Plant diversity: the secret to more nitrogen and carbon in soil

Plants play a key role in soil carbon (C) and nitrogen (N) accumulation. New research suggests that plant diversity may have an important role to play in stimulating C and N storage in some soils. The findings suggest ways to improve carbon sequestration in grasslands and increase biomass production, for example for biofuel crops on nitrogen limited soils.

Soil could be an important carbon sink for atmospheric CO₂ and strategies designed to increase carbon storage in soils could play a role in strategies to mitigate against climate change. Now research suggests that a loss of plant diversity could undermine the ability of soil to act as a carbon sink.

Plants accumulate carbon via the process of photosynthesis. In cooler, temperate countries, plants such as wheat have evolved to produce a compound comprising 3 carbon molecules (C₃ plants). In tropical plants, such as corn, capture of CO₂ through photosynthesis has adapted to conditions of high temperature, increased light intensities and low CO₂ levels, which produces a 4-carbon compound (C₄ plants).

Plants have not evolved the ability to capture atmospheric nitrogen and must depend on soil as a source of nitrogen. In nitrogen-limited soils, fertiliser is added to increase plant growth. However, one group of plants, the legumes, which include peas and alfalfa, use the Rhizobium bacteria to provide a source of nitrogen. This microorganism lives in nodules that form on the roots of leguminous plants and has the ability to trap atmospheric nitrogen. This is supplied to plants as ammonia (NH₃). In return the plants supply the microorganisms with sugars.

The study showed that, compared with monoculture, planting high-diversity mixtures of perennial grassland species led to an increase of 500 per cent and 600 per cent in soil carbon and nitrogen respectively. Plots containing C₄ grasses and legumes in particular were seen to cause a notable increase in carbon accumulation.

C₄ grasses and legumes worked well when planted together. The unique nitrogen-capture ability of legumes complemented the ability of C₄ grasses to take up and use nitrogen efficiently. This resulted in greater root biomass accumulation in soil depths up to 60cm. This could have implications for the production of biomass for biofuels, with optimised legume/C₄ grass mixtures increasing biomass productivity, even in nitrogen-depleted soils. Nitrogen-depleted soils often cannot be used for food production and could potentially be used to produce biomass for biofuel production without diverting land away from food production.


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