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Catch crops as universal and effective method for reducing nitrogen leaching loss in spring cereal production: A meta-analysis.

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Sustainable farms produce adequate amounts of a high-quality product, protect their resources and are both environmentally friendly and economically profitable. Nitrogen (N) fertilization decisively influences the cereal yields as well as increases soil N balance (N input in fertilizer – N output in harvested yield), thereby leading to N losses to the environment. However, while N input reduction affects soil N balance, such approach would markedly reduce N leaching loss only in case of abnormally high N balances.

As an alternative approach, the growing of catch crops aims to prevent nutrient leaching in autumn after harvest and during the following winter, but due to competition, catch crops may also reduce yields of the main crop. Although studies have explored the environmental effects of catch crops in cereal production in the Nordic countries (Denmark, Sweden, Finland and Norway) during the past 40 years, none has yet carried out a meta-analysis. We quantitatively summarized 35 studies on the effect of catch crops (non-legume and legume) undersown in spring cereals on N leaching loss or its risk as estimated by the content of soil nitrate N or its sum with ammonium in late autumn. The meta-analysis also included the grain yield and N content of spring cereals. To identify sources of variation, we studied the effects of soil texture and management (ploughing time, the amount of N applied, fertilizer type), as well as climatic (annual precipitation) and experimental conditions (duration of experiments, lysimeter vs. field experiments). Finally, we examined whether the results differed between the countries or over the decades.

Compared to control groups with no catch crops, non-legume catch crops, mainly ryegrass species, reduced N leaching loss by 50% on average, and soil nitrate N or inorganic N by 35% in autumn. Italian ryegrass depleted soil N more effectively (by 60%) than did perennial ryegrass or Westerwolds ryegrass (by 25%). In contrast, legumes (white and red clovers) did not diminish the risk for N leaching. Otherwise, the effect on N leaching and its risk were consistent across the studies conducted in different countries on clay and coarse-textured mineral soils with different ploughing times, N fertilization rates (50–160 kg/ha), and amounts of annual precipitation (480–1040 mm). Non-legume catch crops reduced grain yield by 3% with no changes in grain N content. In contrast, legumes and mixed catch crops increased both grain yield and grain N content by 6%.

In spring cereal production, undersown non-legume catch crops are deemed a universal and effective method for reducing N leaching loss across the various soils, management practices and weather conditions in the Nordic countries. The environmental benefits of using non-legume catch crops appear considerable compared to the adverse reduction in grain yields, amounting to only a few percent. Catch crops are advisable for fields at high risk for N leaching (e.g., sandy soils or soils and crops requiring high N fertilization).