FARMING PRACTICE
COVER AND CATCH CROPS

IMPACT: SOIL WATER RETENTION

Reference 21

Meyer, N; Bergez, JE; Constantin, J; Justes, E 2019 Cover crops reduce water drainage in temperate climates: A meta-analysis Agronomy for Sustainable Development 39, 3 10.1007/s13593-018-0546-y

Background and objective

Cover crops provide many ecosystem services, such as soil protection, nitrate pollution of water mitigation, and green manure effects. However, the impact of cover crops on soil water balance is poorly studied, despite its potential impact on groundwater recharge. Some studies reported a reduction of the water drainage due to an increase of the evapotranspiration by plant cover transpiration. However, there is no real consensus on the intensity of this phenomenon, which highlights the importance to quantify the impact of cover crops on drainage compared to that of bare soil. Meta-analysis of impacts of cover crops on water balance and drainage is lacking. The authors used a meta-analysis approach to quantify the impact of cover crops on water drainage compared to that of fallow bare soil, i.e., without plant cover, under temperate climates, such as in Europe and North America.

Search strategy and selection criteria

We searched the Web of Science database (27 Sep 2017) for papers written in English using the following query:

"Topic = ((cover crop* OR green manure OR catch crop*) AND (drain*) NOT vine* NOT orchard* NOT banana* NOT microbial* NOT rice NOT residu* NOT grape* NOT greenhouse NOT carbon NOT bacteri*))"

The search identified 436 papers. We then added 18 other papers from a review paper (Justes et al. 2012; Tribouillois et al. 2016) not found in our query but with all the query markers of our study. These papers were not specifically focused on drainage and therefore not found by our query. (1) Contain data on water drainage, which we defined as water unavailable to plant roots and likely to recharge groundwater, i.e., measured at a depth of 90 cm or more (2) Compare the impact of cover crops to that of fallow bare soil, without plant cover (3) Cover crops sown in summer or autumn after the cash crop harvest and destroyed (soil tillage) or terminated (crushing or herbicide) before sowing the next cash crop (4) Provide drained plot or lysimeter measurements or soil-crop model outputs (5) Perform studies under climates of class B, C, or D of the Köppen-Geiger classification (Peel et al. 2007) in order to represent temperate climates (6) Studies performed at the field scale

Data and analysis

The authors used the "metafor" package, "rma" function, and "REML" method (Viechtbauer 2010) of R software to perform the meta-analysis. Between-study variance was calculated using the maximum and restricted maximum likelihood methods. The standard deviation of mean effect size ($\sigma\mu$) equaled the reciprocal of the sum of the studies' weights. The 95% confidence interval of the mean effect size was then calculated. We conducted two separate meta-analysis to calculate the mean effect size: (i) one for field experiment studies and (ii) another for studies based on modeling.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
28	Arable fields	Cover crops	no cover crop (fallow)	Metric: Water drainage; Effect size: Difference of of the considered metrics between intervention and control	87.5

Results

- Cover crops reduce drainage compared to that of bare soil: the mean effect size of the meta-analysis was − 27 mm for studies based on measurements and − 32 mm for studies based on modeling. The 95% confidence interval of the effect size was very close: 20–34 mm for studies based on measurements and 21–43 mm for studies based on modeling. It was larger for studies based on modeling because there is less studies to calculate the mean effect size (22 studies versus 10 studies).
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Factors influencing effect sizes

- No factors influencing effect sizes to report

Conclusion

This meta-analysis indicated a reduction in drainage in 90% of the studies analyzed and a mean weighted reduction between 32 and 27 mm compared to that of bare soil.