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Influence of Sowing and Harvest Date on Yield and Nutritional Quality of Forage Rye

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ABSTRACT

In order to find out the optimum harvest (clipping) date combined with sowing date on yield and nutrient quality of forage rye which is suitable at the Southern part of Korea, Paldanghomil variety was grown Sep. 2001 to May 2002 at Sunchon National University, and yield and nutrient quality of plant were observed. As harvest date and sowing date were delayed, the plant length was longest, number of leaves per plant was increased in the time of May 20 clipping. Fresh yield was the heaviest in the time of May 20 clipping and Oct.10 sowing, and the most dry matter yield was the heaviest in the time of May 20 clipping and Oct. 10 sowing. Content of crude protein was the highest and that of crude fiber such as NDF, ADF, hemicellulose, cellulose and lignin were the lowest in the late time of clipping and sowing. Further more IVDMD was high and dry matter yield and digestible dry matter yield were the highest in the time of May 20 clipping and Oct. 10 sowing. Judging from the results reported above, at optimum harvest (clipping) date combined with sowing date for yield and nutrient quality of forage rye seemed to be the time of May 20 clipping and Oct. 10 sowing.

Key words **:** Forage rye, yield nutrient Quality.

INTRODUCTION

Since forage rye is a winter annual crop, its productivity and nutrient quality are greatly affected by variations of the sowing date, plant density and the harvest date. For example, if the sowing date is too early or too late, growth and yield of forage rye greatly decrease because of invasion of insects cold diseases or cold injury. However, sowing rate should be adjusted depending upon the fertility of soil, the sowing date and variety.

Although there have been many reports for the effects of the sowing date and the harvest date on yield and nutrient quality of forage crops (Beren donk, 1982a, 1982b, 1983a, 1983b ; Han and Kim, 1985 ; Harper and compton, 1980 ; Harris, 1964 ; Jung et al., 1984, 1986 ; Kalmbacher et al., 1982 ; Kim and Han, 1984 ; Timirgaziu, 1983 ; Veneni and Axamit, 1984a, 1984b), such an experiment has not been conducted for forage crop at the Southern area of Korea. This experiment was conducted to examine the effects of the harvest date combined with the sowing date on yield components, yield and nutrient quality of forage rye at the Southern area of Korea.

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MATERIALS AND METHODS

An experiment was conducted from October 2001 to May 2002 at the experimental farm of Sunchon National University. Variety used in this trial was Paldanghomil. A split plot design was used with the sowing date as the main plot and the harvest date as the sub plot replicated three times. Each experimental plot size was 12.5 m^2 (2.5 × 5 m).

The sowing dates were chosen to be Sep. 20, Sep. 30 and October 10, and the harvest dates included April 30, May 10 and May 20. Seeds of 15 kg per 10a were sown at the experimental field with 120 cm ridge width and 90 cm sowing width.

Fertilizer was applied at the rate of 12-9-7 kg/10a of N-P_2O_5-K_2O. On the total N, total P_2O_5 and K_2O and manure of 1 MT/10a were incorporated into the soil before sowing and rest of N fertilizer was applied in late-February.

Ten plants were randomly sampled from each plot at flowering stage, and plant length, number of leaves were measured. To determine yield, all the plants in 1m^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 their respective weights, were determined. Dry matter of samples were measured after drying for 30 min, at 105 ℃, then 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). Content 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-cellulase essay (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 componets and yield

The means of plant length, number of leaves, fresh yield and dry matter yield are presented in table 1 and the results of analyses of variance for the characters in table 2.

Table 1. Effects of sowing time and clipping time on the agronomic characters.

Sowing time (Main plot)	Clipping time (Sub plot)	Heading date	Harvesting date	Plant length (cm)	No. of leaves/ plant	Yield (kg/10a)	
						Fresh matter	Dry matter
Sep. 20	Apr. 30	Apr. 30	Apr. 30	128	2.8	3016	569
	May 10	May 10	May 10	136	3.4	3321	601
	May 20	May 20	May 20	147	4.5	3521	678
Sep. 30	Apr. 30	Apr. 30	Apr. 30	129	2.9	3115	572
	May 10	May 10	May 10	138	3.6	3427	651
	May 20	May 20	May 20	149	4.7	3584	689
Oct. 10	Apr. 30	Apr. 30	Apr. 30	135	3.6	3257	595
	May 10	May 10	May 10	146	4.0	3446	703
	May 20	May 20	May 20	157	5.6	3727	748

Table 2. Analysis of variance for agronomic characters.

SV	df	Plant length (cm)	No. of leaves	Yield(kg/10a)	
				Fresh matter	Dry matter
Main (Sowing time)	2	137.28**	0.28**	102.674**	18731.86*
Error(a)	4	1.53	0.45	4761.25	51.01
Sub (Clipping time)	2	138.29**	2.821**	108576.7*	12864.25*
Interaction	4	406.28	5.46	207814.5**	25270.25**
Error(b)	12	0.78	0.48	6272.21	165.24
C.V (%)		0.57	10.12	2.65	1.82
LSD(0.05)					
Main	a	1.57	0.75	80.72	8.51
Sub	b	0.85	0.63	71.66	12.54

Table 3. Effects of sowing time and clipping time on the chemical compositions(DM%), *in vitro* dry matter digestibility and digestible dry matter yield.

Sowing time (Main plot)	Clipping time (Sub plot)	CP	NDF	ADF	Hemi-cellulose (NDF-ADF)	Cellulose	Lignin	IVDMD (%)	DDMY (kg/10a)
Sep. 20	Apr. 30	6.45	56.34	41.95	14.39	33.45	6.15	71.64	495.31
	May 10	11.36	36.17	21.45	14.72	21.17	3.17	50.11	695.72
	May 20	14.65	31.17	15.14	16.03	18.35	2.49	63.27	726.38
Sep. 30	Apr. 30	7.38	54.25	40.87	13.38	32.17	6.03	74.88	524.88
	May 10	12.29	35.04	20.87	14.17	20.24	3.04	52.36	714.67
	May 20	15.35	30.24	14.58	15.66	17.27	2.34	65.33	747.49
Sep. 10	Apr. 30	8.94	52.17	39.27	12.90	31.43	5.76	76.28	567.94
	May 10	13.44	34.24	19.21	15.03	19.75	2.81	53.42	731.76
	May 20	15.87	28.75	13.39	15.36	17.00	2.11	67.28	766.21

Plant length increased with progressively later sowings and later harvests. It increased greatly from Apr. 30 and significant differences among the sowing dates as well as the harvest dates were observed. The patterns of changes in number of leaves under variations of the sowing dates and the harvest dates and the harvest dates were similar to that of plant length. Fresh yield increased with progressively later sowings but for each sowing date it was the highest at the harvest date of May 20 and the lowest at the harvest date of Apr. 30 stage. The treatment combining the sowing date of Oct. 10 with the harvest date of May 20 (Oct. 10 × May 20) produced the highest fresh yield with 3,727 kg/10a and treatment Sept 20 × Apr. 30 the lowest with 3016 kg/10a. There were significant differences ($P < 0.01$) in fresh yield among sowing dates as well as harvest dates. Dry matter yield increased significantly differences ($P < 0.01$) with progressively later sowings and later harvests. Treatment Oct.10 × May 20 produced the highest dry

Table 4. Analysis of variance for chemical compositions (DM%), in vitro dry matter digestibility and digestible dry matter yield.

SV	df	CP	NDF	ADF	Hemi-cellulose	Cellulose	Lignin	IVDMD (%)	DDMY (kg/10a)
Main (Sowing time)	2	4.87	0.28	10.87	0.26	1.67	2.46	8.27	24341.26
Error(a)	4	0.01	0.18	0.17	0.24	1.45	0.01	0.29	7315.3
Sub (Clipping time)	2	21.04	1287.51	327.12	1.50	112.68	2.72	117.17	16112.75
Interaction	4	59.72	18.75	574.69	0.76	259.27	5.10	402.11	404.35
Error(b)	12	0.17	0.84	0.67	1.47	0.35	0.002	0.58	0.56
C.V (%)	3.72	2.28	3.10	7.54	2.51	1.72	1.18	1.21	1.19
LSD(0.05)									
Main	a	0.18	0.54	0.59	0.57	1.54	0.13	0.71	104.21
Sub	b	0.38	0.95	0.81	1.28	0.62	0.63	0.75	76.65

matter yield with 748kg/10a and treatment Sept.20 × Apr. 30 produced the lowest dry matter yield.

The results reveal that forage rye grows slowly before winter but from the next spring as temperature becomes higher and day length is longer it grows rapidly by developing many leaves. Fresh yield was the highest in treatment Oct. 10 × May 20. This results from the fact that water content of plant is lower at May 20 than at May 10 and hence dry matter percentage is higher at May 20.

Ntrient quality and digestible dry matter yield

The means of IVDMD, digestible dry matter yield (DDMY), content of crude protein, and contents of fiber such as NDF, ADF, hemicellulose, cellulose and lignin are given in table 3 and the results of analyses of variance for the characters in table 4.

Content of crude protein ranged from 6.45 to 15.87 percent and it increased with progressively later sowings and declined rapidly with later harvest. There were significant differences in the content at the 1% level among sowing dates as well as harvest dates. Content of NDF ranged from 28.75 to 56.34 percent, ADF from 13.29 to 41.95 percent, hemicellulose from 12.90 to 16.03 percent, cellulose from 17.00 to 33.45 percent and lignin from 2.11 to 6.15 percent, respectively. The contents of fiber decreased with later sowings and increased greatly with later harvests. Significant differences in the contents among sowing dates as well as harvest dates were observed at the 1% level.

IVDMD ranged from 50.11 to 76.28 percent. IVDMD increased with later sowings and earlier harvests. For a given sowing date, IVDMD was the highest in plant harvested at Apr. 30 and the lowest at May 20 and hence. significant differences in IVDMD among sowing dates as well as harveśt dates were observed at the 1% level. DDMY increased with progressively later sowings and it was the highest at the harvest date of May 20 and the lowest at May 20 and the lowest at the harvest date of Apr. 30 for a given sowing date. Treatment Oct. 10 × May 20 produced th highest DDMY of 766 kg/10a and there were significant differences among treatments at the 1%

level.

In the experiment, content of crude protein and IVDMD increased with earlier sowings or earlier harvests. The reason for the results can be explained by the facts that with longer growth period plant length increases greatly and plant length and leaves are thicker.

DDMY increased with later sowings but for a given sowing date, harvest at May 10 showed the highest DDMY and at Apr.30 the lowest. This may result from the fact that plants at the harvest date May 10 can develop more leaves vigorously for a longer duration under better environmental conditions, because temperature is high and day length is longer from March. On the other hand, plants at the harvest date of May 10 greatly accumulate fiber and are lignified and hence IVDMD of plans decreases greatly.

Kim and Han (1984) and Han and Kim (1985) reported that at the Southern area of Korea it was effective to use forage rye providing forage with high nutrient quality by sowing at mid-September and harvesting at early spring from mid - April to late- April when production from grassland was not sufficient. The results from the reports are in agreement with the results from this experiment. Judging from the above results, the optimal sowing date of Paldanhomil seems to be Oct.10 and the optimal harvest date May 20, which is May 20 in the Southern area of Korea.

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