Effect of seeding rates on productivity and quality of Alfalfa in northern area of Korea

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Abstract

Alfalfa cultivation in south Korea is not common. There are many reasons, but low productivity has been extremely limited. Although alfalfa growth was poor due to boron deficiency in the soil, the problem has recently been solved. Nevertheless, the cultivation of alfalfa is not expanding. About 200,000 tonnes of alfalfa hay are imported every year. Therefore, this study was conducted to find a way to replace imported hay by expanding alfalfa cultivation in Korea. Alfalfa (P5444) was sown in northern part of South Korea (Pyeongchang). Alfalfa was sown in September 2018 with different seeding rates (20, 30 and 40 kg/ha) and harvested four times in 2019 (3 May, 2 July, 11 September and 13 October). The plant height was the highest at the 3rd harvest (113 cm) and the dry matter content was the highest at the 1st harvest (27.89 %). The yield of fresh and dry matter was the highest at the first harvest (mean 6,856 kg/ha). Annual fresh and DM productivity was significantly higher in 40 kg/ha seeding rates (89,833 and 20,265 kg/ha). Crude protein (CP) content in forage quality was higher than 27% at the 4th harvest and the lowest by 13% at the 3rd harvest. Crude protein, ADF and NDF contents did not show significant difference (P>0.05) according to the increase of seeding rate. TDN content of alfalfa was not significantly different among treatments (P >0.05), but was highest at the 4th harvest (66.98 %) and lowest at the 3rd harvest (44.44 %). The relative feed value (RFV) of alfalfa was highest at the 4th fourth harvest (mean 146) and lowest at the 3rd harvest (mean 83). However, there was no significant difference among the seeding rates (average 120). In conclusion, the possibility of alfalfa production in Korea is sufficient and 40 kg/ha seeding rate is recommended

Introduction

Alfalfa is called the queen of forages and accounts for a large portion of the forage. However, alfalfa is rarely cultivated in Korea. In the early days of the introduction of alfalfa, domestic adaptation was poor, resulting in low productivity, which resulted in the loss of farmers' willingness to grow. There are various reasons, but one of the biggest reasons was the lack of boron in the soil. However, despite the identification of these factors, farmers' perceptions did not disappear easily. Protein feed is very important for dairy cattle feeding. In order to overcome this point, the demand for legume forage has been continuously generated in farms, but due to cultivation limitations in Korea, imports are being made from abroad. In particular, about 200,000 tons of alfalfa are imported every year, which is about 20% of the total imported hay in Korea. The forage market in Korea will open after 2026, and in order to cope with imported alfalfa, it is necessary to develop technology to improve productivity in Korea. Therefore, this experiment was carried out to investigate the effect of seeding rate on productivity and quality of alfalfa in Korea.

Methods and Study Site

Alfalfa (P5444) was sown in the experimental field of Seoul National University, Pyeongchang Campus (located at 37°32′46.1″N, 128°26′17.9″E, 600m ASL) on August 28, 2018, Pyeongchang-gun, Gangwon-do. The seeding rate was 20, 30 and 40 kg/ha, and the fertilizers of 18-180-120 (N-P-K) kg/ha were applied annually. Nitrogen and phosphate fertilizers were distributed on the day of sowing and potassium fertilizer was divided into each harvest time. In 2019, a total of four were harvested (May 3, July 2, September 11 and October 13), and the harvested samples were then dried in a 65°C forced-air drying oven for 72 h for determination of DM content The dried samples were subsequently milled using a Willey mill with a 1-mm screen, placed in a screw-top plastic bottles and stored at 4°C in a dark, dry storage room until analysis. Acid detergent fiber (ADF) and neutral detergent fiber (NDF) were measured by the method of Van Soest (Van Soest et al., 1991). Crude protein (CP) was determined via the Dumas method, as described by Jean-Baptiste Dumas (1884). Total digestible nutrient (TDN) and relative feed value (RFV) were calculated by the formulae described by Holland et al. (1990). TDN was calculated from the ADF value (TDN% = 88.9 − 0.79 × ADF%), and RFV was estimated through digestible dry matter (DDM) and dry matter intake (DMI) as RFV = (DMI% × DDM%) / 1.29.

Results

Plant height and feed value according to harvest time and seeding amount are shown in Table 1. There was no difference according to the seeding rate, and plant height was the longest at the 3rd harvest and the shortest at the 4th harvest. There was no significant difference in the dry matter content among seeding rates, but the highest at the first harvest and the lowest at the fourth harvest.

The crude protein content was highest at the 4th harvest, followed by 2nd>1st>3rd order. Meanwhile, at the third harvest the higher the seeding rate, the higher the crude protein content tended to be(P<0.05).

ADF content was highest at the third harvest and lowest at the fourth harvest. On the other hand, there was a significant difference with the seeding rate, but there was no certain trend, and it showed different patterns for each cutting time. The NDF content did not differ according to the seeding rate, but showed a similar tendency to the ADF content among the cutting time.

Since the TDN content was calculated as the ADF content, the significance was the same as the ADF content. The RFV value representing the feed value was the highest at the 4th harvest, followed by 1st>2nd>3rd order.

Table 1. Plant height and forage quality of alfalfa according to seeding rates in northern area of Korea

Cut	Seeding rate	Plant height (cm)	CP (%)	ADF (%)	NDF (%)	TDN (%)	RFV
1st	20	77.3	15.25	35.31^{a}	47.72	61.01^{b}	120^{b}
	30	80.6	15.48	31.75^{b}	45.71	63.82^{a}	131^{ab}
	40	83.6	15.75	30.26^{b}	42.27	64.99^{a}	144^{a}
Mean		80.6^{B}	15.50^{C}	32.44^{C}	45.23^{C}	63.27^{B}	132^{B}
2nd	20	82.5	17.06	34.97^{a}	49.94	61.27^{b}	115
	30	81.4	18.31	32.69^{b}	46.39	63.07^{a}	127
	40	81.5	17.37	34.78^{a}	50.13	61.42^{b}	115
Mean		81.8^{B}	17.58^{B}	34.15^{B}	48.82^{B}	61.92^{C}	119^{C}
3rd	20	110.3	15.92^{a}	41.79^{c}	58.53	55.89^{a}	90^{a}
	30	112.8	13.68^{b}	45.61^{b}	60.76	52.87^{b}	82^{ab}
	40	114.7	12.81^{b}	48.03^{a}	61.97	50.96^{c}	77^{b}
Mean		112.6^{A}	14.13^{D}	45.14^{A}	60.41^{A}	53.24^{D}	83^{D}
4th	20	46.0	27.38	25.49	44.98	68.76	143
	30	41.3	27.82	24.64	43.39	69.43	149
	40	44.0	28.12	26.48	43.48	67.98	147
Mean		43.8^{C}	27.77^{A}	25.53^{D}	43.95^{C}	68.73^{A}	146^{A}

Within a column, $^{A\text{-}D}$ different superscripts in capital letters indicate that main plots differ; $^{a\text{-}c}$ those in lower-case letters indicate that sub-plots differ (P < 0.05).

Table 2 shows the DM content and yield according to the harvest time and seeding rate. The dry matter content was the highest at 27.89% at the first harvest and the lowest at 15.65% at the fourth harvest. There was no significant difference according to the seeding rate in yield, but there was a difference in the cutting time. Due to the high dry matter and TND content in the first harvest, the dry matter and TDN yield were significantly higher than those of other harvest periods. In general, the yield was highest at the first harvest and the lowest tendency was at the fourth harvest.

In terms of total DM yield, there was significance in seeding rate and cutting time, but no interaction effect was observed (Figure. 1). The same trend was observed for the yield of crude protein (Figure 2).

Table 2. Dry matter content and yield of alfalfa according to seeding rates in northern area of Korea

Cut	Seeding rate	Dry matter (%)	Yield (kg/ha)		
			FM	DM	TDN
1st	20	27.06	23,389	6,343	3,869
	30	28.41	24,167	6,867	4,384
	40	28.19	26,111	7,358	4,782
Mean		27.89^{A}	$24,556^{A}$	$6,856^{A}$	$4,345^{A}$
2nd	20	20.76	20,278	4,197	2,572
	30	21.69	21,333	4,629	2,921
	40	22.67	21,444	4,859	2,985
Mean		21.70^{B}	$21,019^{B}$	$4,562^{C}$	$2,826^{B}$
3rd	20	21.37	22,389	4,798	2,681
	30	21.79	23,222	5,059	2,674
	40	21.04	26,389	5,539	2,823
Mean		21.40^{B}	$24,000^{A}$	$5,132^{B}$	$2,726^{B}$
4th	20	15.71	14,833	2,327	1,601
	30	15.46	15,944	2,463	1,711
	40	15.79	15,889	2,509	1,707
Mean		15.65^{C}	$15,555^{C}$	$2,433^{D}$	$1,673^{C}$

Within a column, $^{A\text{-}D}$ different superscripts in capital letters indicate that main plots differ; $^{a\text{-}c}$ those in lower-case letters indicate that sub-plots differ (P < 0.05).

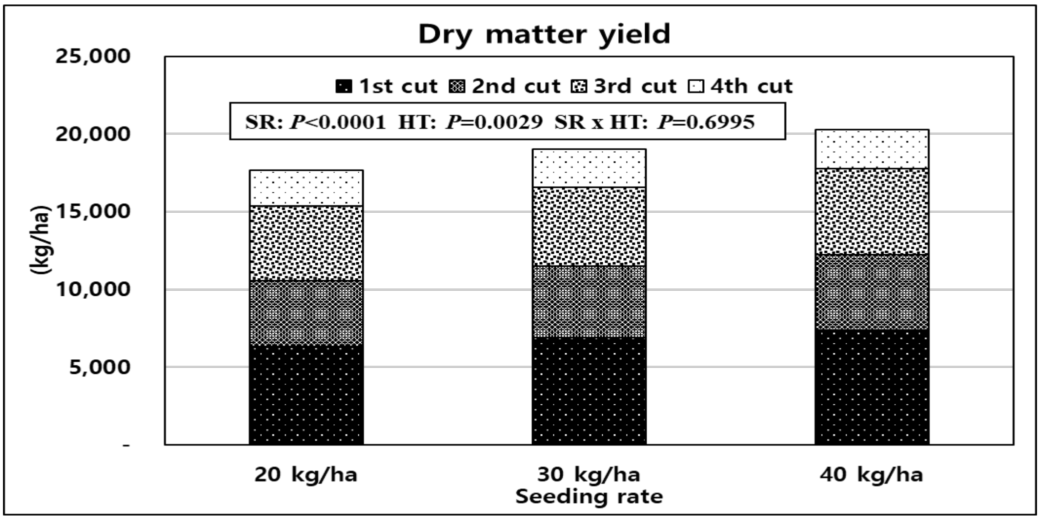

Figure 1. Total DM yield of alfalfa according to seeding rates in northern area of Korea

*SR: seeding rate, HT: harvest time

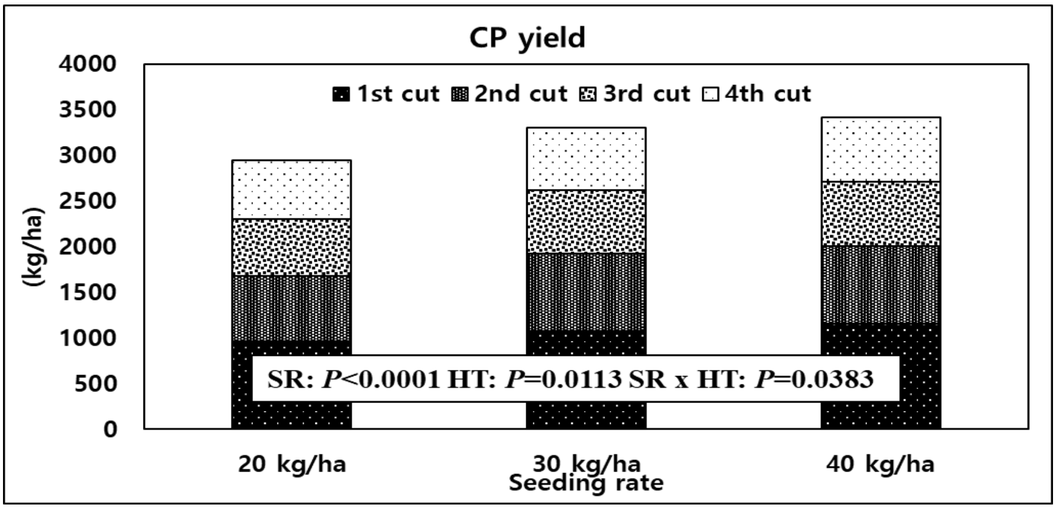

Figure 2 Total CP yield of alfalfa according to seeding rates in northern area of Korea

*SR: seeding rate, HT: harvest time

Discussion [Conclusions/Implications]

Although the recommended seeding rate for alfalfa varies by region, Wisconsin state recommends 12 pounds per acre (about 13.44 kg/ha). This is equivalent to planting 60 seeds per square foot (about 645 seeds/m^2) (Mike, 2008). In Nebraska, 13.44 kg/ha in dry areas and 16.8 kg/ha in irrigated areas are recommended (Anderson and Jerry, 2014). However, in this experiment, the productivity was best when the seeding rate was 40 kg/ha. Higher seeding rates are recommended in Korea for several reasons. Dwain (2008) reported that there is little justification for seeding rates above 8 lb/acre (about 9 kg/ha) for seeding without a companion crop. And also insist that crude protein, ADF, NDF, hemicellulose, cellulose, IVDMD, and RFV were unaffected by the seeding rate. In this experiment, except for ADF content, there was no significant difference according to the seeding rate in the items related to feed value (CP and NDF). On the other hand, according to the seeding rate trials of Elfatih and Awad (2012), the plant density, leaf area index and dry matter yield were the highest at 25 kg/ha seeding rate, and the plant height was the highest at 15 kg/ha.

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