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生物炭和腐植酸类对猪粪堆肥重金属的钝化效果

Passivating effect of biochar and humic acid materials on heavy metals during composting of pig manure

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中文摘要:

为深入了解农业固体废弃物资源化、无害化利用的发展前景，探讨不同钝化材料对畜禽粪便堆肥过程中重金属钝化效果的影响规律，该文利用猪粪和秸秆进行高温好氧堆肥，研究生物炭（木屑炭、玉米秸秆炭、花生壳炭）和腐植酸（福建（fujian，FJ）生物腐植酸、嘉博文（jiabowen，JBW）生物腐植酸、草炭）等不同钝化材料对猪粪堆肥发酵效果及重金属Cu、Pb、Zn、Cd形态的影响。试验结果表明：添加花生壳炭、玉米秸秆炭、JBW腐植酸以及木屑炭分别对重金属Cu、Pb、Zn和Cd表现为相对较好的钝化能力。添加花生壳炭（F3）对重金属Cu的钝化效果为65.79%；添加玉米秸秆炭处理（F2）对重金属Pb的钝化效果为57.2%；添加JBW生物腐植酸处理（F5）对重金属Zn的钝化效果为64.94%；添加木屑炭处理（F1）对Cd的钝化效果为94.67%；并且，针对不同重金属的钝化效果，此4个处理均明显高于不添加钝化材料的对照处理（P＜0.05）。添加花生壳炭虽然对重金属Cu具有较好的钝化效果，但其堆肥物料的最高发酵温度仅为45.14° C、pH值为5.41、电导率为9.48 mS/cm、种子发芽率指数为0.47%，无法达到堆肥无害化标准。基于以上试验结果，综合考虑堆肥发酵效果及重金属钝化效果认为，木屑炭、JBW生物腐植酸是2种较理想的钝化材料，该研究结果为畜禽粪便堆肥过程中重金属钝化技术研发、生物炭和腐植酸改良土壤结构的特性推广及有机肥规模化应用提供参考。

英文摘要:

Abstract: With the rapid development of animal husbandry in China, proportion of large-scale farms is increasing. At the same time, animal manure has largely produced. The soil heavy metal pollution caused by use of manure as organic fertilizer, has seriously affected the quality of the soil and agricultural products. Some of the passivation materials can play a role to immobilize heavy metals. But, issues on use of the passivation material exist, those such as relatively high cost, difficult to obtain, low passivation rate. To better use animal manure as a resource and reduce its environmental impact, and to explore different passivation materials on the influence of passivation effect of heavy metals during manure composting process, a series of composting tests were conducted to study the effect of passivating agents including biochar (wood biochar, corn stalks charcoal, peanut shell biochar) and humic acid (FJ biological humic acid, JBW biological humic acid, peat) on the status of heavy metals through composting. Seven manure mixtures (including a blank) were composted over a 30-day period in an aerobic composting tank using the same source of pig manure but with different bulking agents. Parameters monitored over this period included temperature, pH, electric conductivity (EC) and germination index (GI) to evaluation the compost maturity. The content of heavy metals in various forms before and after the composting was also determined. The results showed that peanut shell biochar (F3), corn stalks charcoal (F2), JBW biological humic acid (F5) and wood biochar (F1) were the best passivation for Cu, Pb, Zn and Cd, respectively when exchangeable heavy metals were used as an indicator. The passivation effect on exchangeable heavy metals (Cu, Pb, Zn and Cd) as compared with the control was reduced 65.79%, 57.2%, 64.94%, 94.67%, respectively. The effect of these four passivation treatments on exchangeable heavy metals was significantly better than the control treatment ($p<0.05$). On the other hand, the treatment of peanut shell biochar as a passivation material (F3) did not reach the standard of compost maturity. The value of highest temperature in the compost file of peanut shell biochar treatment (F3) was 45.14° C, and at the end of the composting, the value of pH was 5.41, EC was 9.48 mS/cm, GI was 0.47%. The low germination index indicated that immature compost may contain phytotoxic materials preventing seed from germination. In this experiment, JBW biological humic acid treatment (F5) not only showed better passivation effect on Zn, but also exhibited good passivation effect on Cu、Pb、Cd (47.78%, 47.54%, 87.36%, respectively). In all, taking into account of the effects of compost maturity, compost quality, and different heavy metals, wood biochar, corn stalks charcoal, and JBW biological humic acid can be used as heavy metal passivation material for pig manure composting. The use of these passivation materials created conditions for use of the manure as a resource. This will help to reduce the environmental risks of heavy metal pollution when using the manure as a source of organic fertilizer.

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