Drivers of Arbuscular Mycorrhizal Fungi Communities in Canadian Wheat Fields.

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Background:

Pathogens have traditionally attracted research attention, but accumulating evidence shows the importance of beneficial microorganisms for sustainable food production. The arbuscular mycorrhizal (AM) fungi form a taxonomic group of soil dwellers secretly promoting the health of most plant species, including wheat. These microscopic fungi naturally mobilize soil minerals for plant uptake and protect roots from pathogen attacks. Despite the important role of AM fungi in plant nutrition, agronomic practices ignore the AM fungal resources naturally occurring in production field soils, as there are currently no practical means to assess the 'health' of a soil`s AM fungal community. We aim to fill this major gap in knowledge by developing indicators of the contribution of the AM fungi to wheat nutrition, in commercial fields. We set out to identify practical indicators of the relative abundance of AM fungi in soils that could reveal where AM fungi are doing a good job with feeding wheat, and where agronomic interventions are required.

Project Overview:

The AM fungal communities living in the soil of 172 wheat fields located across the Canadian landscape was described using cutting-edge metagenomics DNA analysis techniques. They revealed that the vast majority of AM fungi living in Canadian wheat fields belong to unknown species. Podzols seems most favorable to AM fungi as they host 2 to 3 times more AM fungal DNA sequences and 1.5 to 2 times more AM fungal diversity than Prairie soils, among which the Black Chernozems were most populated. AM fungal species distribution across the landscape was best explained by soil fertility. The proliferation of most AM fungi appeared mitigated by high calcium soils. The abundance of soil nitrogen was another key factor of AM fungal species distribution across the landscape. Soil texture and organic matter data derived from the National Soil Databank used Environment Canada weather data and measured soil phosphorus fertility could be used to model the distribution of three of the five major AM fungal strains encountered in the survey. By contrast to expectations, the distribution of AM fungi in the wheat fields surveyed was independent of the identity of the previous crop, and the organic or conventional management used on farms.

Conclusions:

This research demonstrates the possibility of using mathematical models to estimate the quality of important beneficial soil fungal communities invisible to the naked eye. It appears that National data banks on soil and climate and standard soil analytical methods could be used to develop cost effective computerized decision making tools to support an efficient wheat production based on ecological principles.

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