FARMING PRACTICE
COVER AND CATCH CROPS

IMPACT: NUTRIENT LEACHING AND RUN-OFF

Reference 36

Wortman, Sam E. 2016 Weedy fallow as an alternative strategy for reducing nitrogen loss from annual cropping systems Agronomy for Sustainable Development 61 10.1007/s13593-016-0397-3

Background and objective

Nitrogen loss from croplands is a major environmental problem with human health and ecosystem consequences. Cover crops are planted during the fallow period between cash crops to provide a number of ecosystem services and are a popular tool for nitrogen reduction. Naturally occurring weeds, if left unmanaged between cash crops (i.e., "weedy fallow"), may provide similar ecosystem services (e.g., nitrogen reduction) as cover crops. Weedy fallow, as it is currently practiced, requires little to no farmer time, labor, or money, which are all significant barriers to cover crop adoption; in the absence of these barriers, weedy fallow may have greater potential for widespread adoption and net nitrogen reduction, even if the strategy is not as effective as cover crops (or other nitrogen reduction strategies) on a per area basis. Compare potential nitrogen loss from annual cropping systems between crop cycles (e.g., winter) when soil was managed bare, as weedy fallow, or with cover crops.

Search strategy and selection criteria

Two literature searches were conducted by using the Scopus search engines (Elsevier). The first search, targeted toward nitrogen leaching losses from croplands, returned 37 total results and included the terms "cover crop," "green manure," or "catch crop," and "leaching," "nitrogen," and "weed" in the title, abstract, or keywords. To increase the pool of possible studies, the search was broadened to target inorganic soil nitrogen present after the fallow period (as a measure of potential nitrogen loss) in a second search that included the terms "cover crop," "green manure," "catch crop," and "nitrogen," "nitrate," or "NO3," and "weed" in the title, abstract, or keywords. (1) a measure of potential nitrogen loss during (i.e., leachate nitrogen) or at the conclusion (i.e., inorganic soil nitrogen) of a fallow period in annual croplands (this included most grain and vegetable crops but excluded most forages, cellulosic bioenergy crops, and tree fruits) and (2) a comparison of at least one planted annual cover crop treatment and a weedy fallow treatment that did not receive any tillage or chemical application to suppress weed growth. Studies were included regardless of tillage (conservation vs. conventional tillage) or management (organic vs. conventional) system, although conservation tillage and organic systems were under-represented in the final data set (two studies for each system). Other studies were culled because the measure of inorganic soil nitrogen occurred after cover crops and weeds had been terminated and incorporated into the soil (the decomposition of residues confounded estimates of potential nitrogen losses). The species of cover crop and dominant weed species in the weedy fallow treatment were extracted from each study when available; cover crop species were later grouped by legumes and nonlegumes for analysis. In cases where mixtures of cover crops were planted, the treatment was grouped according to the dominant species in the mixture (e.g., a mixture of 70 % nonlegume cover crops and 30 % legume cover crops was grouped with nonlegumes for analysis).

Data and analysis

Due to infrequent reporting of within-study error, response ratios were weighted according to the number (n) of reps × sites × years contributing to a paired mean observation as weight = (n cover crop or bare soil × n weedy) / (n cover crop or bare soil + n weedy). Bootstrap confidence intervals (95 %) were calculated for mean response ratios of interest (i.e., bare soil, legume cover crops, nonlegume cover crops, and all cover crops relative to weedy fallow) based on 4999 iterations by using the "boot" package in R (v. 3.1.3) (Adams et al. 1997). Response ratios for each group were considered significant if the bootstrap confidence interval did not overlap with zero and different from other groups if their bootstrap confidence intervals did not overlap.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
17	Arable fields	Winter weedy fallow; Cover crops (legumes, non-legumes)	Bare fallows; weedy fallow	Metric: Leachate nitrogen and inorganic soil nitrogen are undoubtedly different measures of potential nitrogen loss. The former estimates nitrogen concentrations in soil water beneath or near the bottom of the crop rooting zone via lysimeter, while the latter typically estimates inorganic nitrogen in bulk soil within the crop rooting zone via soil sampling and chemical extraction. Because elevated concentrations of inorganic soil nitrogen in the rooting zone precludes nitrogen leaching deeper in the profile, we elected to use the former as a proxy for future leaching potential given the lack of leachate data available within this literature search (7 of 17 studies eligible for data extraction).; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	68.75

Results

- Potential nitrogen loss was 60 % greater in bare soil compared to weedy fallow.
- Cover crops reduced potential nitrogen loss by 26 % compared to weedy fallow.
- Nonlegume cover crops were more effective than legumes in reducing potential nitrogen loss, and the effect was not significantly different between legumes and weedy fallow.
- NULL
- NULL

Factors influencing effect sizes

- No factors influencing effect sizes to report

Conclusion

Results of this meta-analysis suggest that weeds are effective nitrogen scavengers during fallow periods, but not as effective as nonlegume cover crops.