Action of Effective Microorganisms (EM) on Microbial, Biochemical and Compaction Parameters of Sustainable Soil in Brazil

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Abstract

Soil diseases in the agroecosystems with intensive use of chemicals are due to the loss of biodiversity reflecting on autoregulation of pest, diseases, compaction, erosion and environmental pollution. Physico-chemical, biological and biochemical parameters were used to analyse the effects of changes in management practices on soil stability and productivity. Samples were collected from farm managed by producers with following 9 treatments:1) two natural forest areas around the experimental sites as sustainable system (T4 and T8); 2) 8 years pasture site (T2); 3) three sustainable systems (use of EM-crop residues during 4 to 6 years cultivated with vegetables – T1, T5 and T7). The samples were analysed by chemical (macro and micro-nutrients, pH, organic matter content), biological (microbial counting methods) and biochemical parameters (dehydrogenase activity and polysaccharides content in carbon). Use of EM has improved enhancement in biological and chemical properties compared to conventional management practices. Any soil compaction was observed in EM-treated systems. Polysaccharide content showed to be powerfull tool in measuring the effect of management practices on soil stability.

Introduction

Aggregate stability and size distribution are two physical soil quality measurements that have been positively correlated with organic matter content, which commonly declines under arable cropping (Tisdall and Oades, 1982; Haynes and Swift, 1990). Moreover, Emerson (1995) was able to demonstrate that water retention increased linearly with C content. The effect of management on macro-aggregation can be partly attributed to physical and chemical effects of management on soils. However, it is clear from a number of studies that biological processes can also contribute substantially to short-term changes in macro-aggregation through the production/consumption of labile organic bonding compounds and physical binding of soil particles (Haynes and Francis, 1993). In general, biological attributes such as microbial biomass, respiration, amino acids, soil enzymes, earthworms and arthropods activities have been suggested as factors which influence soil quality.

Microbes promote aggregation by several mechanisms :

(1) fungal hyphae bind solid grains and aggregates together to create larger aggregates;
(2) bacteria attach to soil particles (or vice-versa, depending on relative size), thus forming bridges between particles;
(3) fungi and bacteria release polysaccharides that serve as a binding agent (Lynch and Bragg, 1985).

Plants play various roles in aggregation. Root exudates may flocculate colloids and bind or stabilize aggregates, and may also influence aggregation indirectly through effects on microbial activity. Soil animals (including earthworms, collembola, termites, ants and beetles) promote aggregation by forming fecal pellets and excreting binding agents (Pawluk, 1987; Lavelle, 1988).

Traditionally the most common approach to improve aggregate stability is to incorporate organic residues (eg. green manure, crop residues, compost, farmyard manure, municipal wastes and food processing wastes) into the plough layer to increase the organic matter status, with consequent reestablishment of beneficial microorganisms. With increasing of soil microbial diversity, the non-pathogenic microorganism begin to form communities and associations that compete for nutrients, niches and other resources, improving the conditions more unfavourable to plant pathogens.

Soil microbial polysaccharides are the other important factors influencing soil structure formation. In the past, most of the research on the potential use of bio-conditioners has been focused on bacteria and fungi, regarded as the most important producers of polysaccharides (Metting 1986; 1987), even if some strains of green algae and cyanobacteria from soil have also been known to produce large amounts of extracellular polysaccharides (Barclay and Levin, 1985).
Alteration in management practices results in changes in the physical, chemical and biological characteristics of soils (Wood and Edwards, 1992). Thus, the purpose of this study was to determine multidisciplinary overview of management practices effects on physical, biological, chemical and biochemical properties of farm systems managed by producers.

Materials and Methods

Ten samples of each system were collected from farms managed by producers with following treatments:

1) two natural forest areas around the experimental sites as sustainable system (T4 and T8);
2) 8 years pasture sites (T2);
3) two sustainable areas (use of EM-crop residues during 4 years) cultivated with vegetables (T5 and T7);
4) sustainable system (use of EM-crop residues during 6 years) (T1);
5) three conventionally managed areas cropped with maize (T3, T6 and T9).

In 1996, during the samples collection time, T1 was tilled and un-cropped, and in 1997 it was cropped with black oats, 90 cm height. Diluted EM (1:1000) was sprayed onto plant residues and incorporated into the soil. During the cropping, the same concentration of EM was sprayed into the crops. The samples were analyzed by chemical (macro and micro nutrient), biological (microbial counting after methods described by Martin (1950); Clark (1965) and Catellan and Vidor (1990) and biochemical parameters (dehydrogenase activity described in Bitton and Koopman (1989) and polysaccharides content in carbon (C) described in Stevenson (1982); Santanatoglia and Fernandez (1983). For all statistical analyses 5 variables were analyzed and the significant level considered was 5 percent.

Results and Discussion

It is well known after many studies the benefit of EM use in agriculture. We present here results of multidisciplinary overview of assessment conducted at so called, "green belt" of Sao Paulo city region. Biological and chemical data are reported in Table 1 and biochemical results are shown in Table 2.

Table 1. Effect of Soil Management on Biological and Chemical Parameters from the Farm Managed by Producers with Nine Treatments: Sustainable, Conventional and Forest Sites in Sao-Paulo, Brazil (1996).

Treatment	Biological			Chemical			
(System Management)	Bae (x 10^5)	AC (x 10^6)	Mc (x 10^3)	pH	OM (%)	CTC	V %
T_1-Sustainable	5.88 ab	1.35 c	3.45 d	6.62	2.38	10.2	0.6
T_2-Pasture 8 anos	2.07a	0.24 a	1.14 ab	4.30	3.43	8.9	11.7
T_3-Conventional	4.55 ab	0.33 a	2.62 cd	4.25	2.82	8.6	10.8
T_4-Natural forest	1.86 a	0.50 ab	0.91 a	3.97	3.17	11.6	11.2
T_5-Sustainable	15.65 b	1.58 c	4.69 e	6.52	3.08	19.9	88.8
T_6-Conventional	8.38 ab	0.79 b	2.79 cd	5.51	2.79	9.4	56.5
T_7-Sustainable	23.68 c	1.03 bc	2.44 cd	6.72	3.46	17.3	89.7
T_8-Natural forest	2.07 a	1.22 bc	1.30 ab	3.52	7.30	24.4	5.4
T_9-Conventional	4.08 ab	1.36 c	2.05 bc	5.63	3.12	12.9	65.5

Bae: Sporulating bacteria (ufc/g soil); Ac: Actinomycetes (ufc/g soil); Mc: Cellulolitics (n° /g soil); Dh: Dehydrogenase; Ps: Polysaccharides in C; MO: Organic Matter; CEC: Cation Exchange Capacity (meq/100 cm^3); V. Saturation in basic (%).

Table 2. Effect of Soil Management on Biochemical Parameters from Nine Sustainable Conventional and Forest Sites in Sao-Paulo, Brazil, in 1996 and 1997.

Treatment	**Biochemical 1996**		**Biochemical 1997**	
(System Management)	**Dh (ul H/g soil)**	**Ps (Mg/g soil)**	**Dh (ul H/g soil)**	**Ps (mg/g soil)**
T_1-Sustainable	4.98 b	0.48*a	13.14 c	1.10 b
T_2-Pasture 8 anos	15.24 c	2.12. c	15.30 c	2.00 cd
T_3-Conventional	5.01 b	0.80 ab	7.70 bc	1.36 c
T_4-Natural forest	3.74 b	2.99 d	5.87 b	3.54 d
T_5-Sustainable	4.83 b	0.66 a	10.93 c	1.01 b
T_6-Conventional	4.96 b	1.03 bc	5.44 b	0.86 a
T_7-Sustainable	4.57 b	0.97 bc	8.90 bc	1.39 c
T_8-Natural forest	1.69 a	2.82 d	0.54 a	4.35 d
T_9-Conventional	5.46 b	1.54 c	4.84 b	0.99 ab

Dh: Dehydrogenase; Ps: Polysaccharides in C. *1.64 mg/g soil in 1995 –1996; T1 tillage and uncropping; T3, T6, T9 maize cropping; T5, T7 vegetables. 1997: T1 black oat crop, 90 cm high; T3 maize crop residue; T6 fallow with graminae; T9 tilled soil; T5, T7 broccoli and cabbage.

The following group of systems are comparable : i) T1, T2, T3 and T4; ii) T5 and T6; iii) T7, T8 and T9. Forests (T4, T8) as natural sustainable systems presented low level of macro and micro nutrients in B and Zn, and acceptable levels of Cu, Fe and Mn. The sustainable sites, due to their former conventional management with chemical fertilizers and pesticide applications, were enriched in mineral nutrients and poor in organic matter contents. As seeing in Table 1, sustainable sites (T1, T5, T7) have presented pH, organic matter content and cation exchange capacity slightly higher than its respective conventionally managed sites (T3, T6, T9). No compaction problem was observed in EM-treated area (T1, T5, T7).

In general, use of EM has improved enhancement in chemical and biological properties compared to the conventional management.

Polysaccharides have proved to be a useful tool for measuring the effect of soil management. In our study it has been reported in high level at natural forest and pasture sites (T2, T4, T8) reflecting the soil stability in these areas. Even under conventionally managed systems, if the soil is protected with large diversity of vegetation, the polysaccharide content was comparable to that from under sustainable management systems. Comparing the biochemical data from T1 obtained in 1996 and 1997, one can detect the farmer's mismanagement of sustainable soil (Ps=1,64 mg/g soil in 1995). In 1996 this area was tiled and un-cropped (Ps=0,48 mg/g soil) and in 1997, after advise of our co-worker in soil restoration, the results showed slow recovery process of its stability (Ps=1,10 mg/g soil). As stated by Weber and Van Royen (1971) and supported by the study from Drag-an-Bularda and Kiss (1997) that the sucrose present in molasses induces sequentially the microbial production of enzymes synthesizing levan and dextran. The inducing effect being proportional to the amount of molasses these enzymes activities correlate significantly with water stable aggregation, being the amelioration of molasses treated soils partly due to soil enzyme activities. We also confirmed the above finding, with reduction of irrigation needs.

Conclusion

In conclusion, the use of EM-molasses-crop residues combined with correct soil management practices can improve chemical, biological and biochemical soil properties enhancement. As a practical result of soil restoration, decrease in irrigation needs and soil diseases were observed with re-establishment of beneficial soil microorganisms.

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