International Scientific Conference "Radiobiology: <<MAYAK>>, Chernobyl, Fukushima", held at Institute of Radiobiology of NAS of Belarus, Gomel, Republic of Belarus. 24-25 September 2015.

INFLUENCE ON THE SUPPRESSION OF TRANSFER OF RADIOACTIVE CESIUM FROM SOIL TO GRASS USING COW MANURE COMPOST AND ITS EFFLUENT FERMENTED BY EFFECTIVE MICROORGANISMS™

Shuichi Okumoto[1], Masaki Shintani[1, 2] and Teruo Higa[3]

[1)]EM Research Organization, Inc.,Okinawa, Japan, sokumoto@emro.co.jp, [2)]Tokyo Women's Medical University, Tokyo, Japan, [3)] International EM Technology Center, Meio University, Okinawa, Japan.

Abstract

Inappropriate disposal of manure may lead to environmental problems such as air and water pollution. Composting manure is an effective measure because it will produce a stable material that can be used as a source of nutrients and soil conditioner in the field. A microbial inoculant, Effective Microorganisms™ (EM) is a good tool to convert manure into a high quality compost. The effects of cow manure compost and its effluent fermented with EM on the reduction of transfer of radioactive Cs from soil to Italian ryegrass at a field trial in Fukushima, Japan was previously reported. However, it was not clear that this effect was due to EM treatment on the manure. Therefore, a planter experiment was conducted to evaluate whether the EM fermentation processing of cow manure and its effluent has an effect on the suppression of transfer of radioactive Cs from soil to grass. The experimental results showed that the application of EM fermented cow manure compost and its EM effluent enhanced the suppression of transfer of radioactive Cs from soil to grass compared with regular cow manure compost and its effluent.

Introduction

Effective Microorganisms™ (EM) is a soil improver which consists mainly of lactic acid bacteria, photosynthetic bacteria and yeast. EM was first developed to be used on agricultural fields. However, currently EM is gaining attention for its use in livestock industries, fisheries and environmental protection. One of the EM usages in livestock operations is its application as an additive to manure to convert it into a high quality compost.

In 2014, we reported that applying EM fermented cow manure compost and its compost effluent produced during the fermentation suppressed the transfer of radioactive Cs from soil to plants more than chemical fertilizer at a pasture in Fukushima, Japan[1)]. Therefore, in order to determine whether the EM fermentation process has an effect on the suppression of transfer of radioactive Cs from soil to grass, this experiment used EM cow manure compost, regular cow manure compost as well as effluent from both composts and tested them in planter boxes.

Materials and methods

For the contaminated soil (^{134}Cs+^{137}Cs: about 9,000Bq/kg), EM cow manure compost (EM compost) and regular cow manure compost (Compost) were mixed separately (40 tons/ha). Also, we prepared chemical fertilizer 14-14-14 (1,000kg/ha) mixed with contaminated soil for the Control. Inside the vinyl house, the treated soil was put into planters and Italian ryegrass was seeded. At different time, EM cow manure compost effluent (EM effluent) and regular cow manure compost effluent (Effluent) were applied on the contaminated soil separately (40 tons/ha) and grass was cultivated. The potassium content of each type of manure and effluent were measured beforehand and the content was adjusted so that the potassium content was equal for all samples. Grass was harvested after 52 days of seeding for the manure experiment and after 88 days for the effluent experiment. After measuring the fresh weight of the above-ground grass, radioactive Cs in grass was measured using a Germanium semiconductor detector. For measuring radioactive cesium in soil, NaI (TI) scintillation spectrometer was used.

Results and discussion

Grass fresh weight (g) per planter for the Control, Compost and EM compost were 100±11, 128±9 and 134±6, respectively. It was confirmed that compared with the Control, the grass growth in the Compost and the EM compost were better and the fresh weights were heavier. The sum of radioactive Cs (^{134}Cs+^{137}Cs:Bq/kg) in the grass was 88±13 in the Control, 61±6 in the Compost and 45±8 in the EM compost. The EM compost had a significant difference at the 0.01 level compared with the Control and had a significant difference at the 0.05 level even compared with the Compost (Fig.1A). Transfer factor for the Control, Compost and EM compost were 0.01035, 0.00643 and 0.00496, respectively. Compared with the Control, there was a 38% reduction in the Compost and a 52% reduction in the EM compost in the transfer factor (Fig.2B). The exchangeable potassium content (mg/100g dry soil) in the soil for the Control, Compost, EM Compost were 68±26, 72±21 and 98±4, respectively and there was no significant difference between them.

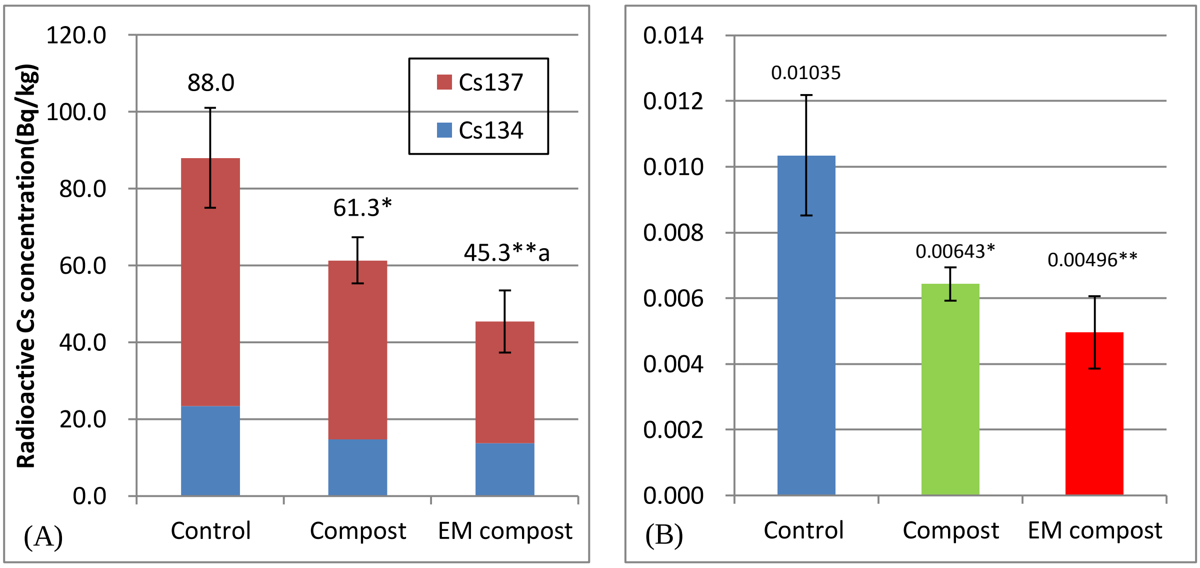

Fig.1. Effect of EM compost on radioactive Cs concentration (Bq/kg) in grass (A) and transfer factor of radioactive Cs to grass (B).

Values are expressed as mean ± SD (n=3)

*and**: significant difference at 0.05 and 0.01 level, respectively in comparison to the Control.

a: significant difference at 0.05 level in comparison to the Compost.

Grass fresh weight (g) per planter was 68±3 for the Effluent and 75±4 for the EM effluent. The EM effluent had a significant difference ($p<0.05$). The radioactive Cs level for the Effluent area was 79±19, for the EM effluent it was 54±4 and a reduction effect was recognized at $p<0.05$ (Fig.2A). The transfer factors for the Effluent and the EM effluent were 0.00683 and 0.00483, respectively. There was no significant difference ($p=0.06$) but the EM effluent showed a tendency of reduction (Fig.2B). The exchangeable potassium content (mg/100g dry soil) in the soil for the Effluent and the EM effluent were 66±6 and 63±3, respectively and had no significant difference. From these results, it was confirmed that applying EM fermented cow manure compost and EM effluent enhanced the suppression of transfer of radioactive Cs to grass compared with regular cow manure compost and effluent.

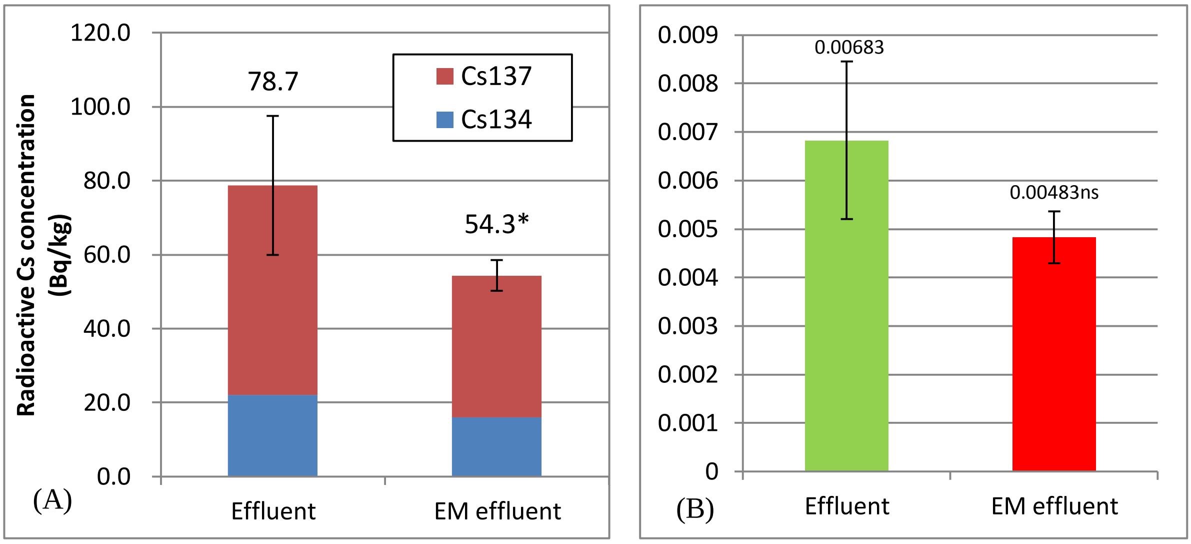

Fig.2. Effect of EM effluent on radioactive Cs concentration (Bq/kg) in grass (A) and transfer factor of radioactive Cs to grass (B).

Values are expressed as mean ± SD (n=3)

*: significant difference at 0.05 level in comparison to the Control

ns: no significant difference ($p=0.057$)

Nikitin *et al*. reported that application of EM or EM Bokashi on the soil decreases the rate at which water-soluble Cs and ion exchangeable Cs was absorbed through plant roots[2]. It would appear that the effect of suppression of transfer in this experiment was due to the same mechanism. In this planter experiment, there was no significant difference for the yield of grass between the Compost area and the EM compost area. However, based on an eleven year field experiment conducted by Hu et al, long term application of EM compost significantly promoted growth, increased yields and nutrition of wheat compared with traditional compost.[3] Therefore, continuous application of EM manure compost to pasture, will not only suppress the transfer of radioactive Cs to grass, but also likely to increase the yield and nutrition of pasture grass.

Conclusion

Application of EM fermented cow manure compost and its effluent enhance the suppression of transfer of radioactive Cs from soil to grass compared with regular cow manure compost and its effluent.

References

1) Okumoto *et al*. (2014). Application of Effective Microorganisms^{TM} (EM) technology contributes to the reconstruction of a cycle based dairy farm in Fukushima (A case study). *In*: Proceedings of the International Scientific Conference "Radiobiology: man-made radiation". Gomel, Republic of Belarus. 153p.

2) Nikitin *et al*. (2013). Effect of Microbiological factor on redistribution of ^{137}Cs by physicochemical forms. *In*: Proceedings of the International Scientific Conference “Radiation and Environment and Technosphere”. Gomel, Republic of Belarus. 113-115p.

3) Hu *et al*. (2013). Long-term effective microorganisms application promote growth and increase yields and nutrition of wheat in China. *European Journal of Agronomy*. 46, 63-67.