Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(4): 3070-3074
Received: 06-05-2020
Accepted: 08-06-2020

N Nayak
Faculty of Agricultural Sciences (IAS), Siksha 'O' Anusandhan (Deemed to be University) Bhubaneswar, Odisha, India

Koushik Sar
Faculty of Agricultural Sciences (IAS), Siksha 'O' Anusandhan (Deemed to be University) Bhubaneswar, Odisha, India

Bijoy Kumar Sahoo
Faculty of Agricultural Sciences (IAS), Siksha 'O' Anusandhan (Deemed to be University) Bhubaneswar, Odisha, India

P Mahapatra
Faculty of Agricultural Sciences (IAS), Siksha 'O' Anusandhan (Deemed to be University) Bhubaneswar, Odisha, India

Corresponding Author:
Koushik Sar
Faculty of Agricultural Sciences (IAS), Siksha 'O' Anusandhan (Deemed to be University) Bhubaneswar, Odisha, India

Beneficial effect of effective microorganism on crop and soil- a review

N Nayak, Koushik Sar, Bijoy Kumar Sahoo and P Mahapatra

Abstract
Environmental protection has the foremost importance in the modern day lifestyles of mankind. EM (effective microorganisms) is a biofertilizer consisting of a mixed culture of potentially usefull microorganisms. EM incorporate a mixture of live natural cultures of microorganisms isolated from fertile soils which might be used to enhance crop production. EM play a vital role to suppress plant pathogen and diseases. EM also helps to to improve photosynthetic efficiency and biological nitrogen fixation. EM includes mixed cultures of beneficial micro-organisms such as photosynthetic bacteria, lactobacilli, yeasts and Actinomycetes. EM can improve the quality and yield of vegetables by using lowering the incidence of pests and diseases, and via protecting in opposition to weeds, thereby contributing to sustainable agriculture. Effective Microorganisms is also help to detoxify our landfills, decontaminate our environment, and promote highly sustainable, closed-cycle agricultural and organic waste treatment methods worldwide.

Keywords: EM, Biofertilizer, photosynthetic bacteria, lactobacilli and Actinomycetes

Introduction
Green revolution in India brought about dramatic change in food grain production and brought about self sufficiency in food and also helped to reduce hunger and poverty. But the growth of food production showed declined after eighties and nineties when compared to the previous years (Rao and Radha Krishna, 1997). Since FAO, State of food & Agril. India needs 4 to 4.5 of Agril. Growth rate to reduce poverty and food industry. The current growth will continue not be enough to eradicate hunger by 2030 and not even 2050 ignoring the nutritional security. At present than exists problem of malnutrition in our country. About 45 million children below five years of age and 51-74% of our child bearing woman are suffering from anemia, due to malnutrition. Malnutrition is directly linked to human resource development, poverty and ultimately natural growth.

Now in twenty century drawn with renewed hope better livelihood for the people for the people of this earth. Hence this often discussed at international form on human welfare and agriculture range for sustainability and food security and self to the provision of a productive and healthy environment to humankind and its future generation. Now there is public become conscious about health hazard. They want poison free food and healthy atmosphere to live healthy and happily. That's why the organic food demands in increasing.

Organic food production system is the only alternative for sustainable healthy food production and will provide safe drinking water by regenerating the soil health, environmental health and biodiversity. The key factor in regenerating the soil health is to increase the soil biological properties. Since the principle of organic farming says "feed the soil not to the plant." Now a days soil become dead due to use of poisonous Agro-chemicals to eradicate the toxic material for soil and the fundamental approach to the transition of conventional to natural farming is that of controlling soil microorganism that directly affect the growth, health and yield of crops. To control soil micro organism ecologically, it is important to know what effect or influence a special organism or mixed culture of micro organism has on the growth and health of a particular crop.

Effective microorganisms
The first concept of Effective Microorganisms (EM) was developed by Professor Teruo Higa (Higa, 1991; Higa and Wididana, 1991a) [12]. EM consists of mixed cultures of beneficial micro-organisms such as photosynthetic bacteria (e.g., Rhodopseudomonas palustris, Rhodobacter sphaeroides), lactobacilli (e.g., *Lactobacillus plantarum*, L. casei, and Streptococcus lactis), yeasts (e.g., Saccharomyces spp.), and Actinomycetes (Streptomyces spp.; Javid, 2010). Condor *et al*., (2007) [6] described these micro organisms as follows:

a) Photosynthetic bacteria

Photosynthetic bacteria are specific types of bacteria that contain light absorbing pigments and they are also capable to convert light energy into chemical energy. **o**xygenic photosynthetic bacteria contain lower-harvesting pigments, soak up carbon dioxide, and release oxygen Whereas Anoxygenic photosynthetic microorganism consume carbon dioxide but do not release oxygen. Photosynthetic bacteria are currently being used in diverse applications which consist of water purification, bio-fertilizers, animal feed and bioremediation of chemicals among many others. They are used inside the remedy the of polluted water since they can develop and utilize toxic materials such as H2S or H2S203. photosynthetic bacteria facilities to improve soil physical properties by means of adding different EM. For example, stages of vesicular-arbuscular mycorrhiza (VAM) in the rhizosphere were increased due to the availability of nitrogenous compounds (amino acids) to be used as substrates after secretion by photosynthetic bacteria (Condor *et al*., 2007) [6]. VAM enhance the solubility of phosphates in soils.

b) Lactic acid bacteria

Lactic acid and bacteria produce lactic acid from sugars. Lactobacillus is a beneficial bacterium that allows sterilize soil and take away byproducts which could increase and create a damaging environment. Lactobacillus helps to decomposition and disease suppression. The bacterial cycle is responsible for regulating the balance of composition in soil, to inspire existence by increasing the formation of humus. Lactobacillus also performs as a growth regulator for fungi, yeast and aerobic bacteria (Bonnie Grant, 2017). Lactic acid acts to sterilize soils and suppress harmful microorganisms, as well as growing the decomposition of organic matter (Condor *et al*., 2007) [6]. Lactic acid bacteria enhance the breakdown of organic matter inclusive of lignin and cellulose, and ferment these materials greater rapidly.

c) Actinomycetes

They play important roles in the rotation of organic matter and inhibit the growth of several plant pathogens in the rhizosphere. They produced many extracellular enzymes which can be conductive to crop production. The main contribution in organic buffering of soils, biological control of soil environments by nitrogen fixation and degradation of high molecular weight compounds like hydrocarbons in the polluted soils are tremendous traits of actinomycetes. Besides this, they are known to improve the availability of nutrients, minerals, enhance the production of metabolites and promote plant growth regulators (Bhatti, 2017) [2]. Actinomycetes can co-exist with photosynthetic bacteria. Actinomycetes and photosynthetic bacteria both can act synergistically to enhance the quality of the soil environment by increasing the anti-microbial activity of the soil (Condor *et al*., 2007) [6]

Role of EM in crop production

There are numerous advantage to using effective micro-organisms in agriculture (Urmi and sariah, 2006) [40]. Plants might be grow particularly nicely in soils inhabited and dominated via these effective micro-organisms (Sun *et al*., 2014) [37]. Crop productivity and quality increased by using Effective microorganisms (Cortez *et al*., 2000) [7]. The population of useful micro-organisms in the soil is likewise improved helping to control of soil diseases through competitive exclusion (Postmablaauw *et al*., 2006) [29]. EM were mostly used in agriculture (Sangakkara, 2012a) [34]. EM helps to reduced the time for preparation of bio-fertilizer when its applied directly in the soil with organic matter composts. Organic matters when composed with EM released more number of nutrients and also increase more advantageous photosynthesis and protein synthetic activity. Sangakkara, 2012 [33] reported that more soil and plant resistance to water stress, higher rates of mineralisation of carbon, improved soil properties, and better penetration of plants roots following the application of EM. EM also helps to increase plant growth and reduced the population of insect and pests. (Sangakkara, 2012) [33]. Research has also proven that inoculation of soil/plant ecosystems with cultures of EM can enhance soil quality and soil health. In some soils, a single inoculation of EM may additionally be sufficient to provide the preferred results, even as in other soils even repeated applications of EM appear to be ineffective. Repeated applications, especially during the first cropping season, can facilitate earlier establishment of the introduced EM (Higa and Parr, 1994) [11]. EM significantly increased grain yield by 24 per cent and 46 per cent in farmyard manure and NPK fertilizers amendments, respectively in mung bean (Javaid and Bajwa, 2011) [17]. Cheng and Yingchum, 2013 concluded that long-term application of effective microorganisms compost could affect soil nematode community structure, wheat biomass and grain yield. D.I.Khan, (2009-10) reported that EM+ Pressmud combination significantly improved soil physical and chemical properties as well as spinach growth. Some soil microbes performed as bio inoculants for supplying nutrients and stimulating plant growth and rhizospheric microbes are known for the synthesis of plant growth porometers, siderophores and antibiotics as well as aiding phosphorous uptake. EM applied in combination with compost increased wheat yield (Hu and Qi, 2013) [14].

Beneficial effect of EM in crop quality

EM increased yields of sweet potato, especially in the dry season when the number of tubers, and bulking rates were generally lower (Sangakkara). In NPK amended soil, the application of EM enhanced NPK nutrition markedly only at a later growth stage (Javaid and Bajwa, 2011) [17].

Beneficial effect of EM in plant protection

EM is a microbial inoculant that works as a bio-control degree in suppressing and/or controlling pests via the advent of useful microorganisms to soils and plants life. Pests and pathogens are suppressed or controlled via natural strategies by way of enhancing the competitive and antagonistic activities of the microorganisms in the EM inoculants (TNAU agri portal). Studies have shown that the use of effective microorganisms in agricultural soil suppress soil-borne pathogens (Singh *et al*., 2003) [35]. Introduction of a population of useful bacteria (EM) within the soil have a supporting impact in decreasing soil associated microbiological diseases. The inoculation of EM stimulates "Rotation effect"**,** an incidence that comes due to regeneration of useful organisms and removal of pathogenic bacteria. Effective microorganisms helps to reduction of pathogenic microorganisms through inoculation will deplete the available resources within the soil due to starvation (Johan and Jesper, 2005) [18]. Combination of EM and 'Bokashi is performed better to reduce the incidence of soft rot disease on cabbage plants (Escano, 1996) [10].

Role of EM in soil

Now a day's chemical fertilizers and pesticides used mostly in the field. But its degraded soil quality. EM can used as a alternative of chemical fertilizers. EM facilitates to enhance soil quality with the aid of fixing atmospheric nitrogen. Levai (2006) [23] mention that improvement in soil fertility has positive effect on plant growth, flowering, fruit development and ripening in crops. Growth and development of crops are mainly depends on nature of soil, mainly soil microflora. i.e., the rhizosphere. So if we want to overcome the limitations of conventional agricultural technologies we should first try to control soil microorganisms. This specific guideline is in reinforced because the evolution of most styles of life on this planet and their environments are sustained through microorganisms. It is essential to develop improved variety with improve genetic quality and with higher level of environmental competitiveness to significantly increase food production. Effective micro-organisms will increase nutrient availability in the soil for plants which will reduce the need for constant fertilization and cost of cultivation (Daniel *et al*., 1992) [8]. Vide *et al*., 2017 [40], concluded that when bacterial isolates are used in combination they perform better in comparison to their individual use and these isolates 34 percent and 52.4 percent increase the mean Fe concentration in grain and straw over none inoculated control significantly and also increase the total Fe uptake in comparison to none inoculated controls. In FYM amended soil effective micro-organisms application markedly enhance plant nutrition at later growth stage of mung bean crop (Javaid and Bajwa, 2011) [17]. EM inoculation to the soil can improve the quality of soil, plant growth and yield (Han *et al*., 2006). EM used in many cropss to enhance soil fertility, increase crop productivity, and control plant diseases (Ndona *et al*, 2011; Rezende *et al*., 2008; Javid *et al*., 2011, Hu *et al*., 2013; Roberti *et al*., 2015; Talaat *et al*., 2015, Pierce *et al*., 2016; Shin *et al*., 2017) [25, 30, 17, 13, 31, 37, 28, 34].

Hussain *et al*., 1999 [15] found an increase in wheat and rice grain yield when effective microorganism"s application was carried out in combination with farmyard manure and mineral NPK. Jusoh *et al*., 2013 [20] reported that compost applied with effective micro-organism has more N,P and K content compared to compost without effective micro-organism. Composting being one of the most attractive on account of its how environmental impact and cost effective also (Bustamante *et al*., 2008; Canet *et al*., 2008 and Lu *et al*., 2009) [3, 5, 24] as well as its capacity for generation a valuable product used for increasing soil fertility (Weber *et al*., 2007 and Perez-Murcia *et al*., 2005) [27]

Addition of EM together with organic manures is thought to be an effective technique for stimulating supply and release of plant nutrients. Studies have shown that inoculating agro-ecosystems with EM can improve soil and crop quality (Higa and Parr; 1994; Hussain *et al*., 1999) [11, 15]. According to Khaliq, Kaleem and Hussain (2006), application of organic materials or EM alone did not significantly increase yield. However, their integrated use resulted in a 44% increase in yield over the control. Application of EM with mineral fertilizer in this case resulted in a slight increase in yield (14%) over the mineral fertilizer alone, demonstrating that EM is more effective when applied with Organic manures. The relatively low response of mineral fertilizer compared to EM application was due to the fact that EM is made up of different microorganisms which can respond well only in the presence of sufficient organic matter.

Aryal, Xu and Fujita (2003) [1] showed that Rhizobia and arbuscular mycorrhizai (AM) inoculation of bean plants significantly increased pod yield in plots with organic matter supplements compared to chemically treated plots. The relative effects of EM were further observed in plant leaf N concentration where its co-application with organic materials increased leaf N concentration by 38% relative to the control compared to 16% increase due to organic materials application alone (Khaliq *et al*., 2006) [22]. EM enhances the degradation and stimulates mineralization of organic materials, releasing plant nutrients into the soil (Hussain *et al*., 1999) [15].

Effective microorganism enhances the activities of beneficial microorganisms, for which fix atmospheric nitrogen and accelerate phosphorus and zinc uptake from soil thereby supplementing the use of chemical fertilizer and pesticides. The accountable use of indigenous microorganisms to get economic, social and environmental benefits is inherently attractive and determines a amazing evolution of research from conventional technologies to trendy techniques to offer an efficient way to defend surrounding and new strategies of environmental monitoring (Cai *et al*. 2013) [4]. Combined Application of EM associated with organic wastes is reported to enhance soil organic matter content through humification of sparking organic materials; which then leads to advanced soil fitness and enhance microbial activities (Valarini *et al*., 2003) [41].

Conclusion

Effective microorganisms have the potential to enhance the growth and productivity of crops. These microorganisms can be particularly effective when applied to soils along with organic amendment. Its also helps to improve the soil health and provides multiple ecosystem services.

References

1. Aryal UK, XU HL, Fujita M. Rhizobia and AM Fungal Inoculation Improve Growth and Nutrient Uptake of Bean Plants Under Organic Fertilization. Journal of Sustainable Agriculture. 2003; 21:3.
2. Bhatti AA, Haq S, Bhat RA. Actinomycetes benefaction role in soil and plant health. Microbial Pathogenesis. 2017; 111:458-467.
3. Bustamante M, Paredes C, Marhuenda-Egea F, Pe´rez-Espinosa A, Bernal M, Moral R. Co-composting of distillery wastes with animal manures: carbon and nitrogen transformations in the evaluation of compost stability. Chemosphere. 2008; 72:551-557.
4. Cai M, Yao J, Yang H, Wang R, Masakorala K. Aerobic biodegradation process of petroleum and pathway of main compounds in water flooding well of Dagang oil field. Bioresour Technol. 2013; 144:100-106.
5. Canet R, Pomares F, Cabot B, Chaves C, Ferrer E, Ribo M, Albiach MR. Composting olive mill pomace and other residues from rural southeastern Spain. Waste Manage. 2008; 28:2585-2592.
6. Condor AF, Gonzalez P, Lakre C. Effective microorganisms: Myth or reality? The Peruvian Journal of Biology. 2007; 14:315-319.
7. Cortez J, Billes G, Bouche MB. Effect of climate, soil type and earthworm activity on nitrogen transfer from a nitrogen-15-labelled decomposing material under field conditions. Biology and Fertility of Soils. 2000; 30(4):318-327.

8. Daniel O, Anderson JM. Microbial biomass and activity in contrasting soil materials after passage through the gut of the earthworm *Lumbricus rubellus* Hoffmeister. Soil Biology & Biochemistry. 1992; 24(5):465-470.
9. David S Powlson, Penny R Hirsch, Philip C Brookes. The role of soil microorganisms in soil organic matter conservation in the tropics. Nutrient Cycling in Agroecosystems. 2001; 61:41-51.
10. Escano CR. Experiences on EM Technology in the Philippines, 1996. http://www.futuretechtoday.net/em/index2.htm
11. Higa T, Parr JF. Beneficial and Effective Microorganisms for a Sustainable Agriculture and Environment. INFRC (International Nature Farming Research Center), Atami, Japan, 1994.
12. Higa T. Effective microorganisms: A biotechnology for mankind. In J.F. Parr, S.B. Hornick, and C.E. Whitman (ed.) Proceedings of the First International Conference on Kyusei Nature Farming. U.S. Department of Agriculture, Washington, D.C., USA, 1991, 8-14.
13. Hu C, Qi Y. Long-term effective microorganisms application promote growth and increase yields and nutrition of wheat in China. Eur. J. Agron. 2013; 46:63-67.
14. Hu C, Qi C. Long-term effective microorganisms application promote growth and increase yields and nutrition of wheat in China. Europ. J. Agronomy. 2013; 46:63-67.
15. Hussain T, Javaid T, Parr JF, Jilani G, Haq MA. Rice and wheat production in Pakistan with effective microorganisms. American Journal of Alternative Agriculture. 1999; 14:30-36.
16. Iriti M, Scarafoni A, Pierce S, Castorina G, Vitalini S. Soil Application of Effective Microorganisms (EM) Maintains Leaf Photosynthetic Efficiency, Increases Seed Yield and Quality Traits of Bean (Phaseolus vulgaris L.) Plants Grown on Different Substrates. Int. J. Mol. Sci. 2019; 20:23-27.
17. Javaid A and Bajwa R. Field evaluation of effective microorganisms (EM) application for growth, nodulation, and nutrition of mung bean. Turkish Journal of Agriculture and Forestry. 2011; 35:443-452.
18. Johan S, Jesper M. Antifungal lactic acid bacteria as bio preservatives. Trends in Food Science & Technology. 2005; 1:70-78.
19. Joshi H, Somduttand, Choudhary P, Mundra SL. Role of Effective Microorganisms (EM) in Sustainable Agriculture. Int. J. Curr. Microbiol. App. Sci. 2019; 8(03):172-181
20. Jusoh ML, Manaf LA, Latiff PA. Composting of rice straw with effective microorganisms (EM) and its influence on compost quality. Iranian Journal of Environmental Health Science & Engineering. 2013; 10(1):17.
21. Khaliq A, Abbasi MK, Hussain T. Effect of integrated use of organic and inorganic nutrient sources with effective microorganisms (EM) on seed cotton yield in Pakistan. Bioresource Technology. 2006; 97:967-972.
22. Kumar BL, Gopal DVR. Effective role of indigenous microorganisms for sustainable environment. 3 Biotech. 2015; 5:867-876.
23. Lévai L, Veres SZ, Makleit P, Marozsán M, Szabó B. New trends in plant nutrition. Proceedings of 41st Croatian and 1 st International Symposium on Agriculture, ISBN 953-6331-39-X, 2006, 435-436.
24. Lu Y, Wu X, Guo J. Characteristics of municipal solid waste and sewage sludge co-composting. Waste Manage. 2009; 29:1152-1157.
25. Ndona RK, Friede JK, Spornberger A, Rinnofner T, Jezik K. Effective micro-organisms (EM): An effective plant strengthening agent for tomatoes in protected cultivation. Biol. Agric. Hortic, 2011; 27:189-203.
26. Olle M, Williams IH Effective microorganisms and their influence on vegetable production – a review. Journal of Horticultural Science & Biotechnology. 2013; 88(4):380-386
27. Perez-Murcia MD, Moreno-Caselles J, Moral R, Perez-Espinosa A, Paredes. Int. J. Curr. Microbiol. App. Sci 8(3): 172-181 181 C. and Rufete, B. 2005. Use of composted sewage sludge as horticultural growth media: effects on germination and trace element extraction. Comm Soil Sci Plant Anal. 2019; 36:571-582.
28. Pierce S, Quaglino F, Montagna M, Spada A, Casati P, Iriti M. Evaluation of effective microorganisms efficacy on 'Candidatus Phytoplasma solani'-infected and healthy periwinkle plants. Mitt. Klosterneubg. Rebe Wein Obstbau Früchteverwert. 2016; 66:89-92.
29. Postma-Blaauw M B, Bloem J, Faber J H, Van Groenigen JW, De Goede RGM, Brussaard L. Earthworm species composition affects the soil bacterial community and net nitrogen mineralization. Pedobiologia. 2006; 50(3):243-256
30. Rezende AMF, Tomita CK, Uesugi CH. Cupric fungicides, benzalconium chlorides and liquid bioactive compost (Bokashi): Phytotoxicity and control of guava bacterial blight caused by Erwinia psidii. Trop. Plant Pathol. 2008; 33:288-294.
31. Roberti R, Bergonzoni F, Finestrelli A, Leonardi P. Biocontrol of Rhizoctonia solani disease and biostimulant effect by microbial products on bean plants. Italian J. Mycol. 2015; 44:49-61.
32. Sangakkara UR. Effect of EM on Nitrogen and Potassium Levels in the Rhizosphere of Bush Bean, 2012. http://www.infrc.or.jp/english/KNF_Data_Base_Web/3rd_Conf _S_6_7.html
33. Sangakkara UR, Weerasekera P. Impact of Effective Microorganisms on Nitrogen Utilisation in Food Crops, 2012a. http://www.infrc.or.jp/english/KNF_Data_Base_Web/ 6th_Conf_S_1_2.html
34. Shin K, Van Diepen G, Blok W, van Bruggen AH. Variability of Effective Micro-organisms (EM) in bokashi and soil and effects on soil-borne plant pathogens. Crop Prot. 2017; 99:168-176.
35. Singh DS, Chand S, Anvar M, Patra. Effect of organic and inorganic amendment on growth and nutrient accumulation by Isabgol (Plantago ovata) in sodic soil under greenhouse conditions. Journal of Medicinal and Aromatic Plant Sciences. 2003; 25:414-419.
36. Sun PF, Fang WT, Shin LY, Wei JY, Fu SF, Chou JY. Indole-3- Acetic Acid-producing yeasts in the phyllosphere of the carnivorous plant Drosera indica L. plos one. 2014; 9(12):e114196.
37. Talaat NB, Ghoniem AE, Abdelhamid MT, Shawky BT. Effective microorganisms improve growth performance, alter nutrients acquisition and induce compatible solutes accumulation in common bean (Phaseolus vulgaris L.) plants subjected to salinity stress. Plant Growth Regul. 2015; 75:281-295.

38. Towett G. What are effective Microorganisms. The Permaculture Research Institute, 2016. https;//www.permaculturenews.org/2016/01/19/ What are effective Microorganisms/
39. Umi KMS and Sariah M. Utilization of microbes for sustainable agriculture in Malaysia: current status. Bio prospecting and management of microorganisms. National Conference on Agro biodiversity conservation and sustainable utilization, 2006, 27-29.
40. Vaid SK, Kumar A, Sharma A, Srivastava PC and Shukla AK Role of some plant growth promotery bacteria on enhanced Fe uptake of wheat. Communications in Soil Science and Plant Analysis. 2017; 48(7):756-768.
41. Valarini PJ, Alvarez MCD, Gasco JM, Guerrero F, Tokeshi H. Assessment of soil properties by organic matter and EM-microorganism incorporation. Rev. Bras. Ciênc. Solo. 2003; 27:3.