

Role of Effective Microorganisms (Em) in Sustainable Agriculture – A Review and Recommendations



Biotechnology

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ABSTRACT

The agricultural systems and practices today are facing many hardships by shrinking land, water and labour resources and hence problems of food scarcity loom in the near future. Excessive and continuous usage of agrochemicals led to diminishing returns from the crop lands and those foods are also with harmful chemical residues. The concept Effective Microorganisms has been developed during 1980's and its beneficial effects on soil, crop and environment was reported here and there. It contains three principal groups of microorganism viz., lactic acid bacteria, photosynthetic bacteria and yeast and its mode of action is not scientifically documented. However the reports and research evidences revealed the beneficial effects of ensuring sustainable agriculture and environmental preservation. This review paper has been prepared with the aim to assess the potential uses of Effective Microorganism, to locate the research lacuna and recommendations were also made to strengthen the research on Effective Microorganism.

Introduction

It is realized that the 'Green Revolution' with high input use has reached a plateau and is now sustained with diminishing return. These systems have been able to produce high yields as evidenced by the green revolution, but at a cost. Yields of plots that have been supplied with agrochemicals continuously for a long time are declining rapidly. The agricultural systems of today are undergoing many hardships recently. Hence problems of food scarcity loom in the future, while most countries are hoping to achieve self sufficiency and food security. Looking at solutions to these problems, one could easily identify that the maintenance of soil fertility and quality are two basic concepts that have been considered vital in achieving sustainability of food systems. The technologies using chemicals do not offer a clear solution, as the excessive use of agrochemicals has brought us to this situation. The ultimate goal of sustainable agriculture is to develop farming systems that are productive, profitable, energy-conserving, environmentally-sound, conserving of natural resources that ensure food safety and quality. Hence this review has been undertaken to elucidate the importance of Effective Microorganisms (EM) in the context of sustainable agriculture, to assess the research gaps and to recommend measures to abridge the research gaps throughout the world.

Microorganisms and Effective Microorganisms

Microorganisms are tiny units of life that are too small to be seen with the naked eye and they exist everywhere in nature. They carry out chemical and biological processes that make it possible for all other organisms including humans to live. Soil microorganisms can have both positive and negative effects on plant growth. They can facilitate nutrient absorption by plants (Bowen and Rovira, 1966); promote plant growth or stimulate seedling development by producing hormone like substances (Brown, 1974); suppress and controls plant pathogens and diseases through various antagonistic activities (Marios et al., 1981); or adversely affect plant growth through their pathogenic behaviour (Elad, 1985).

The concept of effective microorganism, (EM) was developed by Professor Teruo Higa University of the Ryukyus, Okinawa, Japan (Higa, 1991). Effective microorganisms (EM) consist of mixed cultures of beneficial and naturally occurring microorganisms that can be applied as inoculants to increase the microbial diversity of soil and plant. Research has shown that the inoculation of EM cultures to the soil plant ecosystem can improve soil quality, soil health and the growth, yield and quality of the crops (Kengo and Hui-lian, 2000). EM is a combined culture of aerobic and anaerobic microorganisms that co-exist together with symbiotic relationship. Effective Microorganisms has been put into

application since 1980 to alter the use of chemical fertilizers and change the microbial diversity and interaction in soils and plants.

Constituent microbes of EM

Components of EM products are synergistic mixture of several naturally occurring, non-engineered microorganisms. Each member provides a benefit to the other EM and/or plants. The three major components are:

- *Lactic acid bacteria* - They metabolize sugars using a form of fermentation that produces lactic acid as a waste product. These bacteria break down organic material in the soil, and the lactic acid produced is said to lower the soil pH and thereby increased acidity, which inhibits the growth of certain harmful bacteria.
- *Photosynthetic bacteria* - Like plants, they use photosynthesis process to convert the solar energy into sugars. These extremely efficient bacteria produce more sugars than they need, and the excess can be used by other EM and plants.
- *Yeast* - Like lactic acid bacteria, yeast utilizes the extra sugars made by the photosynthetic bacteria and produces a variety of vitamins, enzymes and antimicrobial substances that help the other microbes and plants.

Action of EM

The basis of action of EM can be related to a general method of classifying microorganisms can be classified as reviving, neutral and disintegrating types. The microorganisms found in EM are also found in nature and can be classified as the reviving types. They act harmoniously to develop a more productive and sustainable system of agriculture. For example, the reviving types enhance the biological, chemical and physical properties of the soil by acting as synergists. These microbes decompose organic matter to produce growth requirements of crops and reduce pollution. EM can suppress these disintegrating types. The action of EM does not occur in isolation and it requires organic matter as food and thus the effectiveness of EM is best obtained with organic matter. The microbes have the ability to breakdown the organic matter thus releasing beneficial soluble substances such as amino acids, sugars, alcohol, hormones and similar organic compounds. These are absorbed by plants and thus growth is enhanced.

Application of EM in sustainable agriculture and environment

EM has been used on many different soils and crops over a wide range of conditions. Results showed that in most cases EM gives positive results. EM is not a substitute for other management

practices but EM technology is an added dimension for optimising our best soil and crop management practices such as crop rotations, use of composts, crop residue recycling and biological control of pests. EM enhances soil fertility and promotes growth, flowering, fruit development and ripening in crops. It can increase crop yields and improve crop quality as well as accelerating the breakdown of organic matter from crop residues. Yield is expected to increase by 20% to 30% with the general use of EM and even by 50% to 100% when a high level of EM is maintained in the soil. Better taste, higher content of vitamins C and E, longer shelf life are the added advantages of EM. The population of beneficial microorganisms in the soil is also increased helping to control soil diseases through competitive exclusion. Due to its wide range of adoption, it could be used to treat organic matters, such as crop residue, weeds, animal excreta and kitchen garbage. EM technology show the possibility for solving problems related with environment, water and hygiene all at the same time.

Application of EM through silage, haylage, adding to drinking water of animals improves its productivity and spraying inside the animal barn will reduce bad odour as well as pests such as flies, maggots, etc., drastically. The improvement in meat quality, egg-laying rate and dairy production was also reported. When EM is applied and propagated at the source of pollution, such as toilets and a sewage treatment system, water will be cleaned enough for recycling for agriculture, aqua-culture, and even household uses.

Research findings

Gorski and Kleiber (2010) conducted the studies on effect of EM, applied both to the roots and as foliar application in Rose and Gerbera at Poland. The significantly highest number and yield of flowers in case of both Rose and Gerbera was recorded by the application of the EM inoculum to the roots. Foliar application of EM had a positive effect on the diameter of flowers in roses and the number of formed inflorescence and the number of leaves in case of gerbera. Chrispaul *et al.*, (2010) studied the influence of EM on growth and yield of *Amaranthus dubians* with and without use of EM along with soil and organic manures under Kenyan condition. They found significant increase in shoot length, stem diameter, number of leaves per plant, dry matter from the treatment combinations with EM. They concluded that the growth and yield of *A.dubians* could be improved by use of EM with reduced use of chemical fertilizers. The study conducted at Hohai University, China by Chantal *et al.*, (2010) to assesses the effect of EM on vegetable Cabbage by comparing with nitrogen and phosphoric fertilisers reported the positive significant effects of EM on leaf area, net photosynthetic rate

and there by the enhanced yield. They also suggested that the EM could be effectively utilized in agricultural crop production along with organic manures and on long run it may become the best practice for ensuring sustainable agriculture. However, further studies have to be strengthened for the deep understanding of the mechanism of its action on plant system.

Research lacuna

Several studies including those from Brazil, China, Costa Rica and New Zealand claim to demonstrate a positive effect for EM. Yet, critics have cited flawed experimental design and statistical analysis that prevent definitive conclusions from being drawn. In particular, the effectiveness of single microorganism strains has been called into question. And studies from the Netherlands and Switzerland both concluded that EM had no effect but it is no where reported as harmful. Though the reports says EM had been use since 1980's the quantity and method of application, its mode of action on soils, crops and environmental pollutants is not thoroughly understood. By lack of research efforts and suitable recommendations alone, the usage of EM is not wide spread among the researchers and farmers.

Conclusion and Recommendations

From the foregoing discussion, the beneficial effect of EM is understood well in the field of agriculture, animal husbandry and reducing environmental pollution. But the scientific data base to develop knowledge and bring into practice is scanty and hence this is the need of this hour to make unrelenting efforts to prove its beneficial effects to augment agricultural productivity in a sustainable manner and also to address environmental issues threatening the world.

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