

Reference 17

Basche, AD; DeLonge, MS 2019 Comparing infiltration rates in soils managed with conventional and alternative farming methods: A meta-analysis PloS one, 14 (9): e0215702. 10.1371/journal.pone.0215702

Background and objective

Identifying agricultural practices that enhance water cycling is critical, particularly with increased rainfall variability and greater risks of droughts and floods. Soil infiltration rates offer useful insights to water cycling in farming systems because they affect both yields (through soil water availability) and other ecosystem outcomes (such as pollution and flooding from runoff). For example, conventional agricultural practices that leave soils bare and vulnerable to degradation are believed to limit the capacity of soils to quickly absorb and retain water needed for crop growth. Further, it is widely assumed that farming methods such as no-till and cover crops can improve infiltration rates. Despite interest in the impacts of agricultural practices on infiltration rates, this effect has not been systematically quantified across a range of practices. The authors considered a range of specific alternative practices that can be adopted on farms, including no-till, cover crops, crop rotations, introducing perennials, and livestock grazing on croplands, compared to more conventional controls (experiments with tillage, no cover crops, monocropping, annual crops, and no grazing). The authors hypothesized that the various alternative practices would increase infiltration rates, but that the relative impacts would vary, and that is the motivation behind including multiple practices in our analysis. We secondarily explored patterns of additional environmental and management factors (e.g. soil texture, climate indices, and the length of the experiment) that we hypothesized could be modulating observed effects.

Search strategy and selection criteria

The literature search was conducted using EBSCO Discovery Service (detailed in Basche and DeLonge) and only included field experiments in English language peer-reviewed literature through 2015 (the earliest publication that met our criteria was from 1978). Keyword strings included: infiltration W₁ rate AND crop* for all searches, and additional keywords were used for individual practices. These searches returned approximately 700 studies, of which 79 fit our criteria. The USDA-NRCS Soil Health Literature database was used to find additional papers, leading to 10 more studies for a total of 89. The main criteria for inclusion were field experiments that: 1. Measured and reported steady-state infiltration rates, defined as the volume of water entering the soil over a designated period; 2. Compared one of the alternative practices of interest relative to select conventional controls in a standardized way.

Data and analysis

For statistical analyses, the five practices were analyzed separately because there were notable differences in experimental designs and control treatments. A linear mixed model (lme4 package in R) was used to calculate means and standard errors for the five practices. The statistical model also included a random effect of study to account for the factor of similar environments and locations in the cases where experimental designs allowed for multiple paired observations

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
23	Annual crops	Cover crops	no cover crop (fallow)	Metric: Soil water infiltration rate; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	93-75

Results

- The mean increase in infiltration rates for cover crop experiments (n = 81, 23 studies) was significantly above zero (34.8%, confidence interval 19.8–50.0%)
- NULL
- NULL
- NULL
- NULL

Factors influencing effect sizes

- Years of treatment : There was a significant improvement in infiltration rates when cover crop experiments were in place for more than four years (30.0%, confidence interval 1.7–51.3%, representing 34 of the 71 comparisons)
- Soil texture : The effects of cover crops on infiltration rate improvements were greater in coarsely textured soils with higher sand contents and less clay
- Associated practices : There to be a significant increase in infiltration rates when experiments combined cover crops with no-till (compared to no cover crops with no-till; 44.6%, confidence interval 11.6–77.5%)

Conclusion

The mean increase in infiltration rates for cover crop experiments (n = 81, 23 studies) was significantly above zero (34.8%, confidence interval 19.8–50.0%)