Nitrogen Budgets on a Pasture under Combined Utilization of Grazing and Cutting

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Abstract

Nitrogen budgets on a pasture being utilized for both grazing and cutting were investigated. A pasture containing tallfescue, orchard grass and white clover was divided into two areas: initially grazed (IA, 0.41ha) and grazed after cutting for hay (BA, 0.49ha). A herd of 4-5 cattle (heifers or steers of Japanese Black or Holstein) grazed at IA from 22 Apr. to 2 Jul. and grazed at both IA and BA from 3 Jul. to 21 Oct. 1999. The amount of N grazed from IA was 3 times higher than the sum of N of grazed herbage and harvested hay from BA. The amount of N inflow to soil as fertilizer or animal excreta seemed to relate to the difference in herbage production between IA and BA. The value of N surplus for the whole pasture was very similar to the value of the difference between inflow to soil and the sum of grazed herbage and harvested hay. N surplus in the pasture seemed to relate closely to soil N balance.

Keywords: combined system, cutting, grazing, soil, nitrogen budget

Introduction

It has been reported that intensive animal production systems based on high nutrient input have the possibility of high nutrient emission through NH_3 volatilization or NO_3^- leaching (Aarts *et al*., 1992). To solve this problem, the relationships among nutrient input, animal production and nutrient emission should be clarified; and with more efficient nutrient management, systems producing sufficiently should be constructed.

A grazed pasture is considered to be an efficient nutrient management system because of the direct return of nutrients through animal excreta. In Japan, especially in mountainous areas, utilization of land as grazed pasture is coming to have a better reputation. High animal performances in pastures used as combined systems of grazing and cutting are reported (Illius *et al*., 1987; Kobayasi *et al*. 1989). The aim of the present study is to clarify the nitrogen budget within grasslands used for such a combined system.

Materials and Methods

The pasture where we conducted the present investigation is located at the Farm of Tokyo University of Agric. & Tech. in a mountainous area of Tukui, Kanagawa. A gently sloping pasture containing tallfescue, orchard grass and white clover was established in the autumn of 1996. A pasture was divided into two areas: an Initial area (IA, 0.41 ha) and a Buffer area (BA, 0.49 ha). From 22 Apr. to 2 July 1999, a herd of cattle grazed only at IA, and from 3 July to 21 Oct., the herd grazed at both IA and BA. Herbage of BA was cut 28 May and harvested as hay. Chemical fertilizer of ammonium sulfate was top dressed at the rate of 69 kgN/ha only on BA on 3 Jun. The herd consisted of 4-5 heads of Japanese Black or Holstein heifers or steers. Body weight at 22 Apr. was in the range of 166-232 kg/head. Concentrated feed (0-1.5 kg/head/day) and alfalfa hay cube (1 kg/head/day) were fed to each cattle as supplements.

The investigation of the amount of herbage mass 5 cm above ground by cutting method and the measurement of cattle body weight was conducted every 2 or 3 weeks. Consumed herbage by grazing cattle was estimated by the equation of Linehan *et al*. (1947). The total nitrogen content in pasture plants and harvested hay was analyzed using an NC analyzer (Sumitomo Chemical SUMIGRAPH NC-80AUTO) by a dry combustion method. On the basis of these investigations, the amounts of nitrogen consumed, digested, excreted and retained by grazing cattle were calculated using the methods or values of the Japanese Feeding Standard for Beef Cattle (1995).

Results and Discussion

Herbage consumption by the cattle changed in the range of 81.2-168.5 kgDM/ha/day on IA during 22 Apr-2 Jul., and in the range of 10.9-135.9 and 1.0-80.5 kgDM/ha/day during 3 Jul.-21 Oct. on IA and BA, respectively. Except for the period during 3-15 Jul., more herbage at IA was consumed than at BA. The average daily gain of the cattle changed in the range of 0.39-0.80 kg/head/day seasonally. The average daily gain throughout the period of the investigation was 0.58 kg/head/day. The yield of harvested hay was 5465 kgDM/ha. The N mass of pasture plants 5 cm above ground was in the range of 25.3-45.6 kgN/ha at IA and 21.3-34.4 kgN/ha at BA. At the time when BA became available to cattle, N mass at BA was more than that at IA. However, after the middle of July, N mass at IA continued to be more than that at BA. The proportion of white clover in total herbage on a dry weight basis was in the range of 3.4-13.4% at IA and less than 0.3% at BA.The N mass of pasture plants 5 cm above ground was in the range of 25.3-45.6 kgN/ha at IA and 21.3-34.4 kgN/ha at BA. At the time when BA became available to cattle, N mass at BA was more than that at IA. However, after the middle of July, N mass at IA continued to be more than that at BA. The proportion of white clover in total herbage on a dry weight basis was in the range of 3.4-13.4% at IA and

less than 0.3% at BA.Table 1 shows the nitrogen budgets of IA, BA and the whole pasture bases. During both 22 Apr.-2 Jul. and 3 Jul-21 Oct., the N amount of herbage grazed from IA was 3 times higher than that of herbage removed (grazed or harvested as hay) from BA. This indicates that the herbage growth rate in N basis at IA was higher than that at BA. The amount of herbage production seems to relate to N inflow (feces and urine excreted by cattle and fertilizer applied) to soil at each area during each period. This suggests that higher N inflow to soil was the one of the causes of higher herbage production at IA.The difference between the N amounts of removed herbage and inflow to soil was estimated to be nearly 40 kgN/ha at each area. Therefore, the difference in the accumulation of N in the soil between IA and BA may have been small, though the same management as that in the present study had been continued from 1997. For more detailed study, soil N contents in several forms, for example soil N biomass content, should be investigated. In terms of the whole pasture, the difference between input to the whole pasture and output from it was also nearly 40 kgN/ha. This suggests that N surplus (Aarts *et al*., 1992) in this combined system was closely related to soil N balance.

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Table 1 - Nitrogen budgets on the pasture used as combined system of grazing and cutting (kgN/ha/period).

Periods	22 Apr.-2 Jul.		3 Jul.-21 Oct.		22 Apr.-21 Oct.		
Areas	Initial	Buffer	Initial	Buffer	Initial	Buffer	Whole
Supplementary feed	37.8	0.0	21.1		-	-	38.3
Grazed herbage	102.5	0.0	78.8	27.7	181.3	27.7	97.6
Feces[1)]	43.5	0.0	33.5	11.8	77.0	11.8	41.5
Urine[1)]	82.6	0.0	63.7	22.4	146.3	22.4	78.8
Retained by cattle	14.2	0.0	7.5		-	-	14.0
Harvested hay	0.0	36.1	0.0	0.0	0.0	36.1	19.7
Fertilizer applied	0.0	68.6	0.0	0.0	0.0	68.6	37.3
Inflow to soil[2)]	126.1	68.6	97.2	34.1	223.3	102.7	157.7
Herbage removed[3)]	102.5	36.1	78.8	27.7	181.3	63.8	117.3
Input to whole pasture[4)]	54.6		21.1		-	-	75.7
Output from whole pasture[5)]	26.2		3.4		-	-	33.7

1) The total amounts of feces and urine were estimated by the methods of the Japanese Feeding Standard for Beef Cattle (1995). It is assumed that feces and urine during 3 Jul.-21 Oct. were distributed between IA and BA at the same proportion of grazed herbage at each area.
2) Inflow to soil = Feces + Urine + Fertilizer
3) Herbage removed = Consumed by grazing + Harvested as hay
4) Input to whole pasture = (Supplementary feed + Fertilizer) / whole pasture area
5) Output from whole pasture = Retained by cattle + Harvested hay