COMPOST FOR GROWING PLANTS BY APPLYING EM-BIOFERTILIZER

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Municipal solid waste (MSW) management has become a critical problem for city environment. The amount of MSW increases with increase of population. A number of procedures can be adopted for healthy disposal of MSW. Composting of biodegradable part of MSW is a reliable measure for sustainable recycling of these wastes. In the present study MSW is treated with Effective Microorganisms (EM) inoculum to convert it into Bio-fertilizer. The EM inoculums were applied in different proportions in a greenhouse experiment. The bio-fertilizer thus prepared, was applied to cotton crop in pots to study its effects on different growth parameters. The application treatments included control (no fertilizer), compost (without EM), 1%, 5%, and 10% EM-bio-fertilizer. The best positive results were obtained with 5% EM bio-fertilizer application. The use of bio-fertilizer resulted in the highest number of bolls and plant height. EM-bio-fertilizer not only increased the nutritional assimilation of plant (total N, P and K), but also improved soil properties such as organic matter content and total N, P, K in soil.
Key words: EM, MSW, cotton, NPK in leaf, NPK, OM, C:N in soil

INTRODUCTION

Municipal Solid waste is the organic and inorganic waste materials produced by different sources and have lost their value in the eyes of their owner (Ghosh. 2004). It is a complex mixture of different substances (El Fadel and H. Sbayti*.,* 2000; Rushton 2003). MSW is made up of different organic and inorganic fractions like food, vegetables, paper, wood, plastics, glass, metal and other inert material (Mor, 2006). The most common types of waste treatment and final disposal are materials recycling, composting, incineration and land filling (Marchettini, 2006; Burnley, 2006). Nowadays refuse no longer is simply consider waste, but rather something that must be recovered or re-used as a potential resource (Riva and Tiezzi,1997; Dijkema *et al*., 2000; Korhonen *et al*., 2004). Efficient planning for municipal solid waste management system requires accounting for the complete set of environmental effects and costs associated with the entire life cycle of MSW (Emery, et al.,2006).For such a system to be truly effective it needs to be environmentally sustainable, economically viable and socially acceptable(Nilsson-Djerf and McDougall., 2000).

MSW can be composted to reduce the volume of waste and disease-causing organisms and to convert it in an organic-rich, soil-like product, through aerobic or anaerobic fermentation. To prevent problems of urban waste, recycling efforts should be done in an integrated fashion so that organic energy in the waste may be recycled and utilized by farmers as organic fertilizers (Wididana and Higa, 2000). EM technology has the potential to utilize MSW to convert into biofertilizer to increase organic matter in the soil (Hussain *et al.,* 2002). Most of research and demonstrations have proved that EM could enhance the growth of animals and plants, controls their diseases and raise the quality of foodstuff products and improve the soil environment (Shao *et al.,* 2001, Haq *et al., 2002;* Yadav, 2002).

EM stands for Effective Microorganisms. EM is not specific type of microorganisms. It is a mixed liquid culture solution containing lactic acid bacteria, photosynthetic and nitrogen fixing bacteria, yeast, ray fungi and molds making about 5 families, 10 genera and 80 different species (Higa and Wididana, 1991a). All of these are mutually compatible with one another and can coexist in liquid culture for extended periods (Higa, 1991). Application of EM is known to increase the microbial diversity of soil and plants, improve soil quality, and enhance growth and increase yield and quality of crops (Higa and Parr, 1994; Kishore, 2000). Wididana and Higa (1999) investigated the beneficial aspects of integrated recycling of urban organic waste with EM technology. It was found a profitable business which could be managed professionally with

150 tonnes of urban waste/day. Manure fermented with EM increased the yield of a variety of fruits, vegetables and crops, compared with other fertilizers containing equal nutrient elements (Liang *et al.*, 2000).The Effective Microorganisms (EM) solution has been found to be very effective under field conditions in Nepal. The microbial solution has the ability to breakdown organic matter, thereby producing plant nutrients and enhancing physical and chemical properties (Yadav, 2002).

Ahmed *et al.,* (1993), found that the highest percent increase in cotton yield was obtained with EM. The soil fertility improved with EM application for cotton production (Yamin, 1994). Haq (1997) studied the enhancing efficiency of farmyard manure (FYM) with EM inoculum for cotton production.

In the present study EM inoculums was applied to MSW to convert it into bio-fertilizer. The bio-fertilizer so prepared was applied to cotton to study its effects on growth and nutrient up take in leaves and soil especially N, P, K and OM.

MATERIALS AND METHODS

The investigations reported in this manuscript were carried out during 2003-04 in the Institute of Soil and Environmental Sciences University of Agriculture, Faisalabad, Pakistan, on the aspects of role of EM in the management of solid waste, determination of effect of EM on solid waste degradation and role of EM in the improvement of crop yield and soil quality. These experiments were conducted in the green house of the Institute in different plastic pots. The analytical and laboratory work was carried out in the Soil Fertility Lab. of the Institute. The characteristics of the soil used for laboratory and greenhouse studies are pH 7.69, EC_e 0.40 dS m^{-1}, OM 0. 45%, N 0.04 % P 6.68 % and K 98.44% with the Sandy Loam texture. The description of methodologies for each experiment and analytical procedures are mentioned as follows.

Procedure to make bio-fertilizer

Faisalabad is the third largest city of Pakistan with population of 3.1 millions producing 1570 tonnes of Municipal Solid Waste daily most of which is placed along road sides (Nisar *et al.*, 1998). Prior to conduct the experiments, samples of solid waste were collected from different point sources of pollution as stated below:

- Dumping station of Tehsil Municipal Administration (TMA), Faisalabad.
- Vegetable and Fruit market of the city.
- Jhang Bazar, the largest retail selling market of vegetables, fruits, juice-waste etc. of the city.

The objectives of the study were to preserve the nutrients present in the solid waste and convert them into bio-fertilizer. The raw material was mixed and divided into degradable and non-degradable portions. The biodegradable waste was air dried and ground with the help of grinder and analyzed for total amount of NPK and organic C (N 1.36, P0 40, K 1.35, OM 93.18, OC 54.04% and C:N 39.93) and inoculated/ decomposed with Effective Microorganisms (EM) to convert these wastes into bio-fertilizer The waste was taken in plastic pots and inoculated with 1%, 5% and 10% inoculums with respective control (Higa, 1991; Sena *et al*, .2002; Haq, 2006).The treatments were repeated thrice. The incubation to all the treatments was given for 15 days respectively. After the completion of incubation, the solid waste was analyzed for NPK, organic matter, organic carbon, C:N ratio and named as EM-bio-fertilizer. The application of 5% EM-inoculation was the best one and it contains 1.94% N, 0.90% P, 2.04% K, 94.86% OM, 55.01% OC and 29.82 was the C:N ratio.

Application of bio-fertilizer on the cotton crop

Cotton variety NIAB-III was cultivated in the greenhouse of Institute of Soil and Environmental Sciences University of Agriculture, Faisalabad, Pakistan. The cotton seed was taken from the Nuclear Institute for Agriculture and Biology (NIAB) Pakistan with following set of treatments:

T_1 = Control (normal soil)

T_2 = Compost (without EM) @ 120 g 10 kg^{-1} soil

T_3 = 1% EM bio-fertilizer @ 120 g 10 kg^{-1} soil

T_4 = 5% EM bio-fertilizer @ 120 g 10 kg^{-1} soil

T_5 = 10% EM bio-fertilizer @ 120 g 10 kg^{-1} soil

The experiment was conducted according to Complete Randomized Design (CRD) with four replications. At the stage of flowering, the leaf samples were collected for N, P, K analysis. At maturity, plant height (cm), number of bolls $plant^{-1}$, boll size and number of flowers were recorded. The soil samples were collected at the harvest and analyzed for NPK and OM contents in the soil.

RESULTS

Growth parameters of cotton crop

The 5% applications of EM bio-fertilizer gave better effect rather than the 1 and 10% applications (Table 1). There was significant increase in boll No. and boll size with respect to control and other treatments. There were 80% increases in No. of boll in 5% application with respect to control and there was 29% increase in boll size with respect to control.

Table 1. Growth parameters of cotton crop

Treatments	No. of Flowers	No. of bolls	Plant Height (cm)	Boll size (cm)
Control	1.78	.33	12.67	13.48
Compost	3.43	.78	21.33	16.33
1% EM Bio-fertilizer	3.33	1.33	37.0	17.02
5% EM Bio-fertilizer	4.11	1.67	42.33	17.48
10% EM Bio-fertilizer	4.0	1.44	38.0	17.20
LSD	0.943	1.075	3.151	2.624

Nutrient concentration in leaves and soil

The data regarding the nutrient concentration in cotton leaves and soil are presented in Table 2 and 3. There was significant increase in NPK contents in cotton leaf, the maximum of NPK contents were recorded, where we applied 5% EM–biofertilizer with respect to control and other treatments. Almost similar results were obtained in soil. There was significant improvement in organic matter contents in soil, where 5% EM-bio-fertilizer was applied. This gives the concept to mange MSW as bio-fertilizer and can sustain crop yield. Regarding the interaction of the N, P, K, OM contents in soil, there was +ve co-relation with the boll size and other growth parameters, as the concentration of NPK and OM increases the boll size and other growth parameters of cotton crop increases and vice versa (See Fig. 1, 2, 3, 4).

Table 2. Cotton leaf analysis

Treatments	N % in leaf	P % in leaf	K %
Control	2.89	0.2	1.49
Compost	2.53	0.17	1.85
1% EM Bio-fertilizer	2.55	0.14	1.94
5% EM Bio-fertilizer	2.94	0.31	2.32
10% EM Bio-fertilizer	2.89	0.20	2.02
LSD	0.73	0.21	0.23

Table 3. Soil analysis after cotton crop

Treatments	N %	P %	K %	OM
Control	0.03	4.023	98.7	0.33
Compost	0.04	4.490	115.2	0.35
1% EM Bio-fertilizer	0.04	5.050	135.6	0.49

5% EM Bio-fertilizer	0.05	5.233	140.1	1.62
10% EM Bio-fertilizer	0.04	5.120	137.1	0.49
LSD	0.01	0.307	5.47	0.20

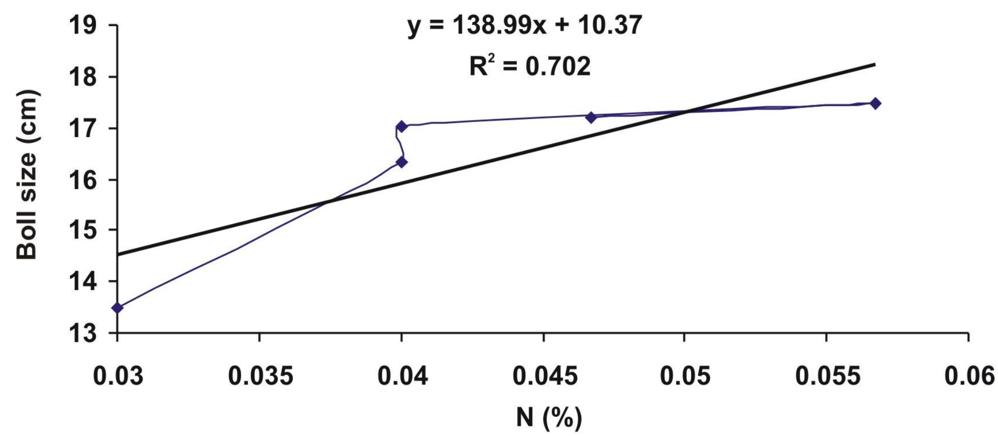

Fig. 1. The relationship of N (% in leaves) with boll size of cotton

DISCUSSION

There was maximum increase in number of flowers, number of bolls, boll size and plant height where we applied 5% EM inoculums with compost. This increase might be due to the activities of microorganisms which decompose/ferment the compost and enriched the nutrient portion of the compost, which helped to build up the growth parameters of the cotton crop (Higa and Wididana, 1991a). The effectiveness of these microorganisms was also studied by Sena *et al.* 2002; the microorganisms have the potential to decompose wastes by anaerobic decomposition which helps to maintain the C/N ratio in the waste to supply the nutrients to the crop. Bajwa and Jilani (1994) also recorded significantly higher crop growth and yield with application of EM over control.

There was maximum increase in NPK where we applied 5% EM along with compost. This increase might be due to the activities of effective micro-organisms which decompose/ferment the compost and enriched the compost with NPK nutrients which were easily available to the compost (Higa and Wididana, 1991a). Similar results were also observed by Rashid e*t al.* (1994) in his experiments under FYM+EM treatment. Such results have also been reported throughout the world by a number of scientists working on EM technology (Sharifuddin *et al.,* 1994; Sanga Kara *et al*., 1995; Hussain *et al.,* 1996; Jilani *et al*., 1996; Myint, 1996).

This experiment was aimed to see the prospects of saving some quantity of NPK fertilizers by adding low-cost EM to the crop. Cotton and soil data showed positive effect of EM application on cotton growth as well as on the availability of NPK nutrients and OM from the soil.

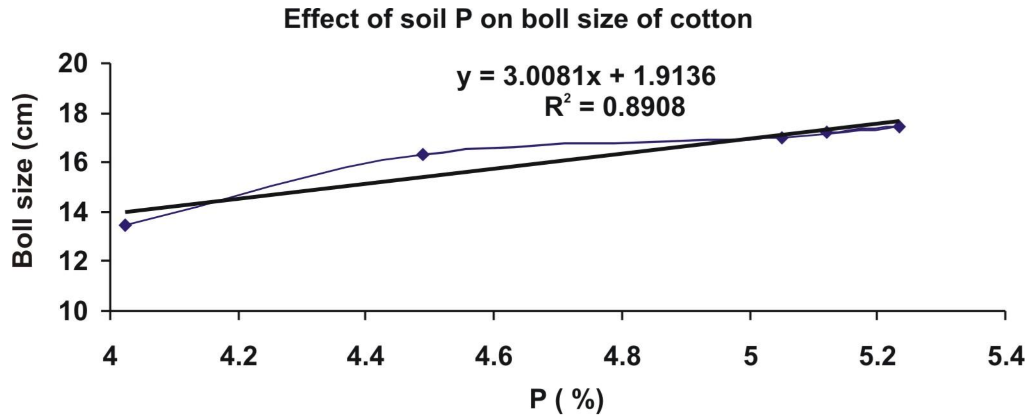

Fig. 2. The relation of P (% in leaves) with boll size of cotton

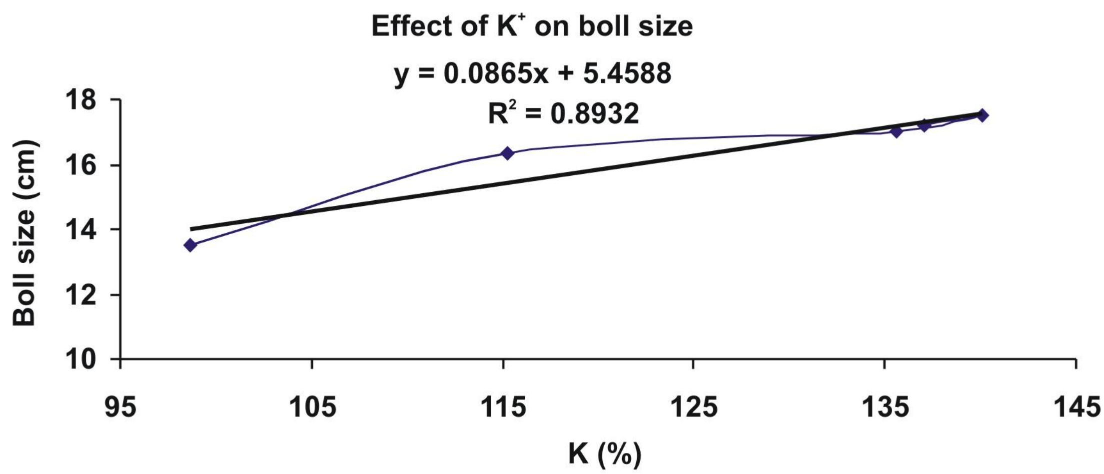

Fig. 3. The relationship of K (% in leaves) with boll size of cotton

CONCLUSION

Owing to increase in MSW with proportion of increase in population creating different types of pollution there is dire need of proper management of MSW and its utilization as a potential source of energy for the farmers. One way of MSW recycling is composting. EM-Technology can very effectively be applied to the biomass to conserve its nutrients and convert it into bio-fertilizer. This technology showed significant effects on growth parameters of cotton.5% application of EM inoculums with compost showed highest results. This technology can also be applied to other crops in fields as well reducing high cost of inorganic fertilizers to the farmers.

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