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Influence of Plant Density on Growth, Yield and Nutritional Quality of Forage Rye

Byung-Sun Kwon*
Dept. of Resources Plant Development, Sunchon Nat'l Univ. Sunchon 540-742, Korea.

ABSTRACT

To determine optimal plant density of forage rye in southern areas of Korea, forage rye cv. Paldanghomil, the highest yielding variety among experimental varieties of forage rye, was grown under five different plant density. Yield components such as plant height, and number of leaves were highest at the broad casting. Plants sown at broadcasting also showed highest fresh and dry matter yield. When plants were grown of the broad casting, they showed higher values in content of crude protein and lower values in contents of crude fiber such as neutral detergent fiber(NDF), acid detergent fiber(ADF), cellulose and lignin. There was no relationship between variation of *in vitro* dry matter digestibility(IVDMD) and plant density. Plants sown at the broad casting showed highest digestible dry matter yields.

Key words : forage rye, growth, nutrient quality, plant density, yield.

INTRODUCTION

Forage rye is the most widely adapted of its extreme winter hardiness and ability to grow on marginal soils. The most drought-resistant of the crops, rye has an extensive root system and adjusts maturity to moisture.

Forage rye responds well to fertilizer and sowing rates, but care must be used to must be used to prevent excess nitrogen fertilization, which will case the plants to lodge.

Although many researchers have reported for the yield and nutrient quality of forage crops (Hart and Burton 1964 ; Kim and Kim, 1980; Lee 1983, 1984; Macfarlane Smith *et al.*, 1985; Pichard *et al.*, 1985),any experiment with plant density has not been reported at the southern area of korea. In this experiment was conducted to examine the effects of plant density on yield components, yield and nutrient quality of forage rye.

MATERIALS AND METHODS

An experiment was conducted at the experimental farm of Sunchon National University from October 1998 to May 1999. Variety used in the trial was Paldanghomil, which was the most promising variety of forage rye at the southern area of Korea. There were five levels of the sowing rate, drilling with 90 cm row spacing and 50 cm row width ; drilling with 90 cm row spacing and 60 cm row width ; drilling with 120 cm row spacing and 70 cm row width ; drilling with 120 cm row spaeing and 90 cm row width ; broadcast. The

*Corresponding author : **Byung-Sun Kwon,** E-mail: kbs@sunchon.ac.kr

complete randomized block design was used with three blocks and each experimental unit was 12.5 m^2 (2.5 m $\times$ 5 m).

Fertilizer was applied at the rate of 12-9-7 kg/10a of N-P_2O_5-K_2O. One third of the total N total P_2O_5 and K_2O and manure of 1,000 kg/10a were incorporated into the soil before sowing and the rest of N fertilizer was applied in late February.

The samples separated into the stem and the leaf and dried in a forced-air oven at section I were ground in a wiley and mill to pass through 18 mesh screen and stored at 18℃ and then subjected to chemical analysis. The methods for determining contents of crude protein and fiber, IVDMD and DDMV were illustrated at section I.

RESULTS AND DISCUSSION

Yield components and yield

Mean values of plant height, number of leaves, fresh yield and dry matter yield are presented in Table 1. Plant height increased as sowing rate increased. It is the highest in treatment broadcast with 162 cm and ranged from 135.7 cm to 155.0 cm in treatments of drilling. The Plants in treatment broadcast showed higher values in number of leaves, fresh yield and dry matter yield than plants at any other treatments of drilling. Dry matter yield ranged 663 kg/10a in treatment of broadcast which was higher than that of any other treatments of drilling from 560.0 to 606.0 kg/10a.

There were significant differences in all characters among treatments at the 1% level. According to Hart and Burton(1964), Macfarlane Smith *et al.*(1985) and Pichard *et al.*(1985), plant density affected dry matter yield, weight of leaves. Based on the results obtained so far, plants grow more up wards as sowing rate is higher, At lower plant density individual plants grow more vigorously because of less severe competition for light, soil water and mineral nutriment among plants. However, dry matter yield in the highest in treatment broadcast, which may result from the fact that broadcast shows higher dry matter percentage than any other treatments.

Table 1. Variations of yield and agronomic characters of forage rye under different plant density.

Item / Plant density	plant height (cm)	No. of leaves	Yield (kg/10a)	
			Fresh matter	Dry matter
90/50cm drilling	135.7	4.3	2933.96	560.0
90/60cm drilling	141.6	4.1	3128.0	575.6
120/70cm drilling	145.3	4.3	3276.3	584.0
120/90cm drilling	155.0	5.1	3372.6	606.0
Broad casting	162.0	5.3	3466.3	663.0

Table 2. Analysis of variance for yield and agronomic traits of forage rye under different plant density.

SV	df	Plant height(cm)	No. of leaves	Yield (kg/10a)	
				Fresh matter	Dry matter
plant density	4	333.23	0.85	129573.34**	4820.58**
Error	8	31.03	0.04	4474.93	68.56
C.V(%)		3.77	4.53	2.07	1.39
L.S.D(0.05)		10.49	0.39	125.95	15.59

Table 3. Comparisons of chemical compositions (DM%), *in vitro* dry matter digestibility and digestible dry matter yield under different plant density.

Item / plant density	CP	NDF	ADF	Hemi-cellulose	Cellulose	Lignin	IVDMD (%)	DDMY (kg/10a)
90/50cm drilling	12.46	35.02	17.06	17.96	24.23	3.91	62.37	645.12
90/60cm drilling	13.47	34.52	16.92	17.59	23.44	3.56	62.17	668.11
120/70cm drilling	13.85	33.59	16.69	16.96	21.40	3.44	63.25	675.86
120/90cm drilling	14.09	32.16	16.24	15.92	19.24	2.91	64.58	692.76
Broad casting	15.54	30.86	16.06	14.01	17.33	2.71	65.56	718.31

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)
plant density	4	3.99**	8.92**	0.56**	4.97**	25.09**	0.71**	6.48**	2254.38**
Error	8	0.02	0.10	0.04	0.09	0.07	0.00	0.13	7.96
C.V.(%)		1.00	0.96	1.14	1.82	1.26	2.07	0.57	0.41
L.S.D.(0.05)		0.26	0.60	0.36	0.57	0.50	0.13	0.68	5.31

** $P < 0.01$

Nutrient quality and digestible dry matter yield (DDMY).

Content of crude protein, contents of fiber such as NDF, ADF, hemicellulose, cellulose and lignin, IVDMD and DDMY are presented in Table 3 and the results of analyses of variance are shown in Table 4.

Content of crude protein was the highest in treatment broadcast with 15.54 percent and it decreased as sowing rate decreased. Accordingly, treatment 90/50cm drilling, which is the lowest content of crude protein with sowing rate, showed the lowest content of crude protein with 12.46 percent and significant differences in the content among treatments at the 1% level were observed. Content and NDF ranged from 30.86 to 35.02 percent, ADF from 16.06 to 17.06 percent, hemicellulose from 14.81 to 17.96 percent, cellulose from 17.33 to 24.33 percent and lignin from 2.71 to 3.91 percent. As sowing rate increased, contents of fiber decreased so that treatment broadcast showed the lowest in the contents. There were significant differences in all the contents among treatments at the 1% level. IVDMD was measured for leaves. IVDMD of leaves ranged from 62.37 to 65.56 percent.

As sowing rate increased, IVDMD of leaves increased, so that it was significantly higher in treatment broadcast($p<0.01$). Treatment broadcast produced the highest digestible dry matter yield with 719kg/10a, treatment drilling from 645 to 693 kg/10a. Significant differences in digestible dry matter yield among treatments were observed at 1% level.

The results may be due to the fact that since competition for light, soil water and mineral nutrients among plants were less severe at treatments of lower sowing rate, plants under such conditions can grow vigorously and accumulate more fiber and hence more lower in content of crude protein and IVDMD.

Treatment broadcast produced the highest digestible dry matter yield than any other treatment. The result may be attributed to higher IVDMD of smaller but much greater number of plants per unit area in treatment broadcast.

Judging from the results obtained that the broadcast seems to be the most suitable sowing method in terms of producing forge feed.

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