EM Research in the Netherlands

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Abstract: *Under Dutch conditions EM can have a positive effect on the growth of plants. In a pot experiment with English rye-grass EM-technology was tested in combination with 6 treatments of manure and fertilizers. In pots with EM, grass production of the first as well as the second cut was higher than without EM. In the first cut this effect was significant in 3 out of the 6 treatments. Combination of first plus second cut resulted in a significant positive effect of EM in one of the 6 treatments. EM effect was most evident in pots with low nutrient supply. This is important because attention is focused whether EM-technology can contribute to maintain high plant production while nutrient supply is reduced. EM-technology was also tested on meadows. Results are very positive: grass production was kept almost at the usual high level while chemical fertilizers were reduced to about 30 percent of the original supply. The effect of EM on the photosynthesis of grass and maize was measured on 8 parcels. Photosynthesis on EM-parcels was higher than on parcels without EM.*

Attention was also paid to possible negative effects of EM1: In a field experiment with 36 plots no significant effect of EM on soil organic matter was measured after one year. On farm meadows: application of EM-technology during four years resulted in an evident increase in content of soil organic matter. Concerning effect of EM1 on microbes: 10 species were isolated from soil and water. Microbial growth was not inhibited by the presence of diluted EM-suspensions.

Introduction Literature concerning EM aroused hope that it could diminish the big problems in Dutch agriculture. The very high intensity of agricultural production and related high input of fertilizers and feed , as well as the intensive use of manure, pesticides, medicines etc. led to big environmental problems, high costs of production, and decrease of the quality of the products. Dutch (and West European) agriculture is coming to a crisis unless the use of fertilizers, pesticides, etc. reduced appreciably. Can the high level of production be maintained?. Can EM-technology contribute to a solution?

Several experiments were done. This contribution describes briefly five experiments. Aim of the first experiment was to see whether under Dutch conditions too in a greenhouse EM- technology could improve the growth of grass. Growth of grass is also studied at farm level. The question is can EM help to maintain grass production at the usual high level while the input of fertilizers is decreased?
The third experiment concerns the influence of EM on plant physiological characteristics by measuring photosynthesis of grass and maize.
Introduction of a new technology always raises questions concerning possible negative side effects as well. Attention is given to the question whether EM-technology will decrease the content of organic matter in soil and the fifth section of this contribution deals with the question whether EM1 has a negative effect on microbes in soil and water?

1. Effect of EM on Growth of Grass: A Pot Experiment

(Nelemans and van Beusichem, 1997)

Aim

To study the effect of EM1 on yield and uptake of NPK under Dutch conditions.

Materials and Methods

EM1 was applied in combination with several additions of fertilizers and under well defined conditions in a greenhouse. Each pot was filled with 6 kg calcareous sea clay soil. Treatments were as follows:

- **Fertilizers:** 1) no fertilizers; 2) NH_4NO_3, 250 kgN/ha.
- **Cattle slurry**: 1) no cattle slurry; 2) 30 ton slurry/ha; 3) slurry (30 ton/ha) combined with addition of crushed sea shells (6 ton/ha) and bentonite (6 ton/ha).
- **EM1**: 1) no EM1; 2) EM1 addition to the soil (1l/ha) and weekly sprayed 1l/ha.

Each treatment was repeated 3 times: 36 pots. Moisture content was kept constant by daily addition of demineralized water. Two cuts were taken. Fresh and dry weight and the content of N, P and K of the dry material were measured. Results were analysed statistically with ANOVA, (LSD (a = 0.01).

Results

Effect of EM1 on Yield of Dry Weight

First cut: The mean dry weight of grass in EM-pots was always higher than in similar pots without EM1. In 3 out of the 6 treatments this effect was statistically significant. EM1 seems to be more effective at lower additions of nutrients.

Second cut: The dry weights in EM-pots were in general lower than in pots without EM1. The effect of EM1 was not significant for all 6 treatments.
First plus second cut: Dry weights in EM-pots were somewhat higher than without EM1. However, significance as found in the first cut disappeared, because of the second cut.

Effect of EM1 on Uptake of Nitrogen, Phosphate and Potassium

In the first cut, uptake of nitrogen in EM-pots was somewhat higher than in pots without EM1. The opposite holds for the second cut. The effects were never significant.

In general there was no significant effect of EM1 from phosphate and potassium. An exception was found in the first cut: treatments without manure showed a significant positive effect.

Conclusions

This experiment shows that under Dutch (and West European) conditions EM1 can have a significant positive effect on the growth of grass. Further research is necessary to improve knowledge concerning these conditions.

2. EM-Effect on Quality and Quantity of Grass Production: On-Farm Research
(Bruggenwert et al., 1998)

Aim

Attention was given to the influence of EM1 on quantity and quality of grass, in particular when the nutrient supply was reduced. Attention was also focused on the relation between yield and the way nutrients were supplied: fertilizer or cattle manure.

Materials and Methods

Farm 1: sandy soil. A parcel was divided in to 3 subparcels, each about 0.6 Farm 2: heavy clay soil. A parcel was divided into 4 subparcels, each about 0.5 ha. In 1997 and 1998 subparcels were treated with fertilizers, cattle slurry and EM1 in several ways. Yields of first and second cuts were determined and their qualtity analysed.

Results and Conclusions

Under the prevailing conditions:

- Nitrogen added as cattle slurry in combination with EM1 showed the same efficiency as N-fertilizer: **Efficiency N-cattle slurry +EM1 $\geq$ Efficiency N fertilizer.**
- In combination with EM1 and the usual supply of cattle slurry, the normal amount of chemical fertilizers can be reduced strongly, keeping the yield almost at the usual level. This is very important for the farmer as well as for the environment.
- The quality of grass was not influenced by EM1 and the decrease in fertilizers.
- A lot of unknown causes may influence the yield. Interpretation of results from "on farm research" must be done very carefully.
- It is important to improve insights on the relation between conditions (soil, plant, tillage, etc.) and optimal application of EM.

Experiment will be continued in 1999 only on one farm. The farm on sandy soil uses no fertilizers anymore (only manure), because of the positive effect of EM1.

3. Influence of EM1 on Chlorophyl-Fluorescence
(Ketel, 1998).

Aim

Use of sunlight energy should be increased by EM1. This study is a first orientation in the Netherlands concerning effect of EM1 on photosynthetic activity of plants.

Materials and Methods

Photosynthetic activity was measured with the EARS Plant Photosynthesismeter (PPM). Measurements were made at four locations: three with grass and one with maize. Eight parcels were involved.Thirty measurements were made per parcel within one day.

Results

The results presented in Table 1 show that the PPM values in grass were highest in location 1 with and without EM1. There was a wider variation of PPM values for grass with EM1 than without it.

Table 1. Mean PPM-Values Measured on Eight Parcels

Location	Plant	PPM - value	
		with EM1	without EM1
1	Grass	78.6 ± 1.2	59.0 ± 1.2
2	Grass	63.4 ± 0.6	59.0 ± 0.6
3	Grass	71.4 ± 0.8	57.3 ± 1.3
4	Maize	53.8 ± 0.8	36.2 ± 2.1

Conclusions

- EM1-parcels showed a statistically significant higher photosynthetic activity than parcels without EM1.
- Visual observable differences (quality of sod, length of maize, etc.) correspond with differences measured in PPM-values.
- More measurements are necessary to see the effect for the whole season.
- Besides the EM1 treatment, other factors also could have influenced the differences.

4.1. Effect of EM1 on Organic Matter Content of the Soil
(Bruggenwert, 1998).

Aim

To see if there is a reason to fear that EM1 could have a strong negative effect on the organic matter content of soils.

Materials and Methods

Spring 1997: 36 plots (100 m^2 each) were installed at a pasture of the Wageningen University and Research Centre. Soil samples were taken and analysed for C_{total}; CEC; N_{total} and P_{total}. Various amounts of fertilizers, manure and EM1 were added. In spring 1998 soil samples were taken again and analysed.

Results

Under the prevailing conditions this first orientation shows no significant negative effect of EM1 on CEC and total amount of C, N and P in the soil after one year.

Conclusion

No evidence for a strong decrease in soil organic matter content.

4.2. Effect of EM1 on Organic Matter Content in Meadow Soils on Farm Level
(Van den Ham 1999)

Aim

The purpose of this study was to follow the effect of the application of EM1 in combination with crushed sea shells and clay minerals (the Agriton treatment) on the organic matter content and pH of meadow soils.

Methods and Materials

The parcels (16) of Attema's dairy farm (one of the first farmers who applied EM in the Netherlands) were treated with EM1 (4 l/ha, year), crushed sea shells (500 kg/ha, 3 years) and clay minerals (300 kg/ha, year) in combination with manure and fertilizers. This treatment was started in 1995. Soil samples were taken and analysed in spring 1994 and in spring 1999 by the Institute for Soil and Plant Analyses, BLGG.

In the period 1995 - 1999 the application of fertilizers was strongly reduced.

Results The results are given in Table 2.

Table 2. Organic Matter Content and pH as Measured by BLGG in 1994 and in 1999

Parcel No.	1994		1999	
	Mean Org. Matter %	pH	Mean Org. Matter %	pH
4, 11a, 11b, 12	7.4	5.3	12.7	5.8
1,7, 8, 9, 10	12.1	5.1	18.7	5.5
2, 3, 5a, 5b, 6, 13, 14	26.0	5.0	29.2	5.6

Conclusion In almost all the parcels there is a strong increase (often a remarkable increase) in organic matter content. The treatment has also a positive effect on the pH of the soil.

5. Effect of EM1 on Growth of Micro-organisms
(van Egeraat, 1998)

Aim To test the effect of EM1 on micro-organisms isolated from soil and sludge.

Materials and Methods The effect was tested with

1) EM1 not diluted, pH 3.70
2) EM1 not diluted, heated up to 90 ^{o}C
3) EM1 diluted in water 1:100
4) EM1 not diluted, pH 6.50

on 10 micro-organisms belonging to Azetobacter, Rhizobium, Pseudomonas, Bacillus, Streptomyces, Mycobacterium, Serratia, Escherichia, Saccharomyces and Penicillium. Proper agar media were contaminated with these micro-organisms. EM1 was put into holes which were made in the agar.

Results Concerning EM1 not diluted, and EM1 not diluted heated up to 90 ^{o}C, the growth was inhibited on all bacteria tested; growth of fungi and yeasts was not inhibited.

Concerning EM1 in water 1:100, and EM1 not diluted at pH 6.50, there was no inhibition of all the micro-organisms tested.

Conclusions There was a pH effect. The low pH of EM1 not diluted causes a negative effect on - growth of the bacteria tested. Fungi and yeast can stand this low pH value. EM1 heated up to 90 ^{0}C shows the same effect. The negative effect disappeared when EM1 was diluted (1:100) and when the pH was increased to 6.5: low concentration of acids.

EM1 diluted (1: 100 - 1000) can have no negative effect on the microbial life in soil, water or on plants.

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