USE OF CONTROLLED DRAINAGE FOR REDUCING THE AMOUNT OF WATER LEAVING A FIELD

first DRAFT author: A. Delgado

Description

The losses of dissolved nutrients and nutrients associated to colloidal particles (mainly P) can be decreased if the amount of water lost by drainage is reduced.

Rationale, mechanism of action

Phosphorus loss from soils through subsurface flow can be environmentally signficant in saturated soils (P) or in the presence of rapid non-equilibrium water movement through macropores which surpasses the buffering capacity of the soil matrix in subsurface horizons – preferential flow - [1,2]. The introduction of artificial drainage increases nutrient losses because macropores connect the nutrient-rich topsoil with drain lines through which water and dissolved/suspended nutrients are transferred to water [3]. This could be of particular concern in drained cracking soils. However, in saline soils or in soils with a shallow saline water table it is necessary to allow some of the applied water to drain in order to decrease/avoid salinization [4]. In this case, an accurate equilibrium between nutrient losses and salt balance in soil is necessary in order to avoid soil degradation. Preferential flow of water is not effective for removing excess salts. Factors considered for reduction of N and P losses (besides other pollutants such as pesticides) in drained soils through the control of water losses involve:

- Accurate calculation of irrigation rates and drainage fraction (portion of irrigation water loss by drainage to avoid salt accumulation).
- Avoid crack opening in cracking soil due to drying (low irrigation rates applied frequently) using drip irrigation or low intensity-sprinklers.
- Artefacts to interrupt drainage (short interrumptions 1-2 hour) and promote “soil wetting from the bottom to the upper part”. This increases the residence time of water, decreasing P losses and increases the efficiency of salt leaching.
- Recovery of drainage water for irrigation if there is no risk of salinization related to this practice.

Applicability

Accurate management of irrigation and drainage fraction is applicable on irrigated fields. Preferential flow through cracks could be of relevance if there is a dry season or a drought period in clayish soils. Artefacts to interrupt drainage could be applicable to non-irrigated soils under humid climates if subsurface horizons are not saturated with P.

Effectiveness, including certainty

There are evidences of non-significant differences in P concentration with different drain-flows and different total amount of drainage water when preferential flow is the dominant sub-surface flow, the total amount of P lost being proportional to the total amount of water lost [2]. Thus, control of drainage could be a way of reducing P losses, but also N. The recovery of drainage water for irrigation of tile drained soils has been proved to be useful to save water (and thus reuse of nutrients) with a decreased risk of salinization when applied under control [5].

Time frame
An accurate water balance in drained soils can reduce nutrient losses immediately. Reduction of preferential flows can also promote a significant reduction of losses immediately.

Environmental side-effects / pollution swapping
Care should be taken to avoid salinization of soils. Accurate management of irrigation water promotes water saving in arid and semi-arid areas. Also, a reduction in other pollutant losses can be expected (e.g. pesticides).

Relevance, potential for targeting, administrative handling, control
The option can be relevant for all drained fields, in particular if irrigated in arid and semiarid areas and where cracking soils could be dominant.

Costs: investment, labor
An accurate calculation of irrigation rate and frequency does not imply costs or investments are known. Administration should facilitate calculations [e.g. 6]. Artefacts for controlling drain flow may account for an investment of 2000 € per ha.

References

[1] Djokic, F., K. Börling, and L. Begström. 2004. Phosphorus leaching in relation to soil type and soil phosphorus content. J. Environ. Qual. 33:678-684.
[2] Delgado, A., M.D. Hurtado, and L. Andreu. 2006. Phosphorus loss in tile drains from a reclaimed marsh soil amended with manure and phosphogypsum. Nutr. Cycl. Agroecosys. 74:191-202.
[3] Addiscott, T.M., D. Brockie, J.A. Catt, D.G. Christian, G.L. Harris, K.R. Howse, N.A. Mirza, and T.J. Pepper. 2000. Phosphate losses through field drains in a heavily cultivated soil. J. Environ. Qual. 29:522-532.
[4] Moreno, F., F. Cabrera, L. Andreu, R. Vaz, J. Martín-Aranda, and G. Vachaud. 1995. Water movement and salt leaching in drained sand irrigated marsh soils of southwest Spain. Agric. Water Manage. 27: 25-44.
[5] Moreno, F., F. Cabrera, E. Fernández-Boy, I.F. Girón, J.E. Fernández, and B. Bellido. 2001. Irrigation with saline water in the reclaimed marsh soils of south-west Spain: impact of soil properties and cotton and sugar beet crops. Agric. Water Manage. 48:133-150.
[6]http://www.juntadeandalucia.es/innovacioncienciayempresa/ifapa/ria/servlet/FrontController (in Spanish)