

Composting of substrates under controlled conditions

*Diliana Vladeva, Zdravka Petkova, Dimitar Slavov
N.Poushkarov Institute of Soil Science, 7 Shosse Bankya, Sofia 1080, Bulgaria,
E-mail: petkova17@yahoo.com*

Abstract

As a result of decrease of stock-breeding and significant limited quantity of organic fertilizers there is a need to use new organic sources. Multiple effects of organic fertilizers on soil fertility can not be replaced from mineral fertilizers. For maintenance the balance of organic matter and preserve the quality of soil it is continued the search of alternative organic fertilizers for fertilizing the soils. Organic wastes used like substrates for composting usually are heterogeneous including complicated complexes of different organic and non-organic substitutes.

Requirements for soil, human health preservation and environment limit the introducing of compost which are risky and could pollute the environment. Decomposition of organic materials depends from microbial activity. Each factor which retards or stops growth of microorganisms stops also the process of decomposition. Effective mineralization is running under the conditions of suitable aeration, moisture and the size of particles are small. There are some requirements for content of heavy metals in compost in order to preserve the soils from pollution.

Introduction

Significantly limited quantity of organic fertilizers followed from decrease in stock-breeding imposes the use of nontraditional organic sources for maintenance the balance of organic matter and preserving quality of soils. The use of different organic materials independently of their useful resource for plants requires control strategy for protection of soils, subsoil waters and environment from contamination.

Composting is a process for transformation of suitable organic materials in useful product like bio-fertilizers and soils improvements. The process of composting settles the problems with accumulation of non-decayed organic waste materials. During the composting these materials decompose into mineral nutrient substances available for plants and the pathogens are destroyed. Organic waste materials represent usually heterogenic groups involving complicated complexes from different organic and non-organic substances. Requirements for preservation of soils, human health and environment limit addition of compost, which are risky in soils.

The research has a goal to clear the influence of physical conditions during the composting for achievement the compost maturity.

Materials and Methods

Controlling the physical conditions during the composting is basic for effective development of mineralization processes under suitable aeration, humidity and temperature. Composting is dependent from the activity of microorganisms attending the process. Each factor which retards and stops the development of microorganisms retards also the process of decomposition of substrates. The materials have to be preliminary fragmented into small pieces. This provide bigger surface for faster decomposition by the microorganisms. The smaller size of substrates particles decreases also the volume. The combination of materials with high content of nitrogen and density with straw, saw-dust and other materials containing more carbon improves consistency of the substrates and the conditions for composting. It is need also to eliminate mechanical admixtures.

Aeration and humidity

Significant part of substrates using for composting are easy decomposable by microorganisms. Maintenance of determined level of oxygen content provide maximum rate of decompose. Turning the substrates supply enough oxygen to escape anaerobic conditions. Dry materials do not decompose effectively and it is a need to moisture periodically to level 50-60% from the weight of composts. This is the optimal humidity suitable for decompose escaping extra moistening.

Temperature

Optimal temperature for composting process is 40-50° C, in which decompose accelerates this way it is obtained the final product with less odours. When the level of oxygen is enough because of biologic activity the temperature increases over 60°C. The temperature is higher into the upper layers than into the medium and lower layers. The regulation is achieved by displacement of the substrates. The volume and quantity of decomposed substrates has to be established in order to reach around 70°C.

Materials unsuitable for composting

Organic materials with high content of heavy metals as well as meat product, bones, citrous peelings, shells, oils and dairy wastes are not suitable for composting. Charcoal contains high content of sulphur and iron which are toxic for plants that is why it is better to avoid. Petrol products has not to remaking and never use for composting.

Discussion

Under anaerobic conditions the final products are mainly organic acids and other organic compounds—methane, carbon dioxide which acid the substrate and stop the decomposition. This is lead to obtain toxic products with pH around 2. It is established that the short period of anaerobic conditions has weak effect on final products (Bollen&Glennie, 1961).

With disarrangement of different layers it is reached the regulation of humidity, content of air and warmth. Jeris&Regan, 1974, on the based of literature references recommend 25 to 80% humidity suitable water content of substrates for composting. They consider that the ratio air/water content depend maximum decomposition and established in their own research that 36-32% air respond to 53-65% water content.

The dependence of nitrogen mineralization from the temperature is determinate by kind of organic matter. It has to be homogenous mass. According to research of Beck (1983) the optimal temperature for the ammonification of organic matter is $\pm 50^{\circ}\text{C}$. Nitrogen nitrification starts and finish in active stage when the temperature fall under 40°C, attending with the increase of nitrates and the decrease of ammonium concentration and pH values of compost (Parades C. et all, 1994). Carbon mineralization is reached maximum between 25 and 40°C (Roper, 1985). There are no significant temperature differences between mineralization of nitrogen and carbon. The increase of temperature when the humidity is 40-50% is needed not only for mineralization of organic compounds but also to destroy pathogens, parasite microorganisms and.

There are requirements for the content of heavy metals in the compost in order to preserve the soils from the contamination.

Permissible concentrations for heavy metals in USA, Europe Union, Japan, Korea and Taiwan are indicate in table 1.

Table 1. Permissible quantity for heavy metals in compost, mg/kg (according to Chang, 2005) and Bulgarian Standard for content of heavy metals in sewage sludge used in agriculture

Country	Quantity heavy metals, mg/kg									
	Cd	Cr	Cu	Hg	Ni	Pb	Zn	As	Co	Mo
USA	2.5	1000	1000	10	200	1000	2500	-	-	10
Japan	5	-	-	2	-	-	-	50	-	-
Austria	4	150	400	4	100	500	1000	-	-	-
Belgium	5	200	500	5	100	1000	1500	-	-	-
Columbia	2.6	210	100	0.8	50	150	315	13	26	5
Italy	10	3500 (Cr ³⁺)	600	10	200	500	2500	-	-	-
Netherlands	2	200	300	2	50	200	900	25	-	-
Canada	4	50	100	0.5	60	500	500	20	25	3
Spain	40	750	1750	-	400	1200	4000	-	-	-
Switzerland	3	150	150	3	50	150	500	-	60	20
Korea	5	-	-	2	-	150	-	50	-	-
Taiwan	5	150	150	2	25	150	500	50	-	-
Bulgaria*	30	500	1500	16	300	1000	3000	30	-	-

*Standard in Bulgaria is only for sewage sludge

The highest values of Cd concentration are possible in Italy and Spain. Utmost permissible concentration for Cr, Cu, Hg, Pb, As and Zn are also the highest in USA, Espanola and Italy, whereas these concentrations in Europe countries like Austria, Belgium, Netherlands and Switzerland are significantly lower. In Japan, Korea and Taiwan the requirements for heavy metals content are reached to the standards matched for Switzerland. Bulgarian standards for heavy metals are higher than in the other countries. We consider that these standards have to be appropriate with those of European countries in order to protect soils from pollution.

According to Harada et al, 1993 the content of Cu (lower from 100 mg/kg) in sheep and birds manure is lower than that in pig manure (over 100 mg/kg), whereas the content of Zn (over 200mg/kg) is higher in pig and birds manure. Usually such high quantity of heavy metals is obtained when the nutrition of animals consist these metals.

Conclusion

Controlling of aeration, humidity and the temperature of substrates during the composting has got significant meaning for their faster decomposition and mineralization of organic compounds. The improvement of substrates consistency with high content of nitrogen and density through stirring with materials, containing more carbon facilitate the composting. Strictly observing of requirements for the compost supposes the use of substrates not containing risk for human health, soils and environment. This enforces the development of standards not only for content of nutrient substances but also for heavy metals content.

References

- Beck, T. (1983). *Die N-mineralisierung von Boden im Laborbrutversuch. Z. Pflanzenernahr. Bodenk.* 146, 243-252.
- Bollen & Glennie, (1961). *Processing wood wastes increase crop yields. Comp. Sci.*, 2. 3:38-44.
- Chang-Shing, Yang, (2005). *Management of composting. Food & Fertilizer Technology Center. An international information center for farmers in the Asia Pasific Region.*
- Harada, Y., K. Haga, T. Osada and M. Koshino (1993). *Quality of Compost Produced from Animal Wastes. JARQ* 26, 238-246.

- Jeris, J.S. and W. Regan, (1973). Controlling environmental parameters for optimum composting. II Moisture, free air, space and recycle. Comp.Sci.14, 2: 8-15.*
- Paredes, C., M.P. Bernal, J. Cegara, A. J. Roig and A. F. Navarro (1994). Nitrogen Transformations during Composting of Organic Wastes. Proceeding of 8th Nitrogen Workshop, Gent, Belgium.*
- Roper, M.M. (1985). Straw Decomposition and Nitrogenase Activity (C₂H₂ reduction): effects of Soil Moisture and Temperature. Soil Biol. Biochem., 17, 65-71.*