



Research Article

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Dairy manure biochar inhibition of soil nitrogen leaching study

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ABSTRACT

To explore the inhibitory effects of the biochar made by dairy manure as raw material against soil nitrogen fertilizer leaching, this paper characterizes and analyzes the structure and elements of dairy manure biochar, and carries out manual simulations of soil column experiments on soil leaching, based on which we study the impacts of dairy manure biochar on 1) the pH value of soil leachate, and 2) overall cumulative loss amount and concentration of NH_4^+ , NO_3^- , and total nitrogen. The results show that compared to dairy manure, dairy manure biochar possesses more developed tubular hole structures, and has 200% and 10% more K and Ca substances, respectively. Concentration of NH_4^+ and NO_3^- were gradually reduced with the addition of dairy manure biochar at 0%, 1%, 2%, 3%, 4% and 5%, respectively. The leaching time of NO_3^- on soil was delayed with the addition of biochar. When the addition of dairy manure biochar is 4~5%, the inhibitory effects of dairy manure biochar on soil nitrogen fertilizer leaching were most effective; compared to the addition 0% of dairy manure biochar, overall cumulative loss amount of NH_4^+ , NO_3^- , and total nitrogen are reduced by about 16%, 32% and 32%, respectively.

Key words: dairy manure biochar, leaching, ammonium nitrogen, nitrate nitrogen, total nitrogen

INTRODUCTION

At present, the using amount of nitrogen fertilizer in our country is the highest in the world, but as a result of nitrogen volatile, easy to leaching, and unreasonable use of nitrogen fertilizer in our country, to make our country of nitrogen utilization rate is much lower than other developed countries in the world. Therefore we must improve the utilization rate of nitrogen fertilizer, reducing soil nitrogen loss has important practical significance on our country social economy development and ecological environment protection^[1].

Because leaching is one of the most serious loss of soil nitrogen, so that in the study of improving the utilization ratio of nitrogenous fertilizer, reducing the loss of soil nitrogen, the study on inhibition of soil nitrogen leaching has become one of the hotspot of the researches^[2]. In inhibition of soil nitrogen leaching study, biochar, as a kind of new functional materials with inhibit soil nitrogen leaching, and no secondary pollution, lower cost and has the advantages of improving soil at the same time, has attracted much attention in recent years.

This article treats the dairy manure as raw material preparation of biochar and its inhibitory effect of nitrogen leaching experiment research, in order to provide scientific basic data to dairy manure biochar application in agricultural production, it is also for our country to improve nitrogen use efficiency, solving the problem of nitrogen use about providing technical support to the environmental pollution problem. At the same time in order to solve the difficulties in dairy manure to use cow breeding production process with dairy manure resource utilization way and extension.

EXPERIMENTAL SECTION

Materials

(1) Dairy manure biochar preparation: In this experiment, dairy manure biochar is made by oxygen pyrolysis prepared in the laboratory. Fresh dairy manure comes from a cattle farms in Shenyan liaozhong, natural dried dairy manure, after smashing in pyrolysis in a muffle furnace temperature control device, a certain temperature pyrolysis 2-3 h, cools in room temperature after grinding, 60 mesh, sets aside. The biochar EDS elements are shown in table 1.

(2) The experiment of soil: From field dry field soil in Shenyan, soil samples to dry naturally, over 40 mesh saved for later use.

Soil column leaching experiment

(1) Using artificial soil column simulation method for soil nitrogen leaching experiment. Simulated soil column at the bottom area of 30 cm², height of 20 cm cylinder of PVC pipe, tube covered by three layer at the bottom of the filter paper and a sterile cotton layer, the cylindrical tube at the bottom of the sealed tightly with sterile gauze.

(2) The dairy manure biochar and the experiment soil, according to dry weight ratio 0%, 1%, 2%, 3%, 4%, 5% fully mixed, load a soil column. Make its density and tilling the soil, about 1g·cm⁻³ or so. In soil column top evenly mixed with 0.5 g of chemically pure urea, applying the content of cultivated soil nitrogen, 260kg·hm⁻¹ and nitrogen fertilization levels roughly the field in Shenyan area.

(3) Simulated rainfall, slowly adding water, make water even through the soil infiltration. Soil column is installed three days before, and add 30-50 ml of water a day, keeping the soil moist state. On the 10th day, each soil column according to the Shenyan area several times the average annual rainfall in 150 ml of water, then to 10 days (d) a cycle of leaching experiment, the experiment for 70 d, a total 7 group of leaching filtrate leaching experiment. Each cycle of the leaching solution of NH₄⁺, NO₃⁻ and total nitrogen determination of relevant data.

RESULTS AND DISCUSSION

Dairy manure biochar elements content analysis

Biochar material inhibition of soil nitrogen leaching and its itself is closely related to the structure and elements, therefore the experiment on the cow muck biochar EDS elements analysis, and compares with dairy manure itself.

Table.1 EDS elemental composition analysis table

Item	C	O	N	K	Ca	Fe	Others
Dairy manure(%)	47.32	19.49	2.59	3.42	5.1	2.08	20
Dairy manure biochar(%)	40.66	26.98	1.27	10.71	5.66	1.52	13.2

Seen from the table 1, through the dairy manure biochar and comparison of several kinds of main elements of dairy manure, dairy manure biochar in alkaline substances such as K, Ca and other content than dairy manure increased by about 200% and 200% respectively. Studies have shown that the pH of the soil for nitrogen leaching is a very important factors, the greater the soil pH is, the better of inhibition effect of nitrogen leaching is. The increase of alkaline substances in dairy manure biochar, is a major factor to restrain nitrogen leaching.

Dairy manure biochar on NH₄⁺ and NO₃⁻ leaching

Table. 2 NH₄⁺ and NO₃⁻ leaching block rate

Treatments	0%	1%	2%	3%	4%	5%
NH ₄ ⁺ leaching inhibition rate (%)	0	3.95	5.3	10.9	16.37	18.29
NO ₃ ⁻ leaching inhibition rate (%)	0	13.19	20.02	25.01	28.79	31.53

In continuous leaching process, when the dairy manure biochar content are respectively 0%, 1%, 2%, 3%, 4% and 5%, drench filtrate of NH₄⁺ and NO₃⁻ accumulation in leaching amount is reduced, the last almost stable. Seen from table 2, dairy manure biochar soil is 5% compared with the control (0%), NH₄⁺ and NO₃⁻ in the soil total cumulative

leaching stop rate are 18.29% and 31.53% respectively. Visible dairy manure biochar is adding proportion of 5% of soil NH_4^+ and NO_3^- leaching of inhibition effect is best. And dairy manure biochar addition, drench filtrate NH_4^+ and nitrate accumulation in the leaching amount compared with reference values (0%) has certain inhibitory effect. This is likely to be on the one hand, dairy manure biochar surfaces contain rich $-\text{COOH}$, $-\text{COH}$ and $-\text{OH}$ oxygen-containing functional groups^[4], such as soil of NH_4^+ and NO_3^- adsorption capacity increased. On the other hand, dairy manure biochar contains more alkaline substance, which increases the soil pH value, the pH of soil can inhibit the nitrification reaction. Moreover dairy manure biochar contains some special material which can inhibit the nitrifying bacteria in the soil the ammonium NO_3^- transformation, thus slow down the process of NO_3^- leaching in the soil^[5].

Dairy manure biochar soil drench filtrate the influence of total nitrogen leaching

Table 3. Percentage of NO_3^- and NH_4^+ leaching accounting

Treatments	Total leaching amount/mg	NO_3^-		NH_4^+	
		Cumulative leaching amount/mg	Percentage accounting for total nitrogen leaching/%	Cumulative leaching amount/mg	Percentage accounting for total nitrogen leaching/%
0%	308.02	243.22	78.96	1.755	0.57
1%	263.19	205.23	77.98	1.711	0.65
2%	231.94	194.52	83.87	1.647	0.71
3%	225.81	182.40	80.77	1.521	0.67
4%	216.92	173.20	79.85	1.625	0.75
5%	211.18	166.54	78.86	1.478	0.70

From table 3 as can see, with the increase of proportion of dairy manure biochar in soil, soil drench filtrate total nitrogen accumulation amount decreases. Dairy manure biochar soil are 4% and 5%, the difference of the amount of total nitrogen accumulation drench filtrate was not obvious, compared with the control (0%), is about 32%. Biochar in upland soil, therefore, seems to be more than 4% to reach the best inhibiting effect of total nitrogen leaching. The dairy manure biochar soil drench filtrate the influence of NO_3^- leaching of consistent results. We can see from table 2, the ration of it rate leaching amount in total amount of nitrogen leaching is 76%~86%, and the proportion of ammonium nitrogen, accounts for only 0.5% ~ 8%. NO_3^- is the most active in the process of soil nitrogen transformation, migration of nitrogen form, as well as the most main form of nitrogen leaching^[6]. Nitrate leaching is the most important factors of controlling soil nitrogen leaching. So adding dairy manure biochar, compared with the blank, to pour in the filtrate of total nitrogen and nitrate leaching amount decreases by 32%, dairy manure biochar on soil nitrogen leaching inhibitory effect is obvious.

CONCLUSION

(1) Dairy manure biochar than dairy manure has more developed tubular hole structure, K, Ca, alkaline substance content increased by 200% and 10%.

(2) By biochar added proportion is 0%, 1%, 2%, 1%, 4% and 5%, drench filtrate NH_4^+ and nitrate concentration decreases gradually. Add biochar, reduced the soil drench filtrate NH_4^+ , NO_3^- and total nitrogen accumulation amount of leaching, when soil Dairy manure biochar is 4 ~ 5%, compared with the control (0%), drench filtrate of NH_4^+ , NO_3^- and total nitrogen accumulation leaching amount decreased by 18.29%, 31.53% and 31.53%, the soil NH_4^+ , NO_3^- and total nitrogen leaching best inhibition effect.

(3) Nitrate is soil nitrogen transformation, the main form in the process of migration. To control nitrate leaching is the most important factors controlling soil nitrogen leaching. Dairy manure biochar addition of NO_3^- leaching time had a delay effect.

REFERENCES

- [1] Prendergast-Miller MT, Duvall M, Sohi SP. *Soil Biology and Biochemistry*, **2011**, 43: 2243 - 2246.
- [2] Cao X D, Harris W. *Bioresource Technol*, **2010**, 101(14): 5222-5228.
- [3] Lehmann J, da Silva J P, Steiner C, et al. *Plant and Soil*, **2003**, 249(2): 343 - 357.
- [4] Ying Ding, Yu-Xue Liu, Wei-Xiang Wu, et al. *Water Air Soil Pollute*, **2010**, 213(4): 47-55.
- [5] Sarah AD, Miguel LC, Keshav CD, et al. *International Journal of Environmental Research and Public Health*, **2011**, 8: 1491-1502.
- [6] Taghizadeh-Toosi A, Clough TJ, Sherlock RR, et al. *Plant and Soil*, **2012**, 350: 57-69.