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Cover Crops for Soil Carbon and Nitrogen in Agroecosystems

According to the Carbon Management and Sequestration Center at the Ohio State University, many cultivated soils have lost 50 to 70 percent of their original organic carbon (C) globally, which is due to differences in soil properties, climate, type of land-use conversion, and, importantly, the specific management implementation of a given form of land use (Sanderman et al., 2017). In addition, another biggest challenge in cultivated soils is to minimize nitrogen (N) losses to the environment while maintaining adequate N supply to produce higher crop yield. To combat these challenges, cover crops can be considered as a key strategy. However, this is not a straightforward option because it is quite difficult to manage C and N dynamics in soils.

Soil is the main reservoir of C and N, which determine the soil health and agroecosystems sustainability. Cover crops are good source of soil C and N, especially, while winter cover crops are becoming a viable to improve soil conservation with co-benefits for sustainability and resilience of agriculture (Adeli et al., 2019; Novara et al., 2021) through erosion control, and nutrient and water conservation (Schipanski et al., 2014). Hence, it is necessary to understand need of cover crop practices, selection of cover crop species, cultivation practices, termination stage, and their influences on C and N dynamics under given climate.

Cover crops increase soil organic C by adding biomass-derived carbon input, improving protection for soil organic C in the form of soil aggregation, and decreasing C loss through soil erosion (Ruiz and Blanco-Canqui, 2017). Legume cover crop (such as, red clover, hairy vetch, cowpea) tissues with high C:N ratio can increase N mineralization and its availability to cash crops by microbial decomposition. However, there are some uncertainties associated with cover crop inclusion, for example, to observe the impact of no-till and cover crops on soil organic C can take a long time (>10 years) (Poeplau and Don, 2015), grass cover crops (such as, cereal rye, winter wheat) are good at scavenging N from soil (Finney et al., 2016).

It is the farmers' choice to include cover crop(s) in cropping systems based on the biggest challenges in farm operation. For example, if it is a weed pressure, cereal rye can be a good candidate because it grows quickly and its allelopathic effects suppress small-seed weeds and summer weeds like dandelions. Cereal rye is also good for building soil C due to its extensive root system supports nutrient cycling and produced biomass provides plentiful organic matter. Root systems have been shown to be more important than surface residue to increase soil organic matter (Thorup-Kristensen and Kirkegaard, 2016; Poeplau et al., 2021). If you are looking for increasing N level, legume-based cover crops are good candidate to fix atmospheric N into ammonia in soils. Instead of single cover crop, if it can be cost effective and meet the farmers' requirement, multi-species can be blended. A combination of cereal rye, hairy vetch and forage radish may be able to increase N uptake by preventing leaching in the spring, reducing soil compaction while building soil C, and erosion control prevention. Overall, using cover crops in cultivated soils is a win-win situation for farmers and the environment.

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