The Application of the Solid Waste Compost Products in Garden Plant Planting

Xiaolong Cai¹, Jinyang Tan¹, Huaji Chen¹, Mingji Huang¹ and Xinying Huang¹*

¹Guangzhou Newearth Environmental Protection Industry Co., Ltd, Guangzhou 510380, China

*Corresponding author’s e-mail: xinying1112@qq.com

Abstract. To solve the problem of solid waste pollution generated during the Ecological Rural Construction in China, the products obtained from composting were used for garden utilization on the premise of mixed compost product treatment of rotten garbage in rural areas. The results showed that the solid waste compost products had good biosafety and fertilizer efficiency in the growth of landscaping plants such as woody flowers, herbaceous flowers, turf plants and foliage plants. The experimental plants could not only survive in the soil containing compost products, but also grow well, significantly better than growing in the garden soil.

1. Introduction
With the rapid development of rural economy in China, the problem of solid waste pollution in rural areas has become prominent. Rural solid waste mainly includes domestic garbage, farmland garbage and garden garbage. At present, more than 40% of rural solid waste has not been collected or treated[1]. Untreated solid waste will cause serious problems to the environment. On the other hand, solid waste itself can be used as resources since it contains organic matter and plant growth nutrients such as nitrogen, phosphorus and potassium[2].

In view of the unbalance of water content and C/N of three kinds of garbage compost separately in traditional composting process, the decaying parts of three kinds of garbage were collected and mixed, so that the parameters of water content and C/N can be adjusted to the optimum state. After composting, compost products were reused for land, realizing the utilization of solid waste, alleviating rural environmental pollution, and maintaining the sustainable development of rural ecology.

2. Experimental materials

2.1 Compost products
4 categories of rural solid waste materials, including kitchen waste, fruit husk, garden garbage and crops, were mixed, ventilated and fermented for 28 days.

2.2 Contrastive soil
Choose one kinds of the garden soil with better sales in the market, and compare it with the compost product. The product properties of both is shown in Table 1.

| Methodology | Total nutrient /% | water content /% | Organic matter /% | EC value (ms/cm) |
|-------------|------------------|------------------|-------------------|-----------------|

Table 1 Properties of products
2.3 Planting plants
Investigating large flower markets such as Guangzhou Flower Expo Garden and Lingnan Flower Market and surrounding nurseries, Scarlet Sage, Bougainvillea, and snake plant and Bahia Grass were selected for planting experiments.

2.4 Planting shed
The area of the planting shed is about 70 m². There were two experimental areas under different sunlight condition, which can satisfy the growth of a variety of garden plants. The planting experimental shed is shown in figure.1.

![Plant cultivation experiment shed](image)

3. Methods
According to the ratio in Table 2, the composted compost product and the local garden soil were compounded into 5 different planting soils. Plants were planted separately in 6 experimental groups. To study the efficiency of the compost product, indicators such as the growth rate and turf-forming speed of grass, the plant height, crown width and flower number of woody flowers, the number of flowers and dry matter quality of sherdaceous flowers were detected.

| Group number | Compost product proportion (%) | Bulk weight (g/cm³) | pH  | EC value (ms/cm) |
|--------------|--------------------------------|---------------------|-----|-----------------|
| 1#           | 40                             | 0.78                | 6.6 | 0.31            |
| 2#           | 30                             | 0.86                | 6.7 | 0.26            |
| 3#           | 20                             | 0.99                | 6.8 | 0.22            |
| 4#           | 10                             | 1.28                | 7.0 | 0.17            |
| 5#           | 0                              | 1.33                | 7.0 | 0.12            |
| 6#           | Sold planting soil             | 0.51                | 6.5 | 0.56            |
4. Result and Analysis

4.1 Biosafety Analysis

The seed germination index (GI) is one of the important indicators for indicating the toxicity of composted phyto-products. When GI is above 50%, compost product is considered to be basically non-toxic. While GI is higher than 80%, it indicates complete decomposition[3]. High concentrations of soluble salts and high pH can damage plants or cause root system death[4]. Table 3 analyzes the biosafety indicators of compost products.

Table 3 Biosafety indicators of compost products

| Material      | EC Value mS/cm | GI Value   | pH    |
|---------------|---------------|-----------|-------|
| Compost Product | 0.48          | 83.6%     | 6.8   |

(1) GI Value
After fermentation, most harmful bacteria have been killed by high temperature aerobic fermentation. In the meantime, the organic matter has been fermented into nutritious humus. Therefore, the GI value increased, indicating that compost product has been completely decomposed and is not toxic to plant growth.

(2) EC Value
According to the standard of planting soil for landscape greening in Guangzhou, the EC value of common planting soil should be less than 0.6mS/cm. The results show that since most of the solid waste materials were derived from plants, they contain less salt ions and have less impact on plants.

(3) pH
Too much acid or alkali is not conducive to plant growth. The most suitable pH for plant growing is 6.0～7.5[5]. The Test results showed that, pH of the compost product is neutral and does not affect plant growth.

4.2 Pollutant index analysis

Fecal coliform value is an important index to judge the harmless level of compost products[6]. Heavy metals cannot be decomposed by soil microorganisms. And some may enter the food chain, seriously endangering human health [7].

The values of fecal coliform and heavy metals before and after composting were tested. The results shown that after processing, the fecal coliform value and various pollutant index was effectively reduced, the bioavailability of heavy metals and the treated organic waste pollutants were also greatly reduced. The index all reached the standard. The composting products can be used for resource utilization.

Table 4 Comparison between basic index and pollutant index
treatment

| Testing Items | before processing | after processing | Output Standard |
|---------------|-------------------|-----------------|-----------------|
| Fecal Coliform Value | $4 \times 10^{-5}$ | >11.1 | >0.01           |
| Total Cr (mg/kg)    | 216               | 151             | <1000           |
| Zn (mg/kg)          | 713               | 670             | <4000           |
| Cu (mg/kg)          | 193               | 99.5            | <1500           |
| Ni (mg/kg)          | 75.1              | 43.7            | <200            |
| Cd (mg/kg)          | 2.14              | 1.18            | <20             |
| Hg (mg/kg)          | 1.87              | 0.977           | <25             |
| As (mg/kg)          | 20.6              | 11.1            | <75             |
4.3 Planting experiment

(1) Sherbaceous flower planting

The observation of the growth of for nearly half a year showed that the addition of solid waste compost products could promote the growth of Scarlet Sage. The plant grew well in 10%-40% compost group, and 30% compost group had the best effect. Compared with the blank control group, the total number of flowers and total biomass increased by 68.5% and 45.4%, respectively, and increased by 55.7% and 37.6%, respectively, compared with a commercially grown planting soil.

The growth of the Scarlet Sage is shown in figure.2.

(2) Woody flowers planting

A one-year follow-up monitoring of Bougainvillea was conducted, and the results showed that Bougainvillea grew well in each group. The results showed that the plant grew well in each group, and the 20%-40% compost product group grew more vigorously, and the crown width and flower number increased significantly. Compared with blank control group, 30% compost group was the best, crown width and flower number increased by 21.1% and 152.2%, respectively, while compared with a commercial planting soil, they increased by 13.2% and 142.5%, respectively. The results showed that solid waste compost products had obvious promoting effect on the growth of Bougainvillea, and had certain fertilizer efficiency. The higher the proportion of compost products, the more obvious the promoting effect on the growth of Bougainvillea.

(3) Foliage plant planting

The growth of Snake Plant is shown in figure.4. The results showed that all the groups grew well. Compared with the blank control group, the plant height increased significantly. Among them, 30% compost group had the best effect. Compared with the blank control group, the plant height increased by 32.2% and 22.9% respectively. The results showed that the solid waste compost products had obvious promoting effect on the growth of Snake Plant, but the excessive proportion of compost products (>30%) had a certain inhibitory effect on the growth of Snake Plant.
The growth of Bahia grass is shown in figure 5. It can be seen from the results that each group of Bahia grass grows well, and can be formed into a flat in 28-38 days. The 40% group was the best, and the commercial garden soil group was similar to the 30% group.

5. Summary

(1) The GI, EC and pH of solid waste compost products were suitable, have no toxicity to plant growth, and have good bio-safety, which lay a foundation for the harmless and resource treatment of rural solid waste.

(2) Solid waste compost products show good fertilizer efficiency in the growth of landscaping plants such as woody flowers, herbaceous flowers, lawn plants and foliage plants. This may be due to the presence of humus substances in solid waste compost, which can improve the activity of soil Fe2+ and Zn2+, promote the secretion of cytokinin, stimulate the formation of protective effects of plant antioxidant system. Therefore, the application of compost is beneficial to plant growth[8]. However, too high a ratio of addition may have a certain inhibition on plant growth.

(3) Different from the traditional independent composting, collecting and fermenting the rotten parts of the three kinds of garbage can obtain compost products with higher humus, which can realize the harmlessness treatment, stable treatment and resource utilization of rural solid waste. Therefore, this study provides an effective way for the rural solid waste management.

Acknowledgments

This work was financially supported by Pearl River S&T Nova Program of Guangzhou (No.201710010074). We appreciate the help of the Guangzhou Municipal Science and Technology Bureau.

References

[1] Li D., Chen G.Y., Ma W.C., Duan N. (2018) Characteristics and treatment status of rural solid waste in China. China Environmental Science, 38(11): 4187-4197.

[2] Coe James M, Antonelis George Bud, Moy Kirsten. (2019) Taking control of persistent solid waste pollution. Marine pollution bulletin, 139(139): 105-110.
[3] Wang X.J., Wen W.X., Pan S.Q., Lin X.Y., Chen S.H. (2016) Influence of Conditioner proportion on aerobic composting of food waste and microbial characteristics. Chinese Journal of Environmental Engineering, 10(6): 3215-3222.

[4] Li Q., Li Y.C., Li G.X., et al. (2006) Maturity indexes and operational parameters during composting municipal solid waste. Transactions of the CSAE, 22(12): 189-194.

[5] Li J., Zhao X.L., Wei S.Q., et al. (2000) Study on the physic-chemical properties of soil-less culture substrates of pollution-free vegetable. Journal of Southwest Agricultural University, 22(2): 112-115.

[6] Song C.H., Jia X., Li M.X., et al. (2013) Comprehensive evaluation of co-composting fermentation effect of biogas residue mixed with livestock manure. Transactions of the Chinese Society of Agricultural Engineering (Transactions of the CSAE), 29(24): 227-234.

[7] Shi Y.P., Yu H.Y., Song K.F., Xu H., Ma J. (2018) Effects of composted sludge application on greenhouse gases emissions from paddy soil and heavy metals accumulation in soil and plant. Ecology and Environmental Sciences, 27(12): 2352-2359.

[8] Ouni Y, Albacete A, Cantero E, Lakhdar A, Abdelly C, Pérez-Alfocea F, Barhoumi Z (2014) Influence of municipal solid waste (MSW) compost on hormonal status and biomass partitioning in two forage species growing under saline soil conditions. Ecol Eng 64:142–150.