Effects of Fertilizer Levels on Dry Matter Yield and Nutritional Quality of Forage Rye

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ABSTRACT

To find out the optimum fertilizer level for high yielding variety, Paldanghomil, experiment was conducted with 15 compositions of fertilizer levels at the experiment field of forage rye in Sunchon National University from Sep. 1998 to Aug. 1999. The effects of nitrogen fertilizer on plant growth were large significant but increasing rate of application in potassium and phosphate fertilizers above 10kg/10a had negligible effects on plant growth. Raising nitrogen application rate of fertilizers turned out to be 18-10-10 Kg/10a of N-P_2O_5-K_2O. Content of crude protein was the highest and that of crude fiber such as NDF, ADF, cellulose and lignin were lowest at this rate. Furthermore, IVDMD was high and dry matter yield were the highest at the optimum rate.

Keywords : fertilizer level, forage yield, nutrient quality

INTRODUCTION

According to the results from the experiment of fertilizer application, it was necessary to apply high level of nitrogen fertilizer in order to get high yield of forage crops, and yield was increased more when potassium was combined with nitrogen fertilizer (Han and Kim, 1985; Harangozo and Harangozo, 1985; Jung *et al.*, 1984; Lavrova *et al.*, 1983; Patras and Pinzariu, 1983; Sheldrick *et al.*, 1981; Sinyarskii *et al*; 1985; Songin, 1985; Timirgaziu, 1983).

However, high level of nitrogen application increased the content of inorganic nitrogen i.e., NO_3-N forage under conditions of continuous low light intensity and drought. There were several reports about the content of NO_3-N and its toxicity related with N application.

In Korea, varieties of forage rye were bred recently and hence there were only a few researches on forage rye, and forage rye has been grown only at limited areas. In this experiment was conducted to examine the effects on yield components, yield and nutrient quality of forage rye at the southern area of Korea.

MATERIALS AND METHODS

To find out the optimum fertilizer level for high yielding variety, Paldanghomil, experiment was conducted with 15 compositions of fertilizer levels at the experiment field of forage crops in Sunchon National University from Sep. 1998 to Aug. 1999.

The complete randomized block design was used and

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Table 1. Soil properties of the experimental plot at the beginning of experiment.

PH	OM	P_2O_5	Ex	cations	(me/100g)	CEC
H_2O 1 : 5	%	mm	Ca	Mg	K	(me/100g)
6.4	4.5	382	5.1	3.9	0.74	11.2

Table 2. The levels of fertilizer application (kg/10a).

Level / Fertilizer	1	2	3
N	6	12	18
P_2O_5	5	10	15
K_2O	5	10	15

Table 3. Combined application levels of fertilizers on forage rye.

No.	N-P_2O_5-K_2O	No.	N-P_2O_5-K_2O	No.	N-P_2O_5-K_2O
11	0 - 0 - 0	21	0 - 0 - 0	31	0 - 0 - 0
12	0 - 2 - 2	22	3 - 0 - 2	32	3 - 2 - 0
13	1 - 2 - 2	23	3 - 1 - 2	33	3 - 2 - 1
14	2 - 2 - 2	24	3 - 2 - 2	34	3 - 2 - 2
15	3 - 2 - 2	25	3 - 3 - 2	35	3 - 2 - 3

treatment was randomized in each of the three blocks. The size of each experimental unit was 12.5 m^2 (2.5 m $\times$5 m). Soil properties of the experimental plot at the beginnig of experiment was the same as this given in the Table 1. The levels of fertilizer application were the same as in the Table 2 and combined application levels of fertilizers on forage rye was the same as this given in the Table 3.

Ten plants were randomly sampled from each plot at heading stage, and plant height, and number of leaves were measured. To determine yield, all the plants in 1 m^2 from each plot were harvested by cutting at about 3 cm above soil level. After determining fresh yield, plant materials of about 600 g were sampled and separated into stems levels and their respective weights were determined. Dry matter weight of samples were measured after drying for 30 min. at 105℃, then for 72 hour at 70℃ in a forced air oven.

The dried samples were ground in a Wiley mill to pass through 18 mesh screen and stored at 18℃ and then subject to chemical analysis. Kjeldahl procedure was used to estimate crude protein (CP) (AOAC, 1970). Contents of fiber such as neutral detergent fiber (NDF), acid detergent fiber (ADF), permanganate lignin (PL) and cellulose were determined by the procedure described in Goering and Van Soest (1970). The content of hemicellulose was estimated by the difference between NDF and ADF. The procedure of pepsin-cellulose assay (Goto and Minson, 1977) was used to determine *in vitro* dry matter digestibility (IVDMD) and digestible dry matter yield (DDMY) was calculated by the product of dry matter yield and IVDMD.

RESULTS AND DISCUSSION

Yield components and yield

Table 4. Mean values of agronomic traits and yield of forage rye under different application rates of fertilizer.

Combined application levels of fertilizers		Heading date	Plant height (cm)	No. of leaves/ plant	Yield(kg/10a)	
	N -P_2O_5-K_2O				Fresh matter	Dry matter
N	0 - 0 - 0	May 5	128	3.50	2,174.00	535.00
	0 - 0 - 0	May 5	134	4.20	2,425.00	641.00
	1 - 2 - 2	May 10	142	4.70	2,996.00	725.00
	2 - 2 - 2	May 10	151	5.10	3,730.00	821.00
	3 - 2 - 2	May 10	164	5.80	3,979.00	996.00
	L.S.D.(0.05)	May 8	3.21	0.05	193.25	89.73
P_2O_5	0 - 0 - 0	May 5	128	3.50	2,174.00	535.00
	3 - 0 - 2	May 10	143	3.80	3,125.00	750.00
	3 - 1 - 2	May 10	152	4.90	3,750.00	834.00
	3 - 2 - 2	May 10	164	5.80	3,961.00	994.00
	3 - 3 - 2	May 10	157	5.70	3,870.00	895.00
	L.S.D.(0.05)	May 9	1.98	0.03	185.18	75.28
K_2O	0-0-0	May 5	128	3.50	2,174.00	535.00
	3-2-0	May 10	135	3.70	2,440.00	385.00
	3-2-1	May 10	140	4.30	2,860.00	718.00
	3-2-2	May 10	164	5.80	3,968.00	993.00
	3-2-3	May 10	134	3.60	2,430.00	619.00
	L.S.D.(0.05)	May 9	2.10	0.01	171.24	60.25

Mean values of yield components and yield under different fertilizer levels are presented in Table 4.

Plant height and number of leaves increased as fertilizer level by the N-P_2O_5-K_2O=3-2-2 (18-10-10 Kg/10a). Dry matter yield was the highest in fertilizer level, N-P_2O_5-K_2O=3-2-2 (18-10-10 Kg/10a) with 996 Kg/10a, 994 Kg/10a, 993 Kg/10a. The fertilizer level, N-P_2O_5-K_2O=3-2-1 (18-10-5 Kg/10a) was 718 Kg/10a and ranged from 535 to 895 Kg/10a in other fertilizer levels. There were significant differences in all characters among fertilizer level at the 5% level. According to Harangozo and Harangozo (1985), Jung *et al.*, (1984), Timirgaziu (1983) and Sheldrick *et al.*, (1981), fertilizer level affected dry matter yield and components. Based on the results obtained so far, plants grow more upwards as fertilizer level is higher by the N-P_2O_5-K_2O=3-2-2 (18-10-10 Kg/10a) in spring culture at southern area of Korea.

Nutrient quality and digestible dry matter yield

The means of content of crude protein, contents of fiber such as NDF, ADF, hemicellulose and lignin, IVDMD and DDMY are presented in Table 5. The mean content of crude protein ranged from 14.37 to 19.65 percent. The results were in agreement with the reports (Groppel *et al.*, 1982; Gupta *et al.*, 1974) and calculated nutrient content for 19 different types of winter grazing and found that crops and winter cereals were highest in crude protein. Gupta *et al.*, (1974) reported that content of crude protein ranged from 12 to

Table 5. Chemical compositions(DM%), *in vitro* dry mater digestibility and digestible dry matter yield in forage rye under different application rates of fertilizers.

Combined application levels of ferrilizers		CP	NDF	ADF	Hemi-cellulose	Cellulose	Lignin	IVDMD (%)	DDMY (kg/10a)
	N-P_2O_5-K_2O								
N	0 - 0 - 0	14.37	34.59	22.10	12.49	18.50	3.12	70.25	660.1
	0 - 2 - 2	16.24	33.60	21.22	12.38	18.13	2.98	70.14	728.4
	1 - 2 - 2	17.65	32.15	20.17	11.98	17.59	2.75	70.67	751.6
	2 - 2 - 2	18.43	30.47	19.35	11.12	16.37	2.63	73.42	790.2
	3 - 2 - 2	19.55	29.16	18.44	10.72	15.63	2.31	74.30	834.0
	L.S.D.(0.05)	0.27	0.38	0.12	0.06	0.15	0.07	0.68	12.02
P_2O_5	0 - 0 - 0	14.37	34.59	22.10	12.49	18.50	3.12	70.25	660.2
	3 - 0 - 2	16.85	33.56	21.37	12.19	17.29	2.85	70.85	731.5
	3 - 1 - 2	17.29	32.44	20.56	11.88	16.44	2.53	73.27	798.4
	3 - 2 - 2	19.65	30.61	19.11	11.50	15.63	2.31	74.10	814.0
	3 - 3 - 2	19.36	29.54	18.91	10.63	15.25	2.20	74.20	820.0
	L.S.D.(0.05)	0.37	0.64	0.13	0.08	0.13	0.12	0.46	14.01
K_2O	0 - 0 - 0	14.37	34.59	22.10	12.49	18.50	3.12	70.25	660.1
	3 - 2 - 0	16.69	33.72	21.61	12.11	17.48	2.78	73.05	750.1
	3 - 2 - 1	18.27	31.61	20.20	11.41	17.25	2.69	73.10	784.7
	3 - 2 - 2	19.60	30.16	19.62	10.54	15.63	2.31	74.20	824.0
	3 - 2 - 3	19.34	29.77	19.46	10.31	15.21	2.25	74.21	821.1
	L.S.D.(0.05)	0.41	0.59	0.08	0.04	0.11	0.06	0.73	16.09

23 percent when it was measured for nine brassica species. There were significant differences in crude protein among fertilizer levels and the fertilizer level, N-P_2O_5-K_2O=3-2-2 (18-10-10 Kg/10a) was the highest in content of crude protein with 19.55, 19.65 and 19.60 percent.

Mean contents of NDF, ADF, cellulose, hemicellulose and lignin for fertilizer level, N-P_2O_5-K_2O=3-2-2 (18-10-10 Kg/10a) were 29.16~34.59, 18.44~22.10, 10.72~12.49, 15.21~18.50, and 2.20~3.12 percent respectively (Table 5). There were significant differences among fertilizer levels. The fertilizer level of N-P_2O_5-K_2O=3-2-2 (16-6-6 Kg/10a) was the lowest in content of fiber. The results were fairly in agreement with those of Berendonk (1982a, 1982b, 1983a, 1983b) reported that the content of crude fiber in Rye varied within 2 percent under variations of growing environment and with variety. Groppel *et al.*, (1982) found that Rye was the lowest in crude fiber when nutrient content was calculated for 19 different types of winter grazing.

IVDMD of fertilizer level, N-P_2O_5-K_2O=3-2-2 (18-10-10 Kg/10a) was 74.30, 74.10 and 74.20 percent for the leaf (Table 5), and the differences were significant at the 5% level. Fertilizer level, N-P_2O_5-K_2O=3-2-2 (18-10-10 Kg/10a) which was high in crude protein and low in NDF, ADF, cellulose, hemicellulose and lignin shows higher IVDMD.

Judging from the reports and the results so far obtained, forage rye (fertilizer level, N-P_2O_5-K_2O=3-2-2 (18-10-10 Kg/10a) provides high digestible dry matter yield with high nutritive value, so that it can be recommended as a catch fodder crop. Fertilizer level, N-P_2O_5-K_2O=3-2-2 (18-10-10 Kg/10a) is considered to be a suitable fertilizer level of spring seeding culture at the southern area of Korea.

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(Received Jun. 10, 2004)
(Accepted Sep. 10, 2004)