FARMING PRACTICE
COVER AND CATCH CROPS

IMPACT: NUTRIENT LEACHING AND RUN-OFF

Reference 37

Valkama E, Lemola R, Känkänen H, Turtola E 2015 Meta-analysis of the effects of undersown catch crops on nitrogen leaching loss and grain yields in the Nordic countries Agriculture, Ecosystems & Environment 203, 93-101 10.1016/j.agee.2015.01.023

Background and objective

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. The present study aimed to summarize Nordic experiments on the effects of catch crops undersown in spring cereals on N leaching loss or its risk, soil or inorganic N(NO_3- and NH_4+) in late autumn. The meta-analysis also included both the grain yield of the main crops and their quality.

Search strategy and selection criteria

The database consisted of 35 studies published between years 1988 and 2014 in peer-reviewed scientific journals (30 articles), in seminar proceedings (3 articles), in newspapers (1 article), and one unpublished study (Appendix A and Reference list marked with asterisks). Altogether 14 studies were conducted in Denmark, 11 in Sweden, 7 in Finland, and 3 in Norway. We found the articles by searching for key-words ("catch crops" or "cover crops" AND "soil nitrate N" or "soil" or "soil inorganic N" or "soil mineral N" or "nitrogen leaching" or "nitrate leaching" AND Denmark; Sweden; Finland or Norway) in the Web of Science Database; we also found the journal articles in the reference lists of previously published articles. 1. The study was carried out in Denmark, Sweden, Finland or Norway. 2. The main crops were spring wheat, spring barley, and oats. 3. Catch crops were undersown in spring. 4. The study had an appropriate control group (i.e., one with no catch crop). 5. The study assessed the effects of undersown catch crops on total N leaching, nitrate N leaching, soil nitrate N or inorganic N, grain yield, or grain N content. 6. Responses to catch crops were recorded as either original data for each experimental year or as means of treatments (i.e., with undersown catch crops) and controls (i.e., with no catch crops) for the duration of the experiment with standard deviations and sample sizes (number of years).

Data and analysis

For soil and leaching data, a random effects model served to combine estimates across the studies. For yield and grain N data, we used a fixed effects model, since the estimate of the pooled variance was less than or equal to zero. We used a bootstrap statistical method (Efron and Tibshirani, 1986) to generate bias-corrected 95% confidence intervals (CIs) around the log response ratios from 4999 iterations. To test whether ln r differed among the groups of categorical explanatory variables, we used the $\chi 2$ test to examine the between-group heterogeneity (QB) as well as to check for possible inter-correlation between the variables. To study the effect of continuous explanatory variables, we ran weighted meta-regressions with ln r as the dependent variable and the continuous variables as independent ones. We also used the $\chi 2$ test to examine model heterogeneity (QM), which describes the amount of heterogeneity explained by the regression models.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
35	Spring cereals	Winter catch crops undersown to spring cereal. The catch crops were four non-legume species (Italian ryegrass (Lolium multiflorum Lam.), perennial ryegrass (Lolium perenne L.), Westerwolds ryegrass (L. multiflorum Lam. var westerwoldicum) and rapeseed (Brassica napus L.)) and two legume species (white clover (Trifolium repens L.) and red clover (Trifolium pratense L.)).	Bare fallows	Metric: Nitrate and ammmonium leaching; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	81.25

Results

- Compared to control groups with no catch crops, non-legume catch crops, mainly ryegrass species, reduced N leaching loss by 50% on average (–60% to –40% CI, n = 27), 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 the controls, N leaching losses for the entire database varied from 7 to 98 kg ha−1 yr−1, averaging 46 ± 29 kg ha−1 yr−1.
- Legumes (white and red clovers) did not diminish the risk for N leaching.
- 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 (<160 kg ha−1), and amounts of annual precipitation (480–1040 mm).
- NULL
- NULL

Factors influencing effect sizes

- No factors influencing effect sizes to report

Conclusion

Non-legumes, mainly ryegrasses, reduced N leaching loss by 50%. Legumes did not diminish the risk for N leaching. In spring cereal production, non-legume catch crops represent a universal and effective method for reducing N leaching across the varieties of soils and weather conditions in the Nordic countries.