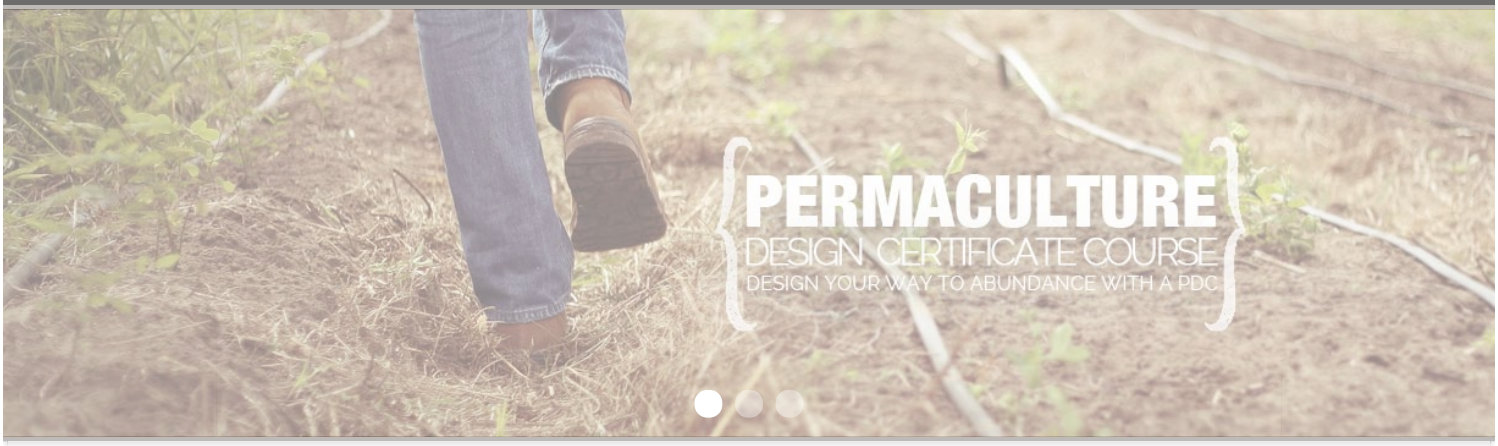

WHAT ARE EFFECTIVE MICROORGANISMS?

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Effective Microorganisms (EM) are mixed cultures of beneficial naturally-occurring organisms that can be applied as inoculants to increase the microbial diversity of soil ecosystem. They consist mainly of the photosynthesizing bacteria, lactic acid bacteria, yeasts, actinomycetes and fermenting fungi. These microorganisms are physiologically compatible with one another and can coexist in liquid culture. There is evidence that EM inoculation to the soil can improve the quality of soil, plant growth and yield (Kengo and Hui-lian, 2000).

BACKGROUND AND CONCEPT OF EFFECTIVE MICROORGANISMS

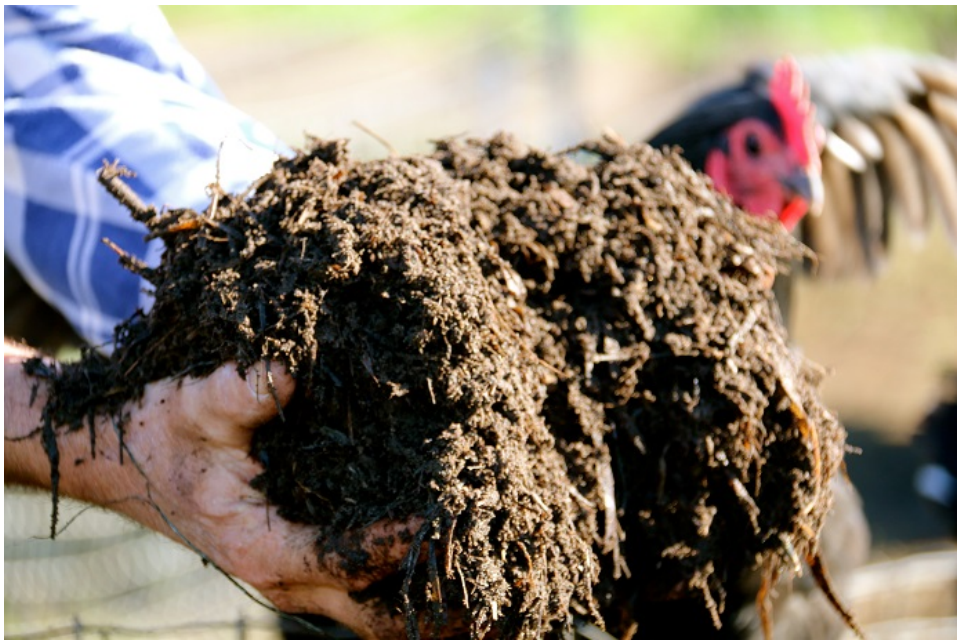

Photo courtesy of Nadia Lawton. Taken at PRI Zaytuna Farm.

Healthy soil ecology has the capability of protecting plants against soil associated diseases caused by pathogenic microorganisms and parasites. The soil system offers this protection through a balanced relationship between pathogenic and billions of beneficial microorganisms working together in synergy. The presence of these beneficial microorganisms in any soil system is what precisely distinguishes a **"living soil"** from a **"dead soil"**. They decompose and ferment organic fraction of the soil system converting it into humus containing nutrients while releasing hormones that facilitate plant growth. They are responsible for providing hormones, nutrients and minerals in a useable form to the plants through the root

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system. In addition, they bring together soil particles in the soil structure enabling it to retain nutrients and moisture (Kengo and Hui-lian, 2000).

Soil ecosystem can therefore be regarded as a **"living system"** costing of diverse groups of microorganisms. For this reason, farmers had long before been using animal manures, composts and **"compost tea"** which is a liquid extract of compost that also contains plant growth compounds and beneficial microorganisms. These mixtures could then be applied to soil and crops to improve the soil quality and help protect crop plants against microbiological infections (Ghosh et al., 2004).

Composted organic materials including animal manures have natural populations of diverse micro-organisms. Many of these organisms exert beneficial effects upon introduction to the soil system. However, they are soon overtaken and suppressed by the natural inhabitants of the soil ecosystem. Building on this practice, microbiologists have developed effective micro-organisms consisting mainly of billions of the beneficial microorganisms that have been isolated from the same natural organic amendments and environments.

BENEFICIAL EFFECTS OF EFFECTIVE MICROORGANISMS

The beneficial effects of micro-organisms introduced with the application of composts, animal manure and **"compost tea"** are often short lived leaving crop plants exposed to soil associated conditions. On application, EM mixtures are also subjected to the same conditions in the soil environment. However, the main advantage the effective microorganisms have over natural organisms in organic amendments is that in EM, beneficial microorganisms are in much greater numbers, and in optimally-balanced populations when introduced. They would therefore persist in the soil environment for a much longer time enough to bring about the beneficial effects.

Photo courtesy of Nadia Lawton. Taken at PRI Zaytuna Farm.

Studies have shown that, not only does the use of **effective microorganisms in agricultural soil suppress soil-borne pathogens**, but also increases the decomposition of organic materials and consequently the availability of mineral nutrients and important organic compounds to plants (Singh et al., 2003). In addition, EM enhances the activities of beneficial indigenous micro organisms, for example mycorrhizae which fix atmospheric nitrogen thereby supplementing the use of chemical fertiliser and pesticides. Improvement in soil fertility has significant positive effect on plant growth, flowering, fruit development and ripening in crops (Lévai et al., 2006).

Introduction of a population of beneficial bacteria (EM) in the soil have a supporting effect in reducing soil associated microbiological diseases. The inoculation of EM stimulates **"Rotation effect"**, an occurrence that comes as a result of regeneration of beneficial organisms and elimination of pathogenic bacteria. Disease suppression is brought about by the competion for available resources between the disease causing microbes in the soil and beneficial microbes introduced in EM. As a result of this, an enhanced population of effective microorganisms through inoculation will deplete the available resources in the soil leading to reduction of pathogenic microorganisms due to starvation (Johan and Jesper, 2005).

The mainstays of EM are the photosynthetic bacteria (Rhodopseudomonas spp.), lactic acid bacteria, (Lactobacillus spp.) and yeasts (Saccharomyces spp.) (Zuraini et al., 2010). The photosynthetic bacteria are independent self sustaining microorganisms. They harvest energy from the sun and soil heat and use it to convert exudates from root systems, soil organic fraction and gases such as ammonia into building materials of cells such as amino acids, nucleic acids and sugars.

These can all be absorbed directly into plants to promote plant growth and also in the soil system promote and maintain the growth and establishment of other beneficial microorganisms. For example, Vesicular-arbuscular mycorrhiza (VAM fungi), known to enhance the plant's absorption capability of soil phosphates, increases in the root zone in the presence of amino acids secreted by the beneficial bacteria. In addition, in the soil ecosystem, The VAM fungi live in association with Azotobacter and Rhizobium which increase the capacity of plants to fix Nitrogen.

The lactic acid bacteria in EM are known to produce lactic acid from sugars and carbohydrates the photosynthetic bacteria and yeasts in EM produce. Lactic acid has sterilizing effects and it presence in the soil checks the proliferation of nematode population and offers protection against nematode associated plant diseases. Lactic acid bacteria in EM also participate in the breakdown of cellulolytic and lignified organic materials in the soil (Ouwehand, 1998).

On the other hand, the yeasts in EM produce hormones and enzymes that are known to promote plant cell and root division. They utilize the amino acids and sugars secreted by the photosynthetic bacteria and plant roots and in turn produce growth factors for the lactic acid bacteria. It can therefore be concluded that, the different species of organisms in EM complement each other and are in a mutually beneficial relationship with the roots of plants in the soil ecosystem. Plants would therefore grow exceptionally well in soils inhabited and dominated by these Effective Microorganisms (Pei-Feng et al., 2014).

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