Comparison of the Effect of EM and Other Bacterial and Mineral Products on Bean Yield

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Abstract. *Effective microorganisms (EM) have an effect on soil, seed and plant metabolism. Its effect is more effective in soils rich in nutrients and organic matter than in poor ones. Soil received limestone and Fosmag (P, K, Ca, Mg, S, Cu, B and Zn). The treatments were in 3 x 4m-plots in the midst of a bean plantation. Treatments were: 1) Diatom (petrified, grounded algae); 2) EM to seeds; 3) Biosol; 4) Cofermol (Co+Fe+Mo); 5) EM + diatom; 6) EM + MB-4 (rock meal); 7) Control, 8) MB-4. After the emergence of bean plants in 3 and 5 weeks, EM foliar application (0,1%) and Mo (0,04%) were made. Being a very rainy season, many farmers lost their yield in spite of frequent pesticide applications due to fungi diseases like anthracnose. Our beans were attacked by anthracnose and 1,5% grains were mottled. The best treatments were: (2) EM application to seeds (1620 g/plot); (6) EM + MB-4 with 1783 g/plot and (7) the test plot only with foliar EM + Mo application having 1925 g/plot. Experiments show that Mo increases the number of pods per plant and the number of grains per pod whilst EM increases grain weight (1000 grains = 300g to 380g and 1 liter from 844 to 920 g). This means that EM increases grain quality because proteins are heavier than amide.*

Introduction In previous experiments it was concluded that EM acts on soil and its life (Primavesi, 1997) as on plant metabolism (Primavesi, 1996, 97, 98). Its effect is more significant in soils rich in organic matter and nutrients than in poor ones.

As new biological and mineral products appear every month it is interesting to know how they work relatively to EM and if there are favorable mixtures with them.

The chosen crop was beans because they are not only the basic food of Brazilian people but also because they are greatly infested by pests and diseases. Besides, beans are one of the cultivated grain legumes which receive the highest amount of pesticide applications. One of the biggest aspirations of organic farmers is to maintain beans healthy and productive.

The nutrient balance of crops seems one of the main problems, especially in soils cultivated for years, which could become poorer in trace elements which are difficult to control.

Several mineral products appeared in the market like FTE (fritted trace elements), Cofermol, Skrill, MB-4 (a stone meal), Diatomea (a ground petrified algae) but especially bacterial products are offered like Biosol, Orgasol, Agroplus, Supermagro and others.

The experiment was conducted in the spring which is somewhat cooler than summertime.

Materials and Methods

The experiment was located in the Southern part of the highland, at an altitude of 700 m in the State of Sao Paulo, South East of Brazil having a tropical climate. The soil was an Ultisol (red yellow podsolic). It was conducted from September to December as the beans have a 105 day cycle. During this season there is less disease and pest attacks.

The characteristics of the soil are given in Table 1. Soil analysis was : (extractor DPTA for B, it was used water)

Table 1. Chemical Constituents of the Soil

PH $CaC1_2$	OM G/dm^2	P resine	H+A1 mmo/dm^3	K mmo/dm^3	Ca mmo/dm^3	Mg mmo/dm^3	B mg/kg	Cu mg/kg	Fe mg/kg	Mn mg/kg	Zn mg/kg
60	17	13	13	14	29	11	0.16	0.9	13	12	27

The rainfall during the two years were variable (Table 2). This variation is attributed to the large scale deforestation in Brazil causing unpredictable rainfall patterns. The temperature was suitable being about 12° to 17°C at night and 20° – 25°C by day. Due to deforestation however, the day and night temperature differences have become bigger.

Table 2. Rainfall (mm) During the Experimental Period

Year	September	October	November	December
1997	50	54	230	109
1998	189	201	12	89

As the variety Carioquinha needs a nearly neutral pH (6.0 to 6.5) and a high level of calcium, the field received 1.000kg/ha limestone (33% CaO and 16%MgO) and 250kg/ha Fosmag ($P_2 0_5$ 18%, CaO 13%, MgO 2.9%, ZnO 0.5%, S 10% and B 0.1%).

The following treatments were made on plots of 3 x 4m with 3 repelications.

1) Diatomea
2) EM to the seeds
3) Biosol to the soil
4) Cofermol to the seeds
5) EM + Diatomea
6) EM + MB-4
7) Control
8) MB-4 to the soil

Three and five weeks after emergence EM (0.1%) and Mo (0.04%) were sprayed over the leaves. Two strips of 10 x 30m were used on the two sides of the experimental block with the same fertilizer. Beans were planted in these strips. One strip remained without any foliar application. The second received only EM, the third (on the other side) received only Mo and the fourth, EM+Mo. Samples were collected from the strips at three different places, from five rows 3m long, which corresponded to one experimental plot.

Results

It was a very rainy season and fungal diseases occurred very frequently. Therefore many farmers lost their yields due to *Anthracnosis* although they had applied 10 fungicides or more. In our soil, which had been organically treated for more than 15 years, beans had also some *Anthracnosis* and 15 percent seeds showed brown spots

which somewhat lowered the price. But yield was relatively successful (1.620kg/ha) and the general health of crop was astonishing (Table 3A).

Table 3. Bean Seed Yields (g/ha) for Different Treatments

Treatments	Block A	Block B	Block C	Average
A. Main Plots				
1) Diatomea	1496	1200	1535	**1410**
2) EM	1495	1475	1890	**1620**
3) Biosol	1435	1630	1560	**1541**
4) Cofermol	1415	1535	1670	**1540**
5) EM+Diatomea	1270	1405	1212	**1295**
6) EM+MB-4	1925	1850	1575	**1783**
7) Control	1310	2090	1775	**1725**
8) MB-4	1440	1580	1190	**1403**
Average	**1473**	**1595**	**1551**	
B. Strips Without Foliar Fertilizer				
I. Control	1200	1270	1291	1253
II. EM	1350	1384	1382	1372
III. Mo	1492	1480	1389	1453
IV. EM+Mo	1910	2157	2050	2039

The samples of the strips gave the results in Table 3B.
It seems clear that yield increased significantly with EM and Mo and much more when EM and Mo were mixed.

By counting pods and seeds, the differences between treatments appeared (Table 4).

Table 4. Bean Yield Components of Treatments

Treatment	Pods/Plant	Seeds/Pod	Weight of 1000 Seeds
Control	6.05	5.0	265g
EM	6.10	5.0	360g
Mo	7.12	6.10	294g
EM+Mo	7.10	6.12	362g

Based on the samples of the strips, it seems that molybdenum increases the number of pods/plants and the number of seeds/pods. But seeds are much heavier and somewhat larger with the application of EM. This means that EM improves seed quality which is always indicated by the 1.000 seed weight. It seems that EM increases the protein content of seeds. This also explains, as it was shown in previous experiments (Primavesi, 1998), why Mo increased yield 23.4 percent, EM 14.9 percent but the two together 85.6 percent. This result has not been understood until now. There are more seeds in Mo treatment and these seeds become heavier with EM application. This year, differences have not been as big as last year but the trend is very clear. On the other hand, none of the treatments with trace elements increased yield, which means that organic treated soils do not become depleted as do chemically treated ones. The basic fertilization and EM + Mo on the leaves were the most effective treatments.

Conclusion Trace elements did not increase yields. Foliar application of EM + Mo was the most effective treatment. This is due probably because EM also increases root development and consequently fosters a better supply of the plant with nutrients from the soil. Lime and Fosmag were sufficient when foliar application of EM and Mo was made, increasing yield 85 percent in 1997 and 62 percent in 1998. Whilst Mo increases the number of pods and seeds in the pods, EM increases seed weight and quality. A better quality means better nourished plants and a good plant nutrition means healthier plants.

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