on erosion risk can be expected in short term. The effects of reduced tillage on soil structure and improved infiltration may however, take some more time.

Surface soil erosion is often the most important P loss process and hence P losses generally decrease with increasing soil infiltration capacity and thus decreasing runoff or risk of surface water ponding conditions [4,5,6]. In contrast, ponding conditions may increase P mobilisation and start P macropore flow [7,8]. High P concentrations can be observed in artificially drained soils even when the P content is temporarily close to the background level [9,10] and the whole soil profile needs to be taken in account when discussing nutrient leaching [11].

References

[1] Withers, P.J.A., Hodgkinson, R.A., Bates, A. & Withers, C.L. 2007. Soil cultivation effects on sediment and phosphorus mobilization on surface runoff for three contrasting soil types in England. Soil & Tillage Res. 93, 438-451.

[2] Lundekvam, H. 2007. Plot studies and modeelling of hydrology and erosion in southeast Norway. Catena 71, 200-209.

[3] Aronsson, H., Lindén, B., Stenberg, M., Torstensson, G., Rydberg, T & Forkman, J. 2006. Nutrient Leaching from a Clay Soil with Crop Rotation Including Winter Wheat and Short Fallow after Ley. Ekohydrology 93. Division of Water Quality Management, Swedish University of Agricultural Sciences 36 pp.

[4] Turtola, E. & Jaakola, A. 1995. Loss of phosphorus by surface runoff and leaching from a heavy clay soil under barley and grass ley in Finland. Acta Agric. Scand., Section B 45, 159-165.

[5] Gillingham, A.G. & Thorrold, B.S. 2000. A review of New Zealand research measuring phosphorus in runoff from pasture. J. Environ. Qual. 29, 88-96.
[6] Simard, R.R., Beauchemin, S. & Haygarth, P.M. 2000. Potential for preferential pathways of phosphorus transport. J. Environ. Qual. 29, 277-293.
[7] Djodjic, F., Bergström, L. & Ulén, B. 2002. Phosphorus losses from a structured clay soil in relation to tillage practices. Soil Use Manage. 18, 79-83.
[8] Øygarden, L., Kværner, J. & Jenssen P.D. 1997. Soil erosion via preferential flow to drainage system in clay soils. Geoderma 76, 65-86.
[9] Ulén, B. 1995. Episodic precipitation and discharge events and their influence on losses of phosphorus and nitrogen from tile drained arable fields. Swedish J. Agric. Res. 25, 25-31.
[10] Kinley, R.D., Gordon, R.J., Stratton, G.E., Pattersson, G.Y. & Hoyle, J. 2007. Phosphorus losses through agricultural tile drainage in Nova Scotia, Canada. J. Environ. Qual. 36, 469-477.
[11] Ulén, B. & Jakobsson, C. 2005. Critical evaluations of measures to mitigate phosphorus losses from agricultural land to surface waters in Sweden. Sci. Total Environ. 344, 37-50.