FARMING PRACTICE
COVER AND CATCH CROPS

IMPACT: SOIL BIOLOGICAL QUALITY

Reference 32

Bowles, TM; Jackson, LE; Loeher, M; Cavagnaro, TR 2017 Ecological intensification and arbuscular mycorrhizas: a meta-analysis of tillage and cover crop effects Journal of applied ecology 54, 6, 1785-1793 10.1111/1365-2664.12815

Background and objective

Reliance on ecosystem services instead of synthetic, non-renewable inputs is increasingly seen as key to achieving food security in an environmentally sustainable way. This process, known as ecological intensification, will depend in large part on enhancing below-ground biological interactions that facilitate resource use efficiency. Arbuscular mycorrhizas (AM), associations formed between the roots of most terrestrial plant species and a specialized group of soil fungi, provide valuable ecosystem services, but the full magnitude of these services may not be fully realized under conventional intensively managed annual agricultural systems. Assess how reducing soil disturbance (alternative tillage) and periods without roots (no cover crops) in agricultural systems affect the formation of AM and the diversity and community composition of arbuscular mycorrhizal fungi (AMF). The authors compiled data from field studies across five continents that measured effects of tillage and/or cover cropping on AMF colonization and/or communities and assessed effects of management and environmental factors on these responses.

Search strategy and selection criteria

The authors searched the literature in 2015 using ISI Web of Knowledge (available online). Two separate searches were conducted for assessing effects of cover cropping or alternative tillage on AMF colonization rates on cash crop roots or on the AMF community. Although AMF colonization of roots is not necessarily indicative of AM functionality, for example benefits for plant nutrient uptake or productivity, it is the most widely measured attribute of AM and the best indicator available. For cover cropping, the search terms were 'mycorr' *AND* '*cover crop*', which resulted in 108 articles in March 2015. For alternative tillage, the search terms were mycorr* AND ('conservation till' *OR* '*no-till*' OR 'reduced till*'), which resulted in 239 articles in October 2015. (i) a field trial comparing (a) bare winter fallow (i.e. unplanted) vs. cover crop(s), or (b) multiple types of tillage, including a comparison between a 'conventional' type (usually a mouldboard plough, i.e. soil inversion) and an alternative (e.g. no-till, chisel till); and (ii) data on AMF colonization rates (i.e. per cent root length colonized) on roots of the subsequent annual cash crop. We also examined studies that analysed AMF community composition from soil or root samples (by spore morphological identification or genetic analysis) following incorporation of the cover crop and/or tillage. Only studies with imposed, replicated treatments at one or more sites were included.

Data and analysis

Response ratios were calculated and analysed using the 'metafor' package (Viechtbauer 2010) in r (R Development Core Team 2015) using a mixed effects approach. A publication-level random effect allowed us to account for non-independence of multiple within-study observations (Mengersen, Gurevitch & Koricheva 2013). A model was first run without any moderator variables to assess the overall heterogeneity, and each moderator was subsequently tested one by one as a sole covariate.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
17	Zea mais, Glycine max, others	Cover crops: 1) Graminoids; 2) Legumes; 3) Non-legume dicots	Winter fallow	Metric: Arbuscular mycorrhizal fungi (AMF) colonization of subsequent cash crop roots; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	75

Results

- Cover crops increased colonization of summer cash crop roots by 28·5% (95% CI: 12·1–47·4) relative to winter fallows.
- Legume cover crops had a greater effect on cash crop root colonization than graminoids or non-legume dicots
- Roots of maize and soya beans, the two most common cash crops in the studies, had similarly higher AMF colonization following a cover crop (95% CI: 16·2–62·8 for maize and 16·5–80·5 for soya beans), but this was not apparent for other cash crops, which encompassed a number of different crop species.
- NULL
- NULL

Factors influencing effect sizes

- No factors influencing effect sizes to report

Conclusion

Cover crops increased colonization of summer cash crop roots by 28·5% (95% CI: 12·1–47·4) relative to winter fallows.