Korean J. Soil Sci. & Fert.(2000)
Vol. 33(2) : 109~113

Chemical Properties of Slow-Released Nitrogen Fertilizer Using Waste Paper Slurry

Bok-Jin Kim*, Jun-Ho Back* and Byung-Guen Lee*

ABSTRACT

The purpose of this study was conducted to develop the slow-released N fertilizer(SRNF) using of waste paper cellulose. Properties of trial product was investigated. Contents of nitrogen, phosphorus, and potassium in trial product were showed 26%, 0.04% and 0.01%, respectively. The contents of Cr, Cu, Pb and Zn were showed 17.4ppm, 259ppm, 12.2ppm and 60.0ppm in the trial product, respectively.However, As and Cd was not detected. Nitrogen of SRNF could be released 60.4% within 12hr after dissolution in water. However, the releasing velocity was thereafter remarkably delayed, showing 75% after dissolution for 72hr.

Key words : Slow-released N fertilizer(SRNF), Dissolution rate, Chromium, Copper, Lead, Zinc, Arsenic, Cadmium.

Introduction

Various attempts were carried out to develop slow-released nitrogen fertilizer(SRNF) for the last half a century. In Korea, first study on the development of SRNF was not conducted by Seong et. al.(1986) until 1970. They had reported that two sulfur coated urea(SCU) fertilizer had exhibit an about 20% fertilizer reduction effect. They had also suggested that the grain yield of rice was not affected by the use of two SCUs. However, the industrial production and the practical application were limited by technical problems. Thereafter, latex coated urea(LCU) fertilizers were developed but also not supplied for farmers because of the lack of uniformity and the expensive price(Kim, 1974; Shin, 1988)

Ureas and other urea form fertilizers as SRNF also had been applied to turf grasses, garden trees and upland crops. Albeit these forms are relatively inexpensive, they have a disadvantage in the quality regulation and the application to paddy field(Seong, et. al. 1990). On the other hand, it was reported that paper waste sludge like as news papers, magazines and packing boxes was produced over one million ton. Wood industrial factories have reused them as raw material for the production of fiberboard. Chang et. al.(1992) have studied on the utilization of ripening sludge fertilizers mixed with sawdust, hog manure and urea to recycle the paper waste slurry containing over 60% organic matters. Allan(1991) and Bailey et. al.(1994) have also tried to improve the utility through an infiltration technique of organic matter and synthetic resin into fibrous cell wall. In

* College of Natural Resources, Yeungnam University, Kyongsan, Korea
※ This study was financially supported by Korean Ministry of Agriculture and Forestry (Agricultural Research and Development Promotion Center).

this study, we report that urea could be incorporated into waste paper fibers and thereafter slowly released to soils and degraded to be optimal condition to uptake for crops. Furthermore, we have improved a SRNF using waste paper slurry.

Materials and Methods.

Fig.1 shows the production process of SRNF. Briefly, wasted papers were mixed to obtain pure pulp slurry in 1~2% alum($Al_2SO_4 \cdot 18H_2O$) solution at 30 to 40℃ using a defibrator. After fiberboards were produced from print ink-removed pulp slurry in 12in×12in deckle box, they were dried at 100±5℃ in a dry oven. Urea saturated solution was fully impregnated to fiberboards and then dried at 75±5℃ in a dry oven. The resulted fertilizer materials were finally manufactured under 100psi at 50℃ through a thermal press and then uniformally sliced. Total N-contents of finally made fertilizers were measured by Kjeldahl method and the contents of other ions like as P, K, Ca, Mg, As, Cd, Cr, Cu, Pb and Zn were done by fertilizer analyzing method in National Institute of Agricultural Science and Technology(1996) using ICP(Varian IBERTY-Series Ⅱ, Australia).

The water dissoluting N was collected in a 500㎖ plastic cylinder in which 10g SRNF were put and mixed 300㎖ with distilled water. The water was sampled 0, 5, 6, 12, 24 and 72hr after reservation at 30℃ in water bath. After filtration, the N-contents were measured by Kjeldahl method. The surface ultrastructures of waste paper and urea were observed by 500 to 4,000 fold magnitude using scanning electron microscope(Hitachi S-4100).

Results and Discussions

1. Chemical components and structure of SRNF

The contents of chemical components were shown in table1. The contents of N, P and K were respectively 26%, 0.04% and 0.01%. Toxic metals like as Cr, Cu, Pb and Zn were detected but the contents were considerably lower than the standards of Korean Fertilizer Regulation. As and Cd were not contained. The structures of urea fertilizer and SRNF in this work were shown in photo1. Urea fertilizers were small round forms in which nitrogen were included 46%. SRNF were flat forms of which magnitude 0.5×0.5×0.2㎝ on the basis of length×width×thick. N-content of SRNF was 26%.

2. Ultrastructure of waste paper fiber and SRNF

The ultra structure of waste paper fiber and urea impregnated SRNF observed 500× and 4,000× under

Fig. 1. Schematic repregentation of process of trial product

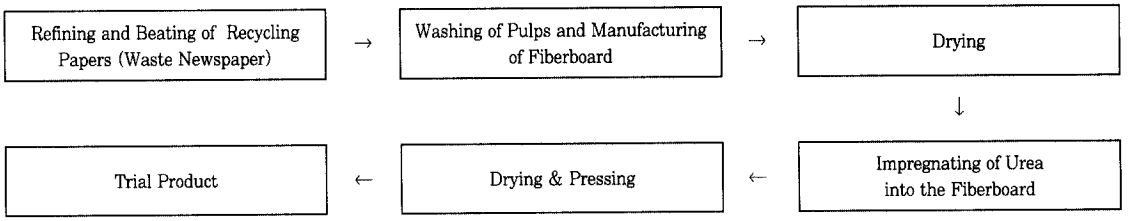
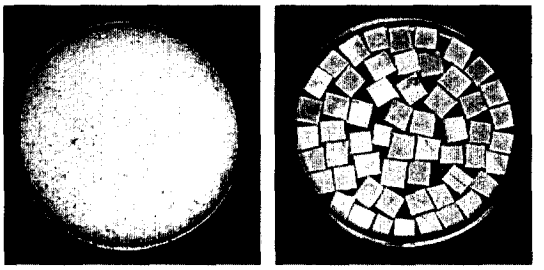


Table 1. Chemical properties of slow-released N fertilizer using waste paper(SRNF)

N	P	K	Ca	Mg	As	Cd	Cr	Cu	Pb	Zn
%					mg kg^{-1}					
26	0.04	0.01	0.55	0.16	ND	ND	17.4	259.0	12.2	60.0



Urea(46% : N) SRF(26% : N)

Photo. 1. Urea and slow-released N fertilizer using waste paper(SRNF).

SEM(Photo2). Vacant spaces was located within the inner side of waste paper fiber whereas the urea depositions were clearly observed in inner side of SRNF resulted from the binding of urea to polar -OH group of fibrous cellulose. Allan(1991) and Bailey et.al(1994) had developed a impregnation technique through which fertilizing materials were filled into the capillary spaces derived of the degradation of lignin and hemicellulose consisting pulp.

3. Underwater dissolution of SRNF

Fig.2 shows the change in dissolution rate of SRNF from which a releasing velocity could be determined. Our results indicated that N of SRNF could be released 60.4% within 12hr after dissolution in water. However, the releasing

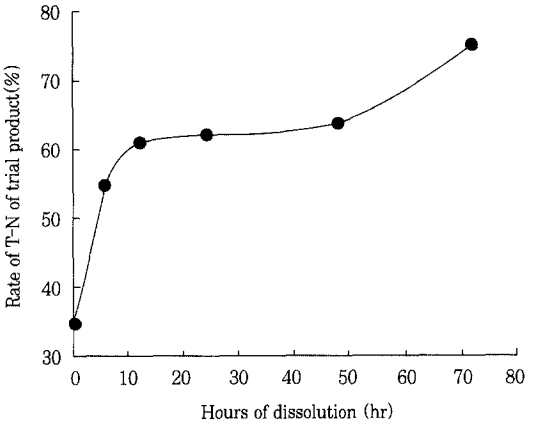
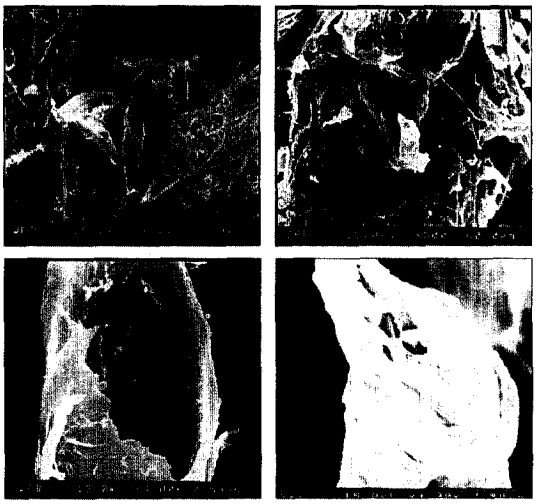


Fig. 2. Change in dissolution rate of total nitrogen(T-N) in the slow-released N fertilizer using waste paper(SRNF)



Waste fiber board(WFB) WFB impregnated with urea

Photo. 2. Structure of slow-released N fertilizer taken by a scanning electron microscope(SEM).
(upper: ×500, down: ×4,000)

velocity was thereafter remarkably delayed, showing 62%, 64% and 75% after 24, 48 and 72hr dissolution, respectively. According "Korean Standards for Fertilizer Regulation", the underwater dissolution rate ought to be lower than 25% at 30℃ for 24hr. Thus, the dissolution rate of SRNF 62%, was slightly higher than standard for Korean Fertilizer Regulation.

References

Allan, G. G. 1991. New technologies based on the microporosity of cellulosic pulp fibers. Tappi J. 45(9):986.

Allan, G. G. and P. Ritzenthaler. 1992. The microporosity of pulp : The prpperties of paper made from pulp fibers internally filled with Calcium Carbonate. Tappi J. 75(3):239.

Bailey, G. M., M. Dana and R. Lefroy. 1994. Micropore structure of pulp cellulose fiber for filling of inorganic fillers. Tappi J. 77:211-219.

Blanck, E. and F. Giesecke. 1923. Z. Pflanzenernahr. D ng. Bodenk. 2:393-420.

Chang, K. W., S. D. Kim, W. Y. Choi, and K. S. Lee. 1992. Agricultural utilization of paper mill sludge manure compost. Ⅱ. Effects on the growth of carrot(Daucus carota

L.). J. Kor. Soc. Soil Fert. 25:155-159.

Dahnke, W. C., O. J. Attoe, L. E. Engelbert, and M. D. Groskopp. 1963. Controlling release of fertilizer constituents by means of coatings

capsules. Agron. J. 55:242-244.

Jeong, I. K, C. S. Lee and D. K. Lim. 1994. Aspects of development of chemical fertilizers. Symposium of policy for the development of chemical fertilizer in 21 century. J. Kor. Soc. Soil Fert. 27:22-49.

Kim, B. J. 1974. Studies on the production of slow-released fertilizer and fertilization effect in rice. Master thesis. Seoul National University.

Lunt, O. R. 1971. Controlled-release fertilizer. Achievements and potential. J. Arg. Food Chem. 19:797-800.

NIAST. 1996. Inspection and sampling methods of fertilizers. RDA Publishment, Suwon, Korea.

Seong, K. S, J. S. Shin and Y. D. Park. 1986. Study on the development of Si- and K-fertilizers. Agricultural Tech. Institute Report. pp13-16.

Seong, K. S., B. J. Kim, and J. S. Shin. 1990. Development of slow-release compound fertilizer used urea-resin for upland crop. J. Kor. Soc. Soil Fert. 23:193-198.

Shin, J. S. 1988. Fertilizer technology and use. J. Kor. Soc. Soil Fert. 21:119-125.

Vincent, S. 1970. Urea form fertilizer. Chemistry and technology of fertilizers. pp 48-54.

韓土肥誌(2000)
Vol. 33(2) : 109~113

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폐지섬유를 이용한 완효성 요소비료의 특성

김복진* · 백준호* · 이병근*

폐지섬유 내로 요소를 침적시켜 폐지섬유 내에 침투된 요소성분이 토양 중에서 서서히 용출됨으로써 작물의 요구에 알맞게 양분을 서서히 공급함과 동시에 이들 폐지섬유도 분해되도록 개발된 완효성 요소비료(시제품)의 화학적 특성, 미세구조 및 수중 질소용출량을 조사한 바 얻어진 결과를 요약하면 시제품의 화학적 조성은 질소가 26%, 인산, 가리는 각각 0.04, 0.01%였으며, 함유된 유해성분들 중에 크롬, 구리 납 등은 검출되었지만 비료공정규격 이하였으며, 비소와 카드뮴은 검출되지 않았다. 폐지섬유와 시제품의 구조를 주사전자현미경(SEM)으로 확대해 보면 폐지섬유의 내부에는 빈 공간이 보이지만, 시제품에서는 폐지섬유의 셀룰로오스성 -OH기에 극성의 요소성분이 달라붙어 있었으며, 세포벽에 요소가 침적된 모습이 보인다. 시제품의 수중 질소용출량은 12시간까지는 60.4%로 급격하게 용출량이 많았으나, 그 후 서서히 용출되어 72시간에 75%까지 용출되었다.

Key words : Slow-released N fertilizer(SRNF), Dissolution rate, Chromium, Copper, Lead, Zinc, Arsenic, Cadmium.

* 영남대학교 자연자원대학(College of Natural Resourses, Yeungnam University, Kyongsan, 712-749)
※ 본 연구는 1996년 농림부 농림기술관리센타 연구비 지원에 의해 수행되었음.