Influence of humic substances on the microbiological activity of soils

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Microorganisms are an active component of soils

- They include Bacteria, Archaea and microscopic eukaryotes
- Microorganisms associated both with plants and soil particles
- They mediate processes of organic matter destruction, nutrients cycling, nitri-/denitrification etc.

Bacterial preparations for agriculture are widely used and studied

- Development, production, and application of microbial cultures as sources of various biologically active metabolites.
- Isolation from environment and application of microbial cultures of protective action (biopesticides).
- Development, application of microbiological preparations on the basis of bacteria which promote more complete assimilation of mineral fertilizers (phosphate-mobilizing).
- Development, production of microbial culture that promote, improve fertility and restore the balance of soil humus, microbial preparations for biological purification of soils, polluted with oil products, radionuclides, heavy metals and agrochemicals.
- Production and use of microbial cultures that ensure the processing and destruction of agricultural waste.

Review Article

Plant Growth-Promoting Bacteria: Mechanisms and Applications

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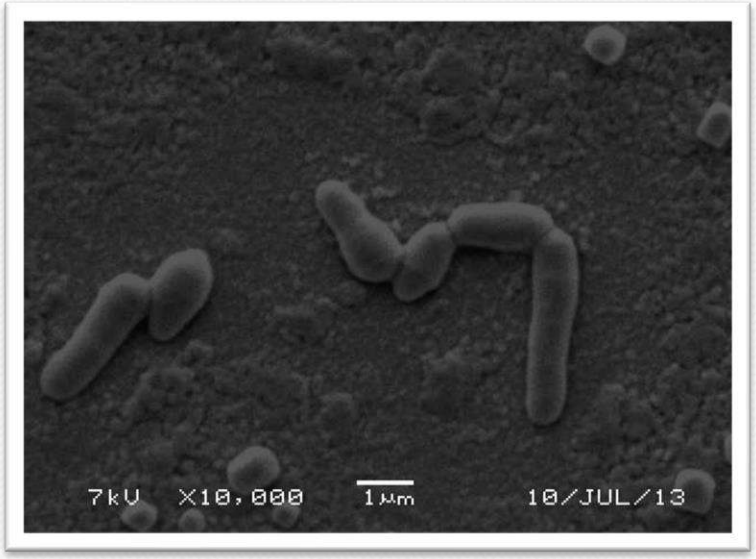
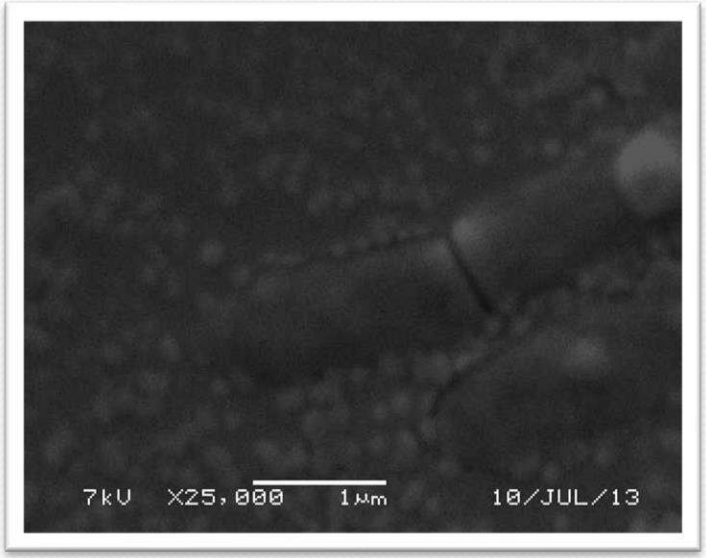
The worldwide increases in both environmental damage and human population pressure have the unfortunate consequence that global food production may soon become insufficient to feed all of the world's people. It is therefore essential that agricultural productivity be significantly increased within the next few decades. To this end, agricultural practice is moving toward a more sustainable and environmentally friendly approach. This includes both the increasing use of transgenic plants and plant growth-

Humic substances (HS) interacting with soil microorganisms on different levels

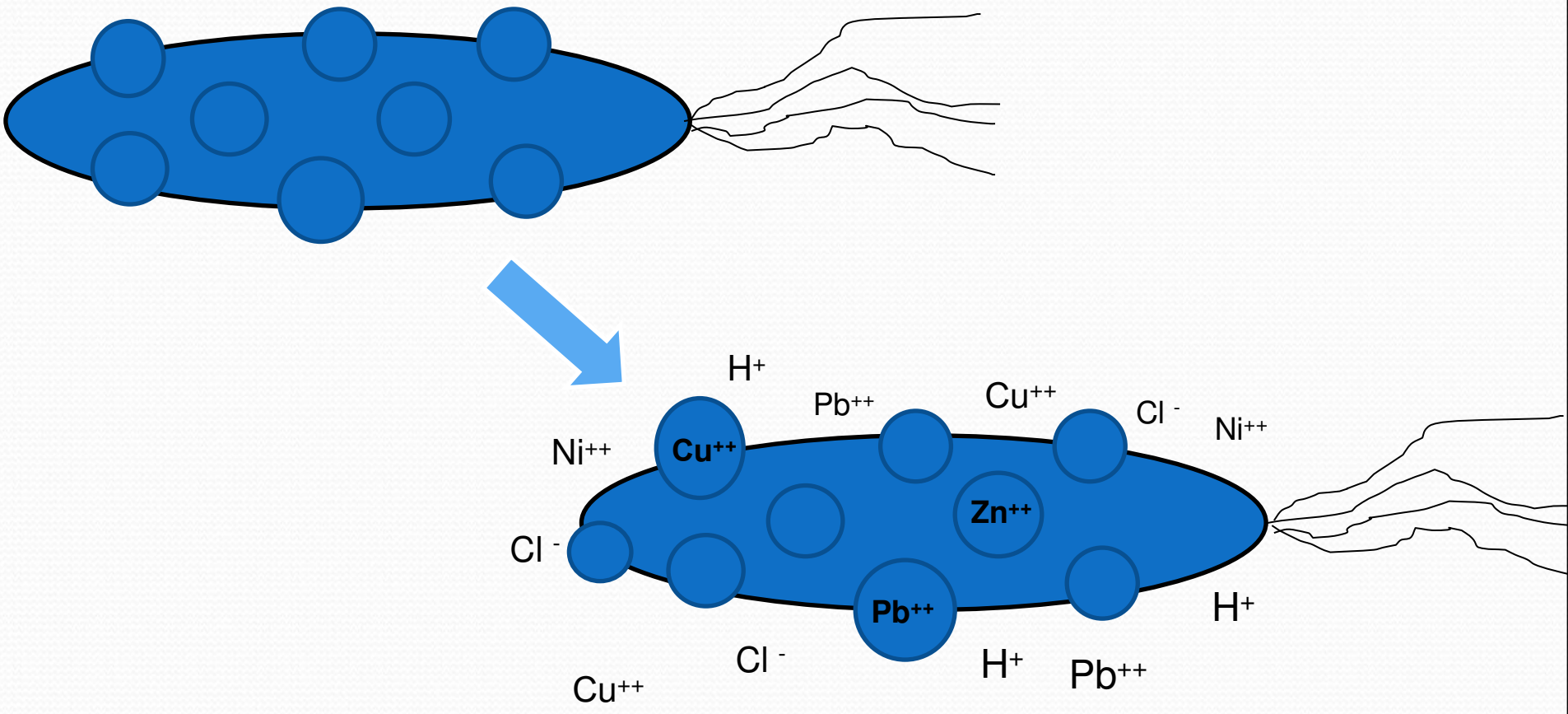
- HS could be additional source of carbon. They are absorbed through the cell surface and digested.

HS interacts with a surface of bacteria





Humic substances form a net on bacterial surface



Effect of Lignohumate on Soil Biological Activity on Bali island, Indonesia

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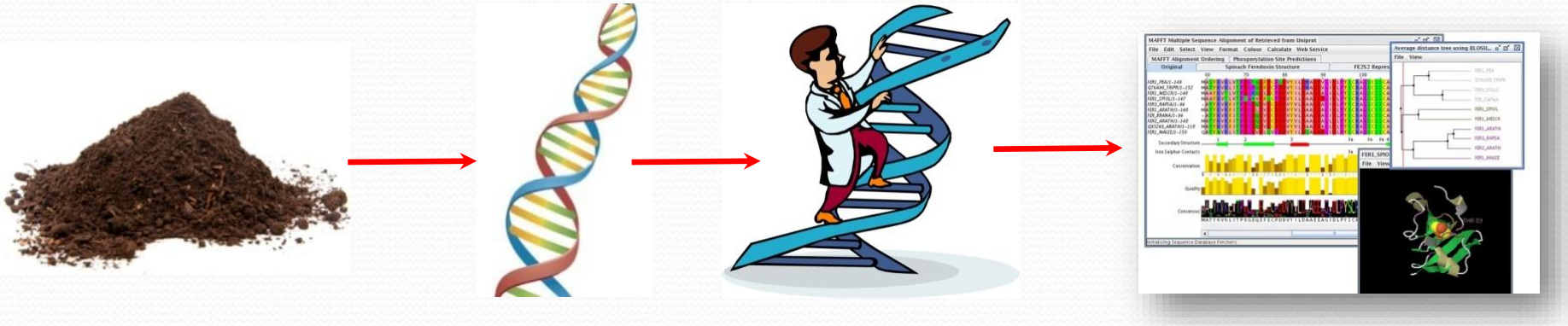
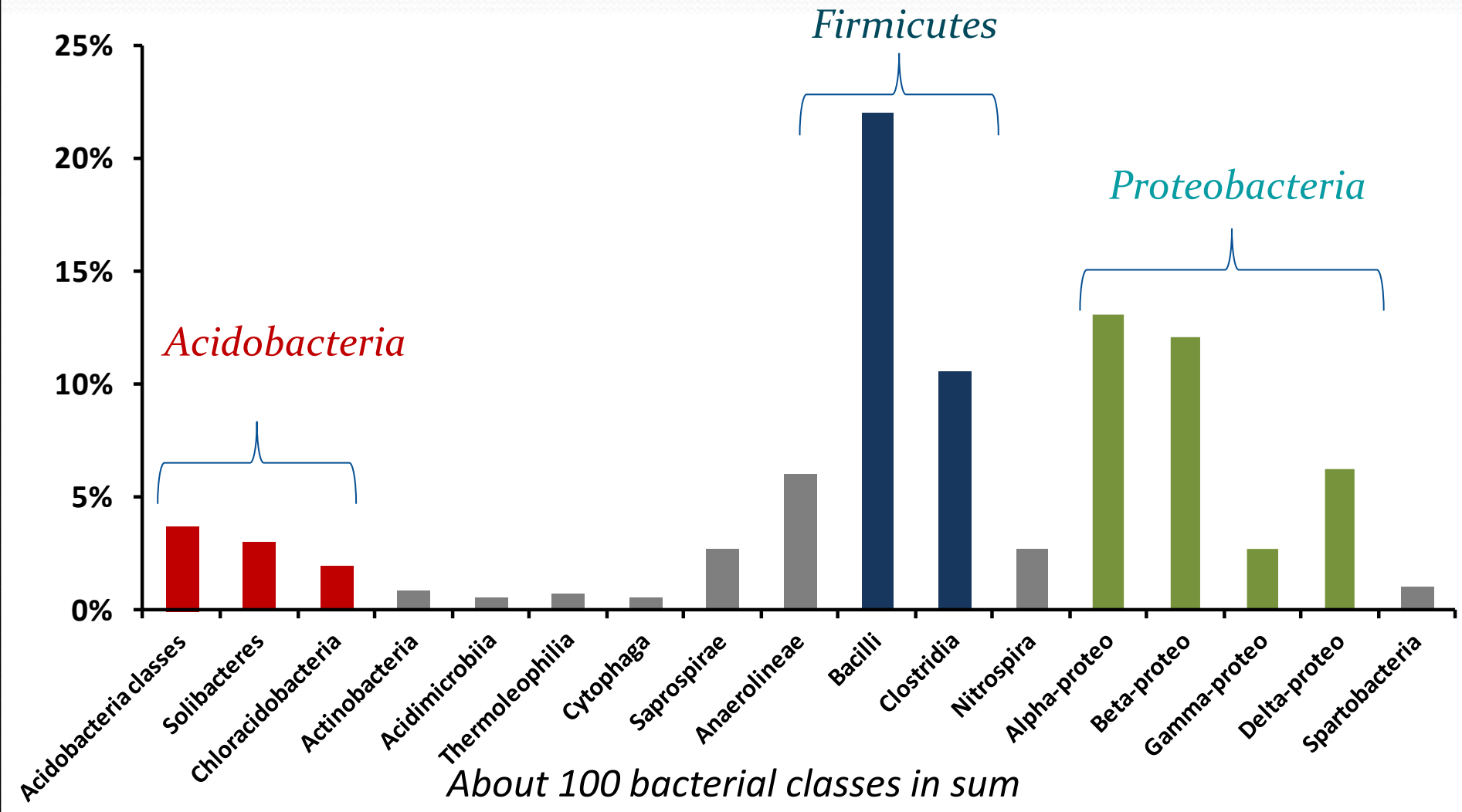
Lignohumate (LH) in 6 different concentrations was added to Bali soil samples

Lignohumate concentrations, %	1	0.25	0.10	0.05	0.01
The amount of lignohumate, mg	5.0	1.25	0.50	0.25	0.05
C content, mg	2.0	0.50	0.20	0.10	0.02

Molecular biological study of Bali soils

- Total soil DNA extraction and purification;
- Amplification with specific primers;
- High-throughput next generation sequencing of amplicons;
- Bioinformatic analysis of the amplicon sequencing data;



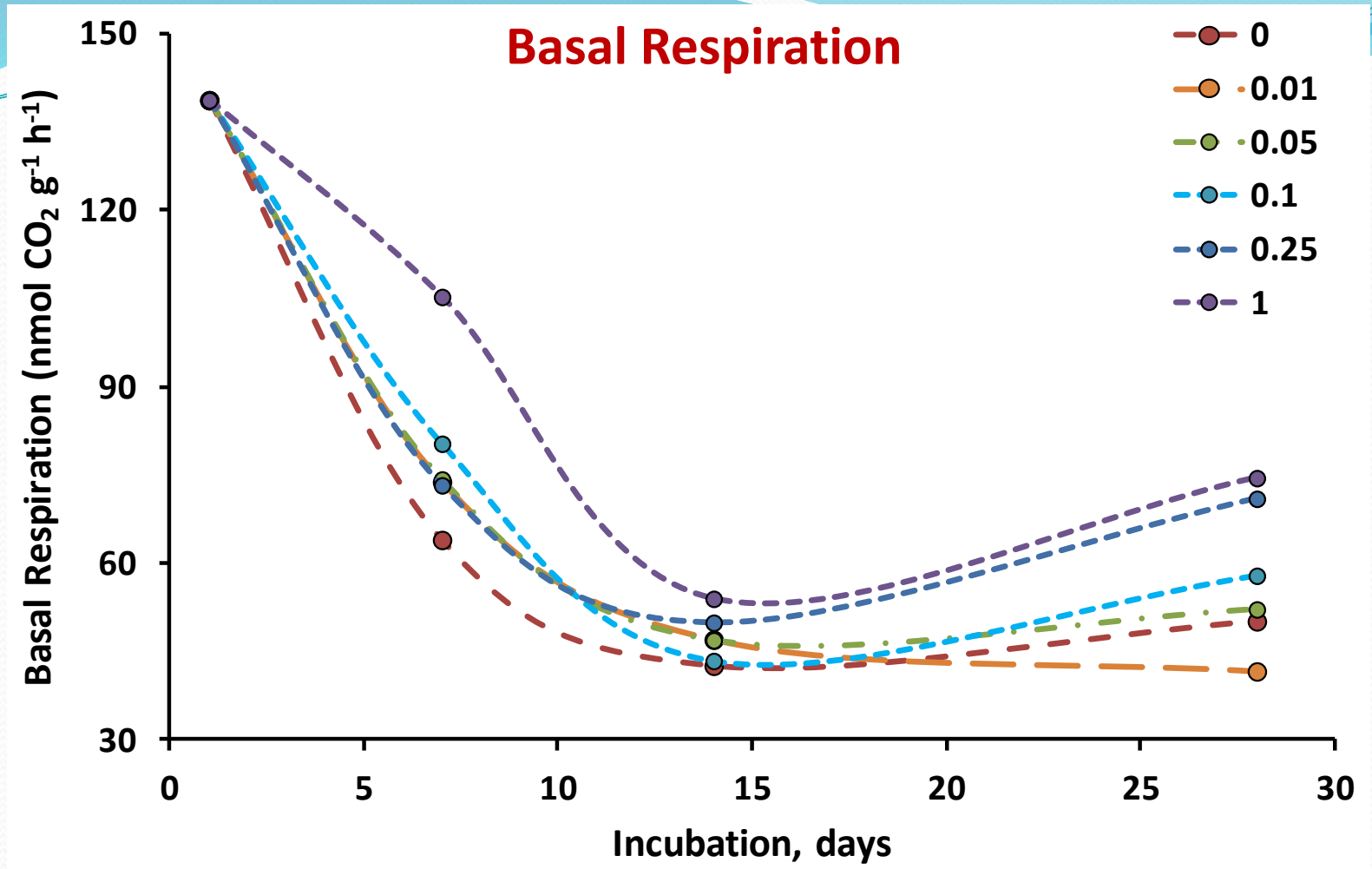


About 100 bacterial classes in sum

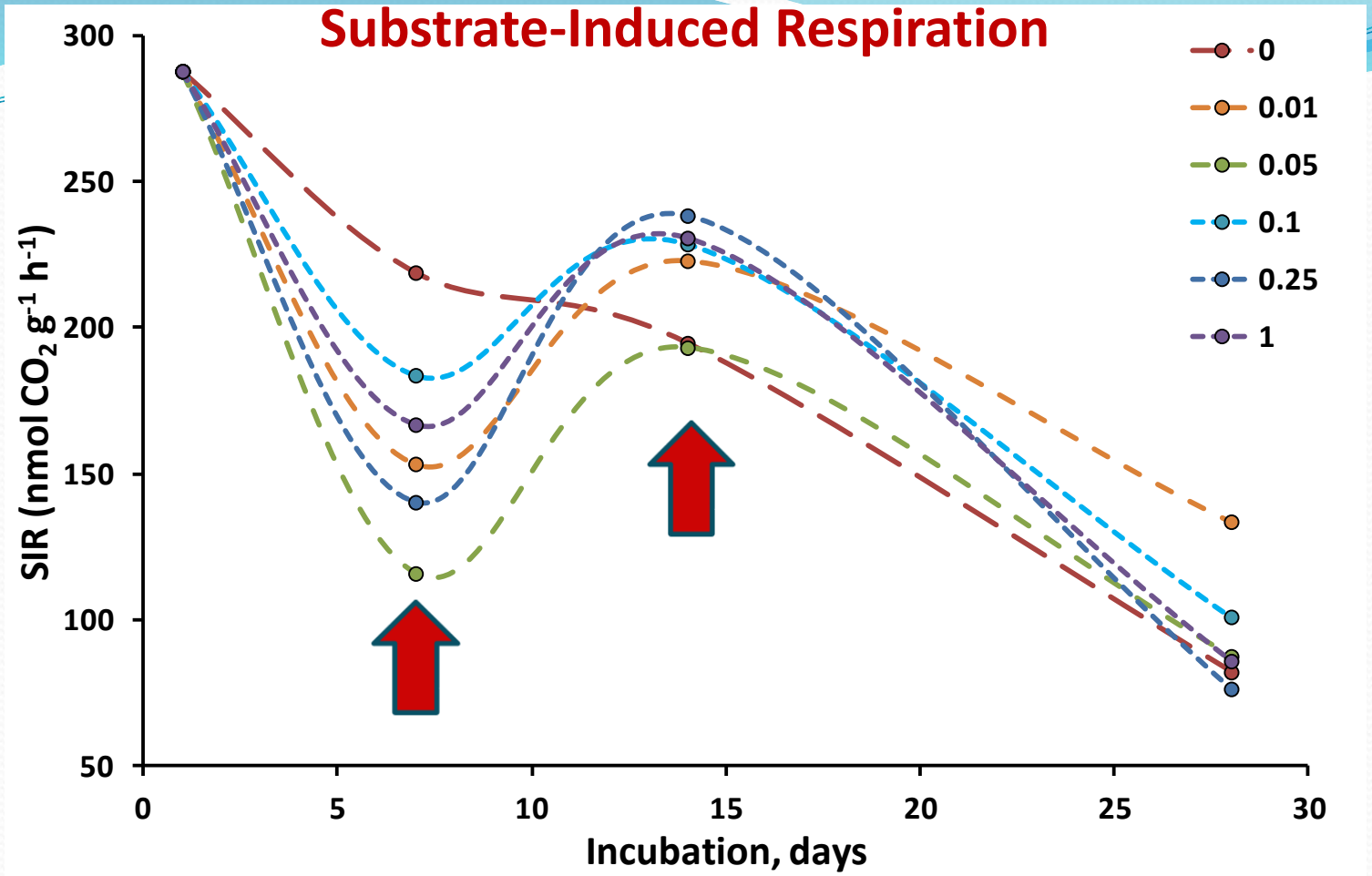
10 classes represent over 80% of soil bacterial community

Activity of which microbial processes was measured?

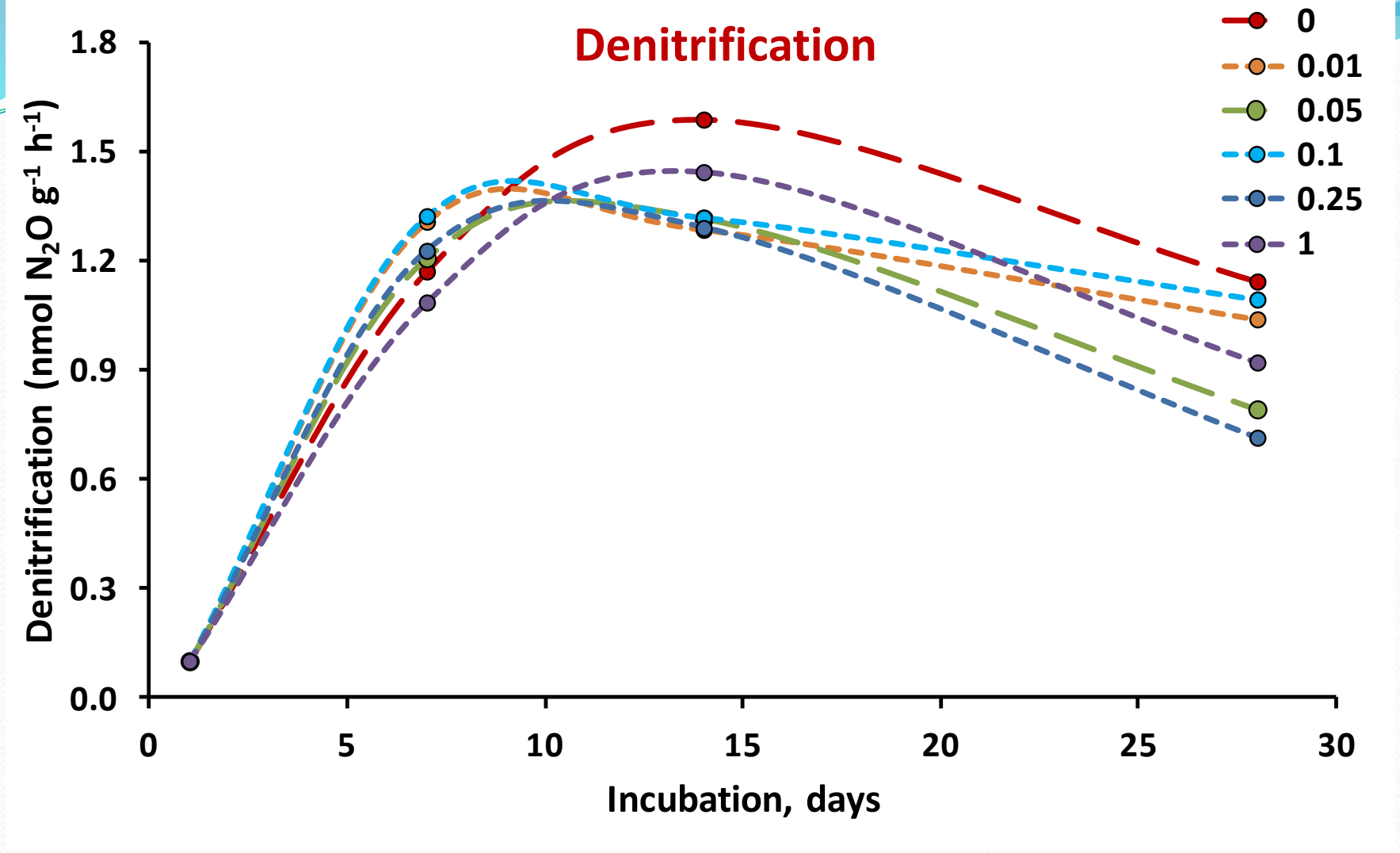
- Substrate-induced respiration (SIR);
- Basal Respiration (BR);
- Nitrogen Fixation (Potential);
- Denitrification (Potential);
- Methanogenesis (Potential) ;



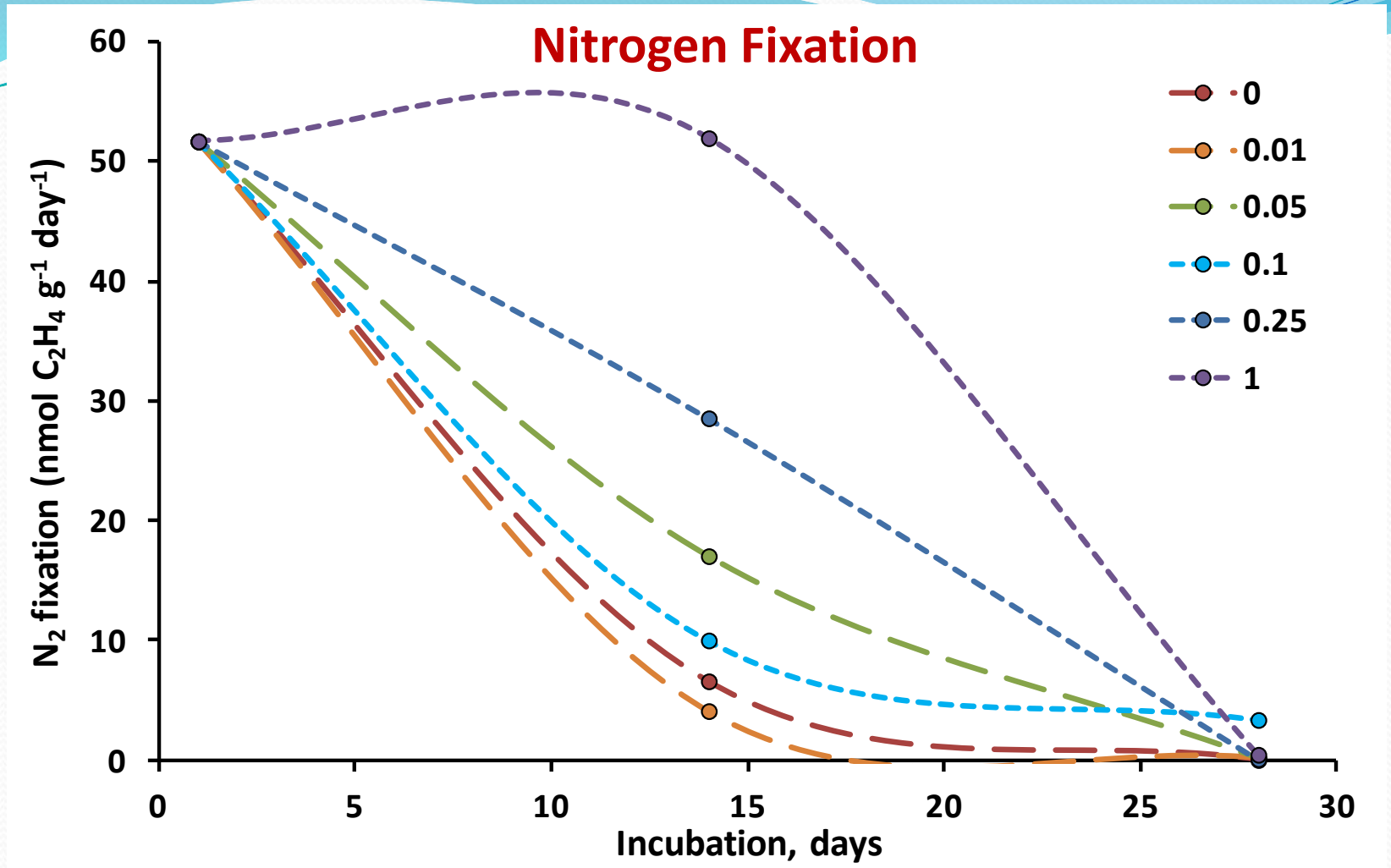
Basal respiration sharply decreased in the period of 1-14 days and then slowly increased. The higher the concentration of the lignohumate added, than more intensive respiration was detected. For the whole period of incubation, the input of the lignohumate to soil samples led to the higher respiration than that in the control soil. Thus, the lignohumate amendment activates soil microbial community



For soil without lignohumate (LH) amendment, SIR values were almost linearly falling during the experiment. In samples with LH, a decrease in SIR was sharper initially, but then it switched to growth, so that the SIR values reached the second maximum at day 14. These data shows that microbial community has altered significantly after the input of LH, and the beginning of microbial succession was detected at day 7



Denitrification activity increased up to 14 days, and then it switched to decrease (the trend was the reverse to the basal respiration). For all concentrations of LH added, denitrification was lower that that in control soil without LH



The input of LH increased an activity of nitrogen fixation.

The higher concentrations of LH led to higher nitrogen fixation

Conclusions

- 3 phyla (*Proteobacteria*, *Firmicutes* and *Acidobacteria*) represent over 75% of Bali soil bacterial community. The contribution of 4 genera (Bacillus, Janthinobacterium, Symbiobacterium, Kaistobacter) into total microbial community is over 40%
- The use of lignohumates increases microbial activity and alters microbial community structure of Bali soil;
- For all added concentrations of lignohumate, denitrification activity decreased compared to control soil. The input of LH increased an activity of nitrogen fixation. Moreover, the higher concentrations of LH led to higher nitrogen fixation.
- Summarizing the above, the use of lignohumates reduces soil nitrogen losses related to microbial activity.

Thank you!