FARMING PRACTICE
COVER AND CATCH CROPS

IMPACT: CROP YIELD

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scientific journals (30 articles), in seminar proceedings (3 articles), in newspapers (1 article), and one unpublished study (Appendix A and Reference list marked with asterisks).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 χ2 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 χ2 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: Crop yield; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	81.25

Results

- On average, non-legume catch crops reduced grain yields by 3%, and the effect was statistically significant, because the 95% CI did not overlap with zero (–8% to –1%). In contrast, legumes and mixed catch crops improved the yields by 6% (2–11% CI).
- In the controls, the grain yield of spring cereals varied across the entire database from 2300 to 8100 kg ha−1, with an average of 4000 ± 1400 kg ha−1.
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Factors influencing effect sizes

- Soil type : Compared to controls, the effect of non-legume catch crops on grain yields tended to vary between soil textures (QB = 1.8, P = 0.06, df = 2): –8% (–10% to –3% CI, n = 11) on loam; –1% (–6% to –1% CI, n = 3) on clay, and no statistically significant change (3%, –10% to 15% CI, n = 4) on sandy soils. In contrast, the effect of legume catch crops showed no difference between the soil types (QB = 0.02, P = 0.9, df = 1).
- N fertilisation rate : Meta-regression indicated that the grain yield responses to the catch crops depended on N application rates (Fig. 4). At low N rates, catch crops had a positive effect; at 60 kg N ha−1, for example, the yield rose to 8% over that of the controls with no catch crops. In contrast, at 95 kg N ha−1, the yield response declined compared to that of the controls, and at 120 kg N ha−1, it dropped to –6%.

Conclusion

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%. The trade-off between potential grain yield loss and environmental benefits seems tolerable and can be taken into account in environmental subsidy schemes.