FARMING PRACTICE
COVER AND CATCH CROPS

IMPACT: SOIL EROSION

Reference 29

Winter, S; Bauer, T; Strauss, P; Kratschmer, S; Paredes, D; Popescu, D; Landa, B; Guzman, G; Gomez, JA; Guernion, M; Zaller, JG; Batary, P 2018 Effects of vegetation management intensity on biodiversity and ecosystem services in vineyards: A meta-analysis J APPL ECOL 10.1111/1365-2664.13124

Background and objective

At the global scale, vineyards are usually managed intensively to optimize wine production without considering possible negative impacts on biodiversity and ecosystem services (ES) such as high soil erosion rates, degradation of soil fertility or contamination of groundwater. Winegrowers regulate competition for water and nutrients between the vines and inter-row vegetation by tilling, mulching and/or herbicide application. Strategies for more sustainable viticulture recommend maintaining vegetation cover in inter-rows, however, there is a lack of knowledge as to what extent this less intensive inter-row management affects biodiversity and associated ES. The main objective of this study was to perform a meta-analysis to identify, whether extensive vineyard vegetation management practices have consequences on biodiversity and associated ES across viticultural regions world-wide. The supposed trade-off between provisioning services of wine yield and quality with other ES and biodiversity is of central interest for this study. Therefore, we addressed the following research questions: (1) Does extensive vineyard vegetation management increase biodiversity and ES provision in comparison to conventional practices? (2) Which ES categories or biodiversity parameters respond positively and which respond negatively to extensive vineyard vegetation management? (3) Which environmental parameters alter the response to vineyard management? The outcomes of this study will help to formulate agricultural policy recommendations in order to benefit service-providing biodiversity and associated ES.

Search strategy and selection criteria

The authors conducted a systematic literature search in two major databases, SCOPUS and Web of Science (WoS) Core Collection Database (SCI-EXPANDED index), for studies that compared ES or biodiversity with different vegetation management (initial database query 25 January 2016; detailed search terms in Appendix S1). This resulted in a total number of 1,429 publications. 1) less than three spatially independent replicates per treatment level, (2) vineyards under plastic or in greenhouses, and (3) treatments not directly manipulating soil or vegetation management in the vineyards (e.g. application of synthetic or external mulches or the use of different fungicide or insecticide treatments) were excluded. In addition, only studies, which reported means and any dispersion measure of the dependent variable (e.g. SD or SEM), were used. We contacted the authors of recently published papers with missing data of variance or additional information like irrigation regime of the treatments.

Data and analysis

The results are reported as the back-transformed values of the relative percentage of increase (positive values) or decrease (negative values) in comparison to the control treatment. We chose to analyse data with hierarchical mixed-effects meta-analysis models that allow incorporating fixed (moderators), true random effects as well as a nesting factor for effect sizes in the respective sources or articles. As several data points were extracted from a single article, we used the article ID as a nesting factor to avoid violating the assumption that effect sizes are independent from each other. We used the rma.mv function of the metafor package (Viechtbauer, 2010) for r (R Development Core Team, 2017) to fit mixed-effects models to incorporate the true variation in the effect size variation across studies and the fixed effects by adding moderators (Borenstein et al., 2009). The effects of treatment are significant, if the confidence interval (CI) did not overlap with zero.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
74	Vineyards. Global dataset. About 40% of all datasets originated from irrigated vineyards, 50% were rainfed vineyards and the other studies did not provide information on the use of irrigation. Most datasets came from vineyards under Mediterranean climates (n = 100), oceanic climates (n = 56), and steppe or continental climates (n = 22; three studies included vineyards from different climates). Most studies implemented randomized block designs within one experimental vineyard (n = 113), only few studies implemented block designs in several vineyards (n = 12), whereas 56 datasets used individual vineyards as replicate. The majority of studies investigated the effects of bare soil management (mostly due to tillage, sometimes by use of herbicides or both) compared to cover crops or natural vegetation (n = 137 datasets). We investigated the effects of conventional vs. organic management in 27 studies and 17 datasets originated from other types of intensive vs. extensive vegetation management like the contrast of single to diverse cover crop species in inter-rows or mulching vs. mowing of vegetation.	Cover crops or natural vegetation growth for soil cover in vineyards	Bare soil or removal of spontaneous vegetation in vineyards by herbicides use or tillage	Metric: 1) Soil loss; 2) Erosion-related parameters;; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	93.75

Results

- If soil erosion was split up into two subsets of parameters measuring soil loss and in general erosion-related soil parameters, there was a strong positive effect of extensive vegetation management on soil loss mitigation (M = 161.9%). This means that soil loss was strongly reduced by using cover crops instead of bare soil management.
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- NULL
- NULL
- NULL

Factors influencing effect sizes

- No factors influencing effect sizes to report

Conclusion

Soil loss was strongly reduced (-162 %) by using cover crops instead of bare soil management. Other general erosion-related soil parameters (Water retention; Topsoil penetration resistance; Aggregate stability; Saturated hydraulic conductivity) showed no significant effects.