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COMPARISON OF NITRATE CONTENTS FOR REED CANARYGRASS AND ORCHARDGRASS IN LARGE AMOUNTS OF COMPOUND FERTILIZATION

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Abstract

Reed canarygrass (*Phalaris arundinacea* L.) could be an ideal candidate for manure application. We compared its growth, crude protein (CP) and nitrate N (NO^3-N) content to that of orchardgrass (*Dactylis glomerata* L.) on different levels of nitrogen fertilization (3,10,15 and 20g N m^{-2}, applied from May 15 th to September 15 after each monthly cutting. The dry weight (DW) of reed canarygrass increased significantly with increasing amounts of N nitrogen on July, August and September. However, orchardgrass only showed a significant increase in yield on September. The concentration of CP of reed canarygrass was significantly lower than that of orchardgrass with 3 g N m^{-2} on June, July, August and 10 g N m^{-2} on August. In contrast to this, CP of reed canarygrass was significantly higher than that of orchardgrass with 15 g N m^{-2} on July and 20 g N m^{-2} on July and August. NO^3-N content of reed canarygrass was significantly lower than that of orchardgrass with 3 g N m^{-2} and 10 g N m^{-2} on June, July and August. We had high NO^3-N (> 0.15% N as NO^3-N was considered unsafe) with 15 g N m^{-2} and 20 g N m^{-2} in both forage species and with 10 g N m^{-2} in orchardgrass. Our results indicate that reed canarygrass accumulates less NO^3-N than orchardgrass with applications of 3 g N m^{-2} and 10 g N m^{-2} per cutting.

Keywords: reed canarygrass, orchardgrass, crude protein, nitrate nitrogen

Introduction

Large amounts of N from slurry and manure are the main causes of high nitrate levels in forage feeds. Instead of slurry and manure, we applied N as a compound fertilizer on reed canarygrass and orchardgrass throughout the growing season. The objective of this study was to determine the effects of applying large amounts of nitrogen on CP and NO^3-N in the leaf blade and stem of reed canarygrass and orchardgrass. We chose reed canarygrass because it is among the highest yielding cool season grasses, it has a high nitrogen uptake capacity (Decker et al., 1967) and can tolerate high rates of slurry addition (Studdy et al., 1995 and Russelle et al., 1997). Therefore, this grass could be an ideal candidate for manure application. We compared its growth and N uptake to that of orchardgrass, which is a common cool season pasture grass in northern Japan (Nomura 1990).

Material and Methods

The study was conducted under greenhouse conditions at Tohoku National Agricultural Experiment Station in Morioka, Japan. On April 15 1997, swards of vegetative adult plants of the two species (reed canarygrass: var. Venture, 1.16 kg total FW, orchardgrass: var. Kitamidori, 1.58 kg total FW) were planted in an andosol soil in plastic containers (70 cm length, 35 cm width, 15 cm depth) and grown for 1 month to allow for adaptation to greenhouse conditions. Dates of cutting were at 1 month intervals from May 15th to September 15th. After each cutting, N fertilizer was applied at rates of 3, 10, 15 and 20 g N m^{-2} in 3 replications. Nitrogen was applied as urea and ammonium sulfate, as part of a compound fertilizer (N:P:K; 20:10:20). Cutting height was approximately 5 cm above soil level. Samples from each cutting were separated into leaf blade and stem. The DW of these parts and their CP and NO^3-N contents were determined. NO^3-N was determined using the hydrazine sulfate reduction method.

Results and Discussion

The DW of reed canarygrass increased significantly with increasing amounts of N on July, August and September (Table 1). However, orchardgrass only showed a significant increase in yield on September. Data of leaf blade to total above ground DW (%) is also shown. Under these experimental conditions, reed canarygrass showed a higher growth response over the 4 month test period than orchardgrass (Table 1). Among cool season grasses, reed canarygrass has been found to have a higher yield response to increasing amounts of compound fertilizer compared to other cool season grasses (Ochi, 1983). With 3N on June, July, August and 10N on August, CP of reed canarygrass was significantly lower than that of orchardgrass. In contrast to this, with 15N on July and 20N on July and August, reed canarygrass CP was significantly higher than that of orchardgrass (Table 2). Frame and Morrison (1991) reported that reed canarygrass generally had a higher CP than various other ryegrass varieties. Compared to orchardgrass, a tendency for progressively higher CP contents in reed canarygrass was found with the two higher N treatments (15N and 20N) on June, July, August. There are some arguments on what constitutes acute or chronic levels of NO^3-N in forage (Emerick, 1963). In our discussion, 0.15% N as NO^3-N was considered as being potentially unsafe. Based on our data, we had high NO^3-N with 15N and 20N in both forage species and with 10N in orchardgrass. However, this was not the case for reed canarygrass, where with 10N the level of NO^3-N was not high. Moreover, with 3N and 10N, reed canarygrass had a significantly lower NO^3-N content than orchardgrass on June, July, August (Table 2). It has been reported that from mid spring to mid summer, high NO^3-N content in orchardgrass is readily reached when 10 g N m^{-2} is applied at every cutting (Nomura 1990). Our results indicate that reed canarygrass accumulates less NO^3-N than orchardgrass with applications of 10 g N m^{-2} per cutting. More NO^3-N usually accumulates in the stems and roots compared to in the leaves in various plants (McKee 1962). This data has been obtained from annual plants like spinach and corn. We also compared reed canarygrass and orchardgrass with regard to the accumulation of NO^3-N in the leaf blade and stem. For CP in the leaf blade, at the lower levels of N (3N and 10N), there were generally no differences between reed canarygrass and orchardgrass. However, with 15N and 20N, reed canarygrass CP was higher than that of orchardgrass. The difference ranged from 20-50%. With 10N, reed canarygrass leaf blade NO^3-N content was significantly lower than that of orchardgrass on all dates of cuttings. With increasing amounts of N, the content of NO^3-N in both species tended to increase. For the stem with 3N and 10N, reed canarygrass CP was significantly lower than that of orchardgrass. However, in general, with 15N and 20N there were no differences between reed canarygrass and orchardgrass. With 3N and 10N reed canarygrass tended to have lower NO^3-N in the stem compared to orchardgrass. However, with 15N and 20N, the stem of both species showed high NO^3-N levels. In this study, we found that at higher levels of applied N (i.e. 15N and 20N), the CP content of the leaf blade tended to be higher in reed canarygrass compared to orchardgrass. In addition, with 10N the NO^3-N content in the leaf blade and stem of reed canarygrass was significantly lower than that of orchardgrass. The results suggest that reed canarygrass can probably receive high rates of slurry and manure application without adversely affecting forage quality.

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Table 1 - The yield response of reed canarygrass and orchardgrass to increasing amounts of N.

	Reed canarygrass				Orchardgrass			
	6/15	7/15	8/15	9/15	6/15	7/15	8/15	9/15
	DM (g/m2)							
3N	127	123a	98a	71a	80	85	60	47a
10N	155	185b	171b	133ab	82	96	93	40a
15N	107	218bc	92a	149b	104	90	96	161b
20N	111	256c	125ab	181b	94	93	108	166b
	Leaf blade to aboveground dry weight (%)							
3N	59	55ab	66b	70	80	81	83	84
10N	55	52a	57a	67	67	81	85	83
15N	73	56b	67b	65	66	83	87	85
20N	63	57b	65b	64	68	84	86	83

Within a column, means with the same letter are not significantly different according to the Tukey test ($p < 0.05$, n=3)

Table 2 - The effect of increasing amounts of nitrogen fertilizer on mean crude protein and nitrate nitrogen content in two forage grasses

	Rate of nitrogen fertilizer (N g /m2)															
	3N				10N				15N				20N			
	6/15	7/15	8/15	9/15	6/15	7/15	8/15	9/15	6/15	7/15	8/15	9/15	6/15	7/15	8/15	9/15
	CP (% DM)															
Reed canarygrass	12.9	10.3	10.6	12.6	16.1	14.2	13.2	18.9	20.4	19.8	19.0	20.9	20.3	21.2	21.4	22.4
Orchardgrass	16.3	11.8	11.5	13.0	16.8	17.4	16.1	18.1	18.4	16.3	17.9	21.1	18.7	17.2	18.1	21.7
Significance	**	*	*	NS	NS	NS	*	NS	NS	*	NS	NS	NS	*	**	NS
	NO3-N (% DM)															
Reed canarygrass	0.01	0.00	0.00	0.00	0.08	0.03	0.00	0.08	0.15	0.14	0.02	0.18	0.17	0.19	0.08	0.24
Orchardgrass	0.04	0.04	0.01	0.03	0.18	0.09	0.06	0.13	0.19	0.06	0.06	0.14	0.16	0.04	0.07	0.26
Significance	*	*	**	NS	*	*	**	NS	NS	*	NS	NS	NS	**	NS	NS

NS, not significant; *p<0.05; **p<0.01.