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Nature's Smorgasbord – Plant nutrient selection by microbial activation and it's role in the soil carbon regime

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Introduction

A long term study of soil-plant interaction suggests that plants obtain the range of nutrient cations they require by manufacturing and releasing highly specific root exudate compounds whose purpose is to activate targeted species of soil micro-organisms which then solubilise 'insoluble' minerals within the soil base for absorption by the plant. The same process is used to obtain antibiotic medication from appropriate microbial sp when plants are threatened by disease organisms. It has been given the working title 'Nature's Smorgasbord.

Results and Discussions

The process operates continuously throughout the life cycle, and in doing so creates an exponential growth of soil microbiota in the rootzone. The growth in turn promotes that of a range of macrobiota, notably earthworms. The breakdown products of this demographic release nitrogen and act to physically cement soil textural particles in the creation of aggregates, and in so doing, strongly modify soil structure to faciltate ongoing plant development. The ultimate decay product is carbon, and it is possible that 30-40% of atmospheric carbon dioxide absorbed by the plant foliage is sequestered as soil carbon in this way, the remainder being applied to creation of actual plant tissue.

The process continues without hindrance in the wild state, and is nature's way of developing soil structure and sequestering carbon for the shelter and energy needs of succeeding microbe generations. The soil microbial demographic is measured in tonnes per hectare where the process is allowed to continue unchecked.

Although root exudation has been common knowledge for a century or more, it's extent and purpose is only now being fully apparent. Within recent years, RNA research conducted by the Max Planck Institute has identified 110 000 different compounds in root exudation from a sample wild tobacco plant.

When soluble chemical fertilizers are applied to crops however, the plants accept them as required, without need to activate target micro-organisms. When this occurs, the development of the soil microbe demographic is aborted, structure development is halted, and carbon sequestration does not take place.

The traditional farming practice of turning land to pasture for 3-4 years between crop cycles exploited the increase in fertility without being aware of it's cause. By contrast, land which was caused to fallow under minimal growth, or that which was consistently over-grazed, was found to decrease in structure and fertility. These characteristics are identical with those of land which is subject to chemical fertillization over an extended period and include reduced drought tolerance, reduced water absorption and increase of fungal and bacterial pathogens.

An assessment of the Morrow plot, the oldest monitored soil in the US, has shown a 10 tonne/hectare loss in soil organic carbon in a fifty year period following the introduction of chemical fertilization. This occurred despite annual return of all crop debris to the soil.

Reference: Journal of Environmental Quality Kahn, Mulvaney et al various.

It is suggested that this result is optimistic in wider world terms due to the fact that the 'null' period, that in which the activity of soil microbiota slows or ceases, is the result of low temperature in the Morrow case. In the world's arid soils it is the product of heat and dehydration. The consequences are quite important because carbon oxidation from cold soils is minimal whereas that from hot, dry soils is extremely high to catastrophic and organic carbon loss may even double that observed in the Morrow example. It is the opinion of the author that CO_2 released to atmosphere as a consequence of world scale chemical fertilization has been grossly understated.

Conclusions

The foregoing discussion suggests that the properties of biochar may best be realized by practising farmers if chemical fertilization is either progressively decreased, or eliminated entirely from the maintenance program in order to maximize development and function of soil biota.

Application by spreader to established pasture at onset of the growing season is perhaps the most economic approach, and attention should be given to maintenance of pasture height in order to maximize microbiota activity on the soil surface. Only very light grazing should be practised in the early stages so as to maximize root growth. Under these conditions biochar is rapidly absorbed into the A horizon, and more deeply by earthworm action. Seeding with earthworm varieties is recommended, particularly where populations have been decimated by chemical practice.

Direct seeding using modern equipment requires a pelleted product.