Effect of Cutting Height on Productivity and Quality of Alfalfa in Northern Area of Korea

Jong Geun Kim
Seoul National University, South Korea

C. Liu
Seoul National University, South Korea

S. N. Wei
Seoul National University, South Korea

Y. F. Li
Seoul National University, South Korea

E. C. Jeong
Seoul National University, South Korea

See next page for additional authors

Presenter Information
Jong Geun Kim, C. Liu, S. N. Wei, Y. F. Li, E. C. Jeong, and H. J. Kim

Effect of cutting height on productivity and quality of Alfalfa in northern area of Korea

Kim JG[1,2,*], Liu C[1], Wei SN[1], Li YF[1], Jeong EC[1], Kim HJ[2]

[1]Graduate School of International Agriculture and Technology, SNU, Pyeongchang, 25354, Korea

[2] Research Institute of Eco-Friendly Livestock Science, GBST, SNU, Pyeongchang, 25354, Korea
*Correspondence: Jong Geun Kim, forage@snu.ac.kr

Key words: Alfalfa, DM, Yield, Quality, RFV, Cutting height

Abstract

Alfalfa is a very important forage for livestock feeding. In particular, due to the high crude protein content, it is widely used as a dairy cattle feeds. However, the cultivation of alfalfa is quite limited and main source is imported hay in Korea. There are many reasons, but most importantly, low productivity due to lack of boron in the soil. This experiment was conducted to expand domestic production and use of alfalfa. Alfalfa was sown in the fall of 2018 at 30 kg/ha seeding rate. Alfalfa was harvested four times (3 May, 2 July, 11 September and 13 October) in 2019 with three different cutting height (5, 15 and 25 cm of stubble height) and investigate productivity, quality and regrowth. The plant height was the highest at the 3rd harvest (108 cm) and the dry matter content was the highest at the 1st harvest (28.78 %). The yield of fresh and dry matter was the highest at the first. Annual fresh and DM productivity was significantly higher in 5cm cutting height. CP was highest at the 4th harvest and lowest at the 3rd. The higher the cutting height, the higher CP content. ADF and NDF contents decreased significantly with increasing cutting height ($p<0.05$). TDN content was highest at the 4th harvest and lowest at the 3rd harvest. It was also found that the higher the cutting height, the higher the TDN content. The relative feed value (RFV) of alfalfa was highest at the 4th fourth harvest (mean 164) and lowest at the 3rd harvest (mean 85). The RFV value increased with increasing cutting height and 25 cm cutting height plot was 152. Regrowth after cutting was good at 15cm and 25cm height and 5cm treatment was slightly lower. In conclusion, the possibility of alfalfa production in Korea is sufficient and a cutting height of 5 cm or more is recommended and requires constant observation.

Introduction

Protein feed is very important in raising dairy cattle. Alfalfa hay is fed to most dairy cattle farms to supplement protein feed. Korea imports more than 200,000 tons of alfalfa hay every year, and it is increasing continuously. When the forage market opens in 2026, the amount of imports will be expected to increase. Therefore, it is judged that the production of alfalfa in Korea is urgent. However, alfalfa cultivation in Korea has been limited due to various reasons, but it is judged that the development and distribution of cultivation technology is necessary through various studies.

In Korea, alfalfa can be harvested 3 or 4 times a year and productivity is high. In grassland, regrowth should be considered at harvest to improve productivity. The cutting height is very important in terms of preserving stored nutrients for regrowth after harvest. Therefore, it is necessary to investigate the difference in productivity and quality according to the cutting height when harvesting alfalfa, and for this purpose, a study to set an appropriate cutting height is required.

Therefore, this study was carried out to determine the change in productivity and feed value according to the cutting height when harvesting four times a year in Korea, and to establish an appropriate cutting height.

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 30 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 period.

In 2019, a total of four were harvested (May 3, July 2, September 11 and October 13) and cutting height were 5, 15 and 25 cm. 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 into screw-top plastic bottles and preserved 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

The plant height and forage quality according to the cutting height are as shown in Table 1. The cutting height did not affect the plant height, and there was the significant difference in plant height according to the harvest time.

The crude protein content was highest at the 4th harvest and the lowest at the 3rd harvest. Also, as the cutting height increased, the crude protein content increased significantly (P<0.05).

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

Harvest time	Cutting height (cm)	Plant height (cm)	CP (%)	ADF (%)	NDF (%)	IVDMD (%)	TDN (%)	RFV
1st	5	76.4	17.51^{c}	27.83^{a}	43.08	79.08^{b}	66.91^{b}	145
	15	74.7	18.18^{b}	28.25^{a}	42.11	77.71^{c}	66.58^{b}	148
	25	75.7	19.53^{a}	26.74^{b}	39.74	80.70^{a}	67.78^{a}	160
Mean		75.6^{B}	18.41^{C}	27.61^{C}	41.64^{C}	79.16^{B}	67.09^{B}	151^{A}
2nd	5	73.3	16.51^{c}	33.41^{a}	46.27^{a}	76.43^{b}	62.51^{c}	127^{c}
	15	68.9	19.63^{b}	30.67^{b}	43.29^{b}	76.79^{b}	64.67^{b}	140^{b}
	25	74.2	21.14^{a}	23.47^{c}	39.78^{c}	83.40^{a}	70.36^{a}	165^{a}
Mean		72.1^{B}	19.09^{B}	29.18^{B}	43.11^{B}	78.87^{B}	65.85^{C}	144^{B}
3rd	5	107.5	12.73^{c}	48.29^{a}	62.41^{a}	63.42^{b}	50.75^{c}	76^{c}
	15	108.3	14.42^{b}	45.00^{b}	60.37^{a}	64.90^{b}	53.35^{b}	83^{b}
	25	110.2	17.79^{a}	38.79^{c}	56.42^{b}	69.65^{a}	58.26^{a}	97^{a}
Mean		108.7^{A}	14.98^{D}	44.03^{A}	59.73^{A}	65.09^{C}	54.12^{D}	85^{C}
4th	5	42.0	24.03^{c}	30.76^{a}	45.90^{a}	80.73^{c}	64.60^{c}	132^{c}
	15	41.5	27.73^{b}	24.64^{b}	42.17^{b}	87.45^{b}	69.43^{b}	154^{b}
	25	40.3	30.95^{a}	22.98^{c}	39.11^{c}	89.63^{a}	70.75^{a}	169^{a}
Mean		41.3^{C}	27.57^{A}	26.13^{D}	42.39^{BC}	85.94^{A}	68.26^{A}	152^{A}

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

The content of ADF and NDF decreased as the cutting height increased, and was highest in the third harvest, where the harvest was delayed. Digestibility was highest at the 4th harvest, and the higher the cutting height, the higher it was.

The TDN content increased as the cutting height increased, and it was found in the order of 4th>1st>2nd>3rd. On the other hand, the RFV values were high in the 1st, 2nd and 4th (151, 144 and 152), but the 3rd harvest was low with an average of 85.

Table 2 shows the dry matter content and yield of alfalfa according to the cutting height. The dry matter content tended to decrease as the cutting height increased, but there was no significant difference at the 3rd and 4th harvests (P>0.05). The yield of fresh matter, dry matter and TDN decreased as the cutting height increased, but there was no significant difference at the third and fourth harvests (P>0.05).

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

Harvest time	Cutting height(cm)	Dry matter (%)	Yield (kg/ha)		
			Fresh matter	Dry matter	TDN
1st	5	30.39^{a}	24,611^{a}	7,478^{a}	5,004^{a}
	15	28.63^{b}	23,667^{b}	6,774^{b}	4,510^{b}
	25	27.33^{c}	22,334^{c}	6,102^{c}	4,136^{c}
	Mean	28.78^{A}	23,537^{A}	6,785^{A}	4,550^{A}
2nd	5	22.94^{a}	24,278^{a}	5,569^{a}	3,481^{a}
	15	21.33^{b}	22,000^{a}	4,694^{b}	3,036^{b}
	25	20.65^{b}	18,555^{b}	3,831^{c}	2,696^{b}
	Mean	21.64^{B}	21,611^{B}	4,698^{B}	3,071^{B}
3rd	5	21.79	22,556	4,940	2,503
	15	21.08	23,889	5,026	2,681
	25	21.24	21,278	4,520	2,633
	Mean	21.37^{B}	22,574^{AB}	4,829^{B}	2,606^{C}
4th	5	17.83	14,889	2,669	1,724
	15	16.22	12,945	2,093	1,453
	25	16.82	11,834	1,985	1,405
	Mean	16.96^{C}	13,222^{C}	2,249^{C}	1,527^{D}

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

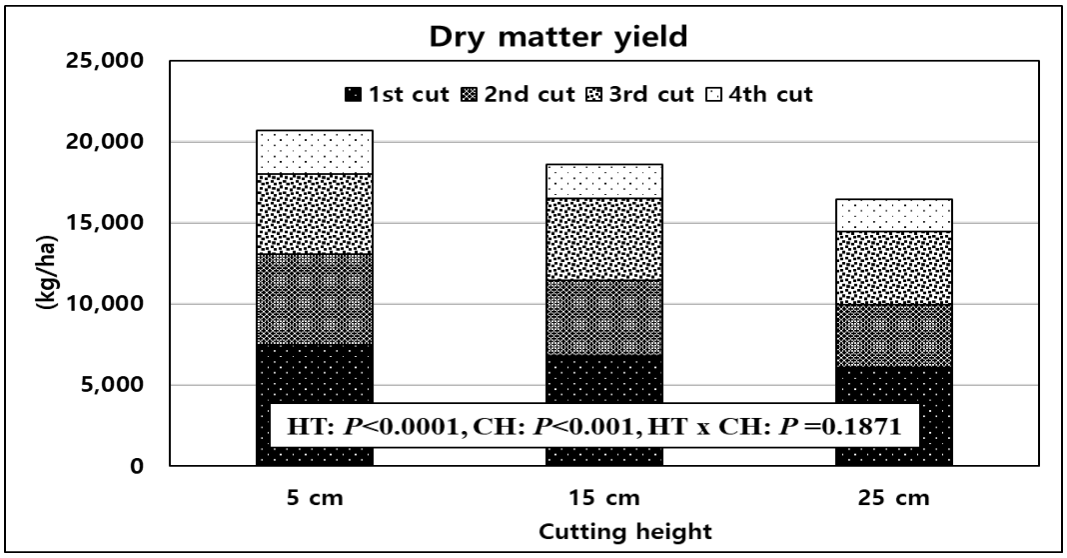

Figure 1. Total DM yield of alfalfa according to cutting height in northern area of Korea

*HT: harvest time, CH: cutting height

The total dry matter yield according to the cutting height was the highest at 20,656 kg/ha at 5 cm cutting height and the lowest at 16,438 kg/ha at 25 cm (Figure 1). The total dry matter yield decreased as the cutting height increased, and the interaction was not significant. However, there was a significant difference in the crude protein yield during the harvest period (P<0.05, Figure 2), but there was no significant difference in the cutting height (P>0.05).

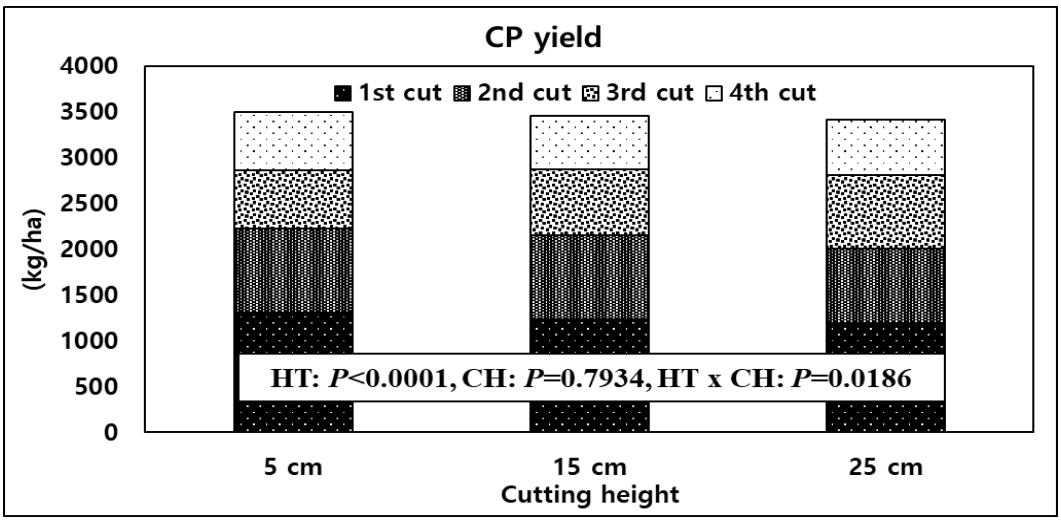

Figure 2 Total CP yield of alfalfa according to cutting height in northern area of Korea

*HT: harvest time, CH: cutting height

Discussion [Conclusions/Implications]

The recommended cutting height of alfalfa is 2 inches (5 cm). Even 1 inch does not have a big problem with regrowth, but it increases the ash content. Too often mowing can reduce (Dwane, 2018). However, in this study, the height of the cutting was set somewhat high (5-25 cm), but about 5 cm is recommended. According to the reports of Shen *et al*. (2013), harvesting to the ground may be a management option to increase alfalfa yield in a short-term cultivation system subjected to irrigation and fertilizer. In the alfalfa/grass mixed pasture, the cutting height (2 or 4 inches) did not affect the forage quality, but there was a difference in yield. Therefore, the cutting height should be determined differently depending on the field conditions, needs for forage, and the grass species planted (Thomas *et al*., 2006).

Acknowledgements

This research was supported by Cooperative Research Program for Agriculture Science & Technology Development (Project No. PJ01401903), Rural Development Administration, Republic Korea.

References

Dwane, M. 2018. Cutting height in hay field: How low can you go? PennState Extension. https://extension.psu.edu/cutting-height-in-hay-fields-how-low-can-you-go.

Holland C, Kezar W, Kautz WP, Lazowski EJ, Mahanna WC, Reinhart R. 1990. The pioneer forage manual; A nutritional guide, pp. 1-55, Pioneer Hi-Bred International, INC., Desmoines, IA.

Jean-Baptiste - André Dumas. 1884. *Science.* 3(72): 750-752.

Shen, Y., Jiang, H., Zhai, G., Cai, Q. 2013. Effects of cutting height on shoot regrowth and forage yield of alfalfa (*Medicago sativa* L.) in a short-term cultivation system. *Grassland Science* 59(2): 73-79.

Thomas, E.D, Ballard, C.S., Cotanch, K.W., Wolford, H.M., Flis, S.A.2006. The effect of cutting height on yield and quality of alfalfa in northern New York. Northern NY Agricultural Development Program 2005-2006 Project Report.

Van Soest PJ, JB Robertson, BA Lewis. 1991. Methods for Dietary Fiber, Neutral Detergent Fiber, and Nonstarch Polysaccharides in Relation to Animal Nutrition. *J. Dairy Sci.* 74(10): 3583-3597.