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Growth, Forage Production, and Quality of *Medicago sativa* in the Northern Part of South Korea

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Abstract A three-year study was conducted in the Pyeongchang area, South Korea, to evaluate the growth and productivity of 26 alfalfa varieties and to select those with superior feed values. We employed a randomized block design with three replications. HybriForce-2410 presented the highest dry matter yield (28.87 t/ha) among the cultivars and the highest three-year average fresh matter yield (118.78 t/ha). The three-year average dry matter yield of Alfalfa-short (26.55 t/ha) and Shockwave BR (26.21 t/ha) were also significantly ($p<0.05$) higher than that of the other cultivars. The acid detergent fiber content of HybriForce-2410 was the lowest, although not significantly different from that of the other cultivars. Burgaltai had the lowest neutral detergent fiber content, whereas A Er Gang Jin had the highest. The crude protein (CP) content ranged from 16.90% to 21.33% at mowing during early flowering; Burgaltai had the highest CP among the cultivars. Digestibility differed significantly among the cultivars compared with other feed value items. Although Burgaltai presented the best feed value, HybriForce-2410 showed the best results for both productivity and feed value.

Keywords: *alfalfa, cultivar, feed value, forage, pasture*

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1. Introduction

Alfalfa (*Medicago sativa* L.) is a perennial leguminous pasture grass with excellent annual productivity in cultivated areas and grasslands. [1] It is native to a mountainous region in Southwest Asia and is currently widely cultivated worldwide for grazing, hay, and silage. It is also commonly used to make powder feed because of its high nutrient content and good palatability for livestock. [2,3]

Additionally, alfalfa fixes nitrogen for plants and soil by fixing atmospheric nitrogen [4,5], which is advantageous for improving soil organic matter. [6] However, research on alfalfa is mainly conducted overseas; [7, 8] with only a few studies in South Korea because the domestic cultivation environment is not appropriate. Alfalfa is a temperate species that grows relatively poor under high-temperature conditions. It is highly adaptable to drought as a deep root crop, but its growth is hindered in the humid environments of South Korea, where the rainy season coincides with summer. Because alfalfa is highly sensitive to soil acidity, it requires soil adjustments when cultivated in acidic soils. Therefore, alfalfa tends to show poor growth and productivity in the soil environments of South Korea, which are mainly weakly acidic. To successfully grow alfalfa in such environments, more research is needed, and cultivars should be selected based on the results of long-term studies. Different alfalfa cultivars require different cultivation environments; thus, identifying alfalfa cultivars with excellent growth in South Korea will help produce high-quality forage in the country. However, cultivar development and distribution in South Korea has mainly focused on improving the productivity of crops such as Italian ryegrass, barley, and rye. [9-12] Although research on the physiology of alfalfa has only recently started in South Korea, [13,14] except for the study of Lee *et al.*, [15] studies on the adaptability of different alfalfa varieties to different regions in South Korea are scarce. Therefore, this study aimed to identify the most adaptable cultivars in a domestic environment based on the evaluation of growth performance, productivity, and feed value of 26 imported alfalfa varieties in the Pyeongchang region.

2. Materials and Methods

This study was conducted over three years from the autumn of 2016 to the autumn of 2018; the first sowing date was September 9, 2016. A field test was conducted in the Pyeongchang campus of Seoul National University, located in Pyeongchang-gun, Gangwon-do, South Korea (37°3240″ N, 128°2633″ E, 550 m above sea level). We used the seeds of 10 alfalfa varieties from Canada (HybriForce-2410, 4030, 4020MF, Shockwave BR, Radar II Brand, Adrenalin, Algonquin, Meritbrand, Alfalfa-short term, and Certified organic), six from China (ShanBei,

XinJiangDaye, AoHan, GanNong No. 3, Zhong Mu No. 1, and LaoBo), eight from the USA (San De Li, WL319HQ, HuangHou, JinHuangHou, Xun Lu, A Er Gang Jin, Vernal, and Natsuwakaba), one from France (42IQ), and one from Mongolia (Burgaltai). We employed a randomized complete block design with three replications. Fertilizers (N-P_2O_5-K_2O) were applied at a ratio of 80-200-70 kg/ha before sowing. Immediately after mowing, fertilisers were applied again as flexible side dressing depending on the cultivation environment; K_2O was applied at 50 kg/ha before winter. Weeding was performed manually when required, and mites and pests were controlled by insecticide application of indoxacarb, sulfoxaflor, and pyrethroid, according to the manufacturers' instructions. The average monthly temperature and precipitation during the experimental period are shown in Figure 1.

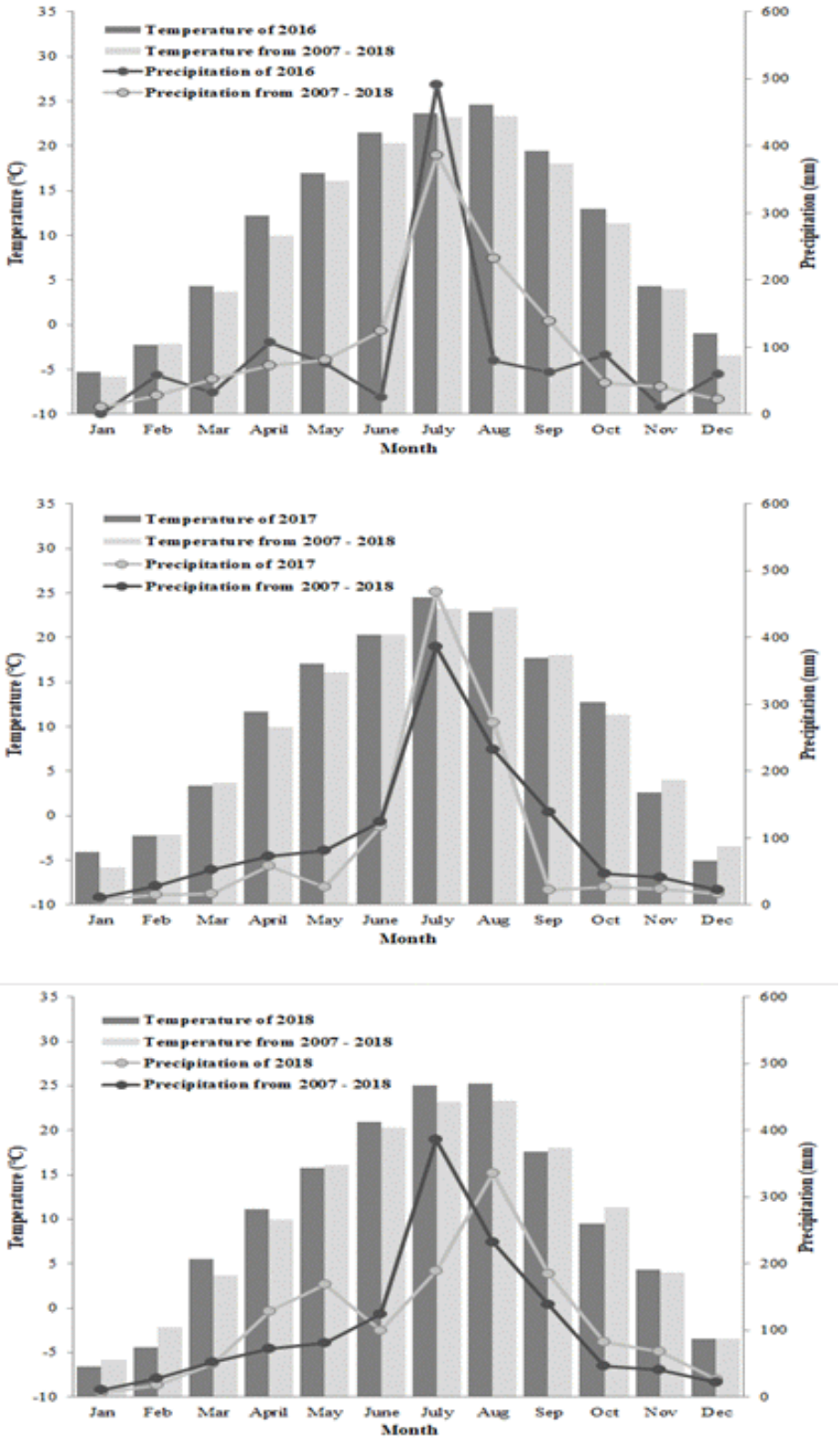

Figure 1. Comparative mean temperature (°C) and total precipitation (mm) over the previous decade (2007–2018) and during the experimental period (2017, 2018, and 2019) in the study area in Pyeongchang-gun, Gangwon-do, South Korea

Plant height (cm) was measured at harvest as the highest point of the plant body from the ground. Plant length was also measured in cm. Damage caused by disease or insect attacks was expressed on a scale of 1-9 (1 indicates the most severe damage, and 9 the least) on the day of harvest. Alfalfa was harvested four times each year during the early stages of flowering. The fresh matter yield was converted to kg/ha, and 300–500 g samples were collected and oven-dried at 60 °C in a circulating blast dryer for more than 72 h. The fresh matter yield was multiplied by percent dry matter to calculate dry matter yield. A feed value was conducted to analyze samples collected on the harvest day; acid detergent fiber (ADF) content and neutral detergent fiber (NDF) content were analyzed using the methods of George and Van Soest. [16] Relative feed value (RFV) was calculated using the digestible dry matter (DDM) and dry matter intake (DMI). Crude protein (CP) content was analyzed using the Association of Official Analytical Chemists (AOAC) method, [17] and total digestible nutrient (TDN) content was determined using the formula described by Menke and Huss. [18] *In vitro* dry matter digestibility was analyzed according to Tilley and Terry [19] as modified by Moore and Mott. [20]

* RFV = Relative feed value = (DDM × DMI) / 1.29
* DDM = Digestible dry matter = 88.9 − (0.779 × % ADF)
* DMI = Dry matter intake = 120 / % NDF
* TDN = Total digestible nutrient = 88.9 − (0.79 × % ADF)

Data are shown as mean ± standard error; all analyses were conducted using SPSS (version 12.0; SPSS Inc., Chicago, IL, USA). Significant differences were determined using Duncan's multiple range test.

3. Results

The plant height and length of the different alfalfa cultivars are shown in Table 1. The average height of the 26 alfalfa varieties was 45.35 cm. The height of HuangHou (50.5 cm) was significantly higher (P <0.05) than that of the other cultivars, and Adrenalin was the shortest (40.65 cm, P <0.05), despite exhibiting a high growth rate. Consistent with a previous study [21], the average height of 392 F1 alfalfa hybrids was 52.30 ± 0.14 cm. The average length of the 26 cultivars was 70.88 cm, and Radar II Brand was significantly longer than the other cultivars at 77.28 cm (P <0.05). Plant length was approximately 25 cm longer than plant height; furthermore, 19 of the 26 cultivars had a plant length of 70 cm or more.

The fresh matter and dry matter yields of the 26 alfalfa cultivars are shown in Table 2. The average fresh matter yield in the first year of evaluation (2016) was 88.83 t/ha. The fresh matter yield of alfalfa grown in the same area varied from 54.33 to 118.00 t/ha, depending on the cultivar. The yield of HybriForce-2410, Shockwave BR, Alfalfa-short, GanNong No. 3, WL319HQ, and Xun Lu was higher (P <0.05) than that of the other cultivars.

Table 1. Growth Performance of 26 Cultivars of Alfalfa (*Medicago sativa* L.) Cultivated in Pyeongchang-Gun, Gangwon-Do, South Korea

Cultivar	Plant height (cm)	Plant length (cm)	Disease tolerance (1-9)[i]
HybriForce-2410	43.56^{cdef}	70.33^{bcdef}	1
4030	43.62^{cdef}	72.08^{bcde}	1
4020MF	45.58^{bcde}	70.19^{cdef}	1
Shockwave BR	45.89^{bcde}	73.61^{abcde}	1
Radar II Brand	43.88^{cdef}	77.28^{a}	1
Adrenalin	40.65^{f}	74.28^{abcd}	1
Algonquin	44.63^{bcdef}	71.06^{bcdef}	1
Meritbrand	42.05^{ef}	73.50^{abcde}	1
Alfalfa-short term	42.97^{cdef}	71.28^{bcdef}	1
Certified organic	41.86^{ef}	66.55^{fg}	1
ShanBei	44.67^{bcdef}	60.42^{h}	1
XinJiangDaye	44.71^{bcdef}	69.50^{def}	1
AoHan	44.47^{bcdef}	66.64^{fg}	1
GanNong No.3	48.78^{ab}	75.09^{abc}	1
Zhong Mu No.1	44.71^{bcdef}	72.31^{bcde}	1
LaoBo	48.82^{ab}	74.11^{abcde}	1
San De Li	46.51^{abcd}	70.47^{bcdef}	1
42IQ	46.85^{abc}	74.95^{abc}	1
WL319HQ	46.35^{abcde}	74.06^{abcd}	1
HuangHou	50.50^{a}	70.17^{cdef}	1
JinHuangHou	48.71^{ab}	74.36^{abcd}	1
Xun Lu	46.92^{abc}	75.33^{ab}	1
A Er Gang Jin	44.46^{bcdef}	68.97^{ef}	1
Burgaltai	47.47^{abc}	61.83^{h}	1
Vernal	45.53^{bcde}	63.78^{gh}	1
Natsuwakaba	44.89^{bcdef}	70.61^{abcde}	1
SEM	1.17	1.33	-

[a-h] Variables with different superscripts in the same rows are significantly different (P <0.05).
[i] Disease tolerance: a lower number indicates more severe disease. (-): not measured.

Table 2. Forage Productivity of 26 Cultivars of Alfalfa (*Medicago sativa* L.) Cultivated in Pyeongchang-Gun, Gangwon-Do, South Korea

Cultivar	Fresh yield (kg/ha)			Dry matter yield (kg/ha)		
	2016	2017	2018	2016	2017	2018
HybriForce-2410	118,000^{a}	111,567^{a}	126,767^{a}	29,134^{a}	26,437^{ab}	31,054^{a}
4030	97,333^{abcd}	94,567^{abc}	88,633^{bcdef}	23,717^{abcde}	23,867^{abc}	21,003^{bcde}
4020MF	97,667^{abcd}	91,733^{abc}	85,267^{bcdef}	25,106^{abcd}	22,879^{bcd}	20,253^{def}
Shockwave BR	106,333^{abc}	90,533^{abc}	92,167^{bcd}	27,016^{abc}	23,086^{bcd}	22,798^{bcd}
Radar II Brand	94,333^{abcde}	84,400^{abc}	75,067^{defgh}	24,862^{abcd}	21,877^{bcde}	19,949^{def}
Adrenalin	98,667^{abcd}	84,067^{abc}	79.867^{cdefgh}	24,638^{abcd}	21,019^{bcde}	20,527^{cdef}
Algonquin	102,000^{abcd}	89,900^{abc}	85,600^{bcdef}	27,901^{ab}	23,038^{bcd}	23,282^{bcd}
Meritbrand	98,667^{abcd}	84,400^{abc}	71,967^{efgh}	24,235^{abcd}	21,647^{bcde}	18,942^{defg}
Alfalfa-short	101,000^{abcd}	84,800^{abc}	73,967^{defgh}	25,193^{abcd}	34,264^{a}	20,196^{def}
Certified organic	79,000^{bcdef}	68,533^{cde}	57,800^{hij}	18,981^{def}	16,845^{bcde}	14,890^{gh}
ShanBei	54,333^{fg}	44,100^{ef}	43,067^{j}	14,364^{ef}	11,332^{de}	11,731^{h}
XinJiangDaye	77,000^{cdef}	80,033^{bcd}	73,167^{defgh}	20,494^{bcdef}	20,481^{bcde}	21,181^{bcde}
AoHan	80,000^{bcdef}	74,933^{cd}	64,800^{fghij}	19,922^{cdef}	17,997^{cde}	17,341^{efg}
GanNong No.3	101,333^{abcd}	95,467^{abc}	92,467^{bcd}	25,329^{abcd}	23,864^{abc}	25,867^{b}
Zhong Mu No.1	92,000^{abcde}	89,533^{abc}	83,967^{bcdef}	23,013^{abcde}	21,631^{bcde}	21,114^{bcde}
LaoBo	81,333^{bcdef}	84,233^{abc}	78,200^{cdefgh}	20,257^{bcdef}	21,016^{bcde}	20,157^{def}
San De Li	85,000^{bcde}	82,533^{bc}	85,067^{bcdef}	21,850^{abcde}	20,667^{bcde}	22,271^{bcde}
42IQ	67,000^{ef}	73,767^{cd}	73,567^{defgh}	16,512^{ef}	19,452^{bcde}	19,362^{defg}
WL319HQ	103,000^{abcd}	104,133^{ab}	107,733^{ab}	25,468^{abcd}	25,080^{ab}	25,787^{b}
HuangHou	87,333^{bcde}	81,933^{bc}	82,567^{cdefg}	21,690^{abcdef}	19,559^{bcde}	19,656^{def}
JinHuangHou	96,000^{abcd}	92,033^{abc}	94,800^{bcd}	22,658^{abcde}	22,277^{bcd}	23,266^{bcd}
Xun Lu	106,667^{ab}	103,767^{ab}	101,567^{abc}	27,469^{abc}	25,863^{ab}	25,298^{bc}
A Er Gang Jin	81,333^{bcdef}	83,400^{abc}	78,967^{cdefgh}	19,999^{cdef}	21,010^{bcde}	20,465^{cdef}
Burgaltai	76,667^{def}	53,900^{def}	59,867^{ghij}	18,715^{def}	12,446^{cde}	15,627^{fgh}
Vernal	37,333^{g}	41,433^{f}	48,733^{ij}	8,622^{f}	10,273^{e}	12,622^{h}
Natsuwakaba	90,333^{abcde}	94,233^{abc}	92,033^{bcdef}	22,181^{abcde}	22,309^{bcd}	22,106^{bcde}
SEM	7,534	7,594	8,315	1,975	2,322	1,314

$^{a-j}$ Variables with different superscripts in the same rows are significantly different (P <0.05).

The average fresh matter yield in the second year (2017) was 83.23 t/ha. Burgaltai presented the most significant decrease in fresh matter yield in the second year relative to that in the first year, with a total decrease of 22.77 t/ha. In the second year, the fresh matter yield of HybriForce-2410, with the highest yield in the first year, was 111.57 t/ha, which was higher (P <0.05) than that of the other cultivars, but it was approximately 6.43 t/ha lower than that in the first year.

The highest increase in fresh matter yield compared with that in the first year was recorded in 42IQ, with a total increase of 6.77 t/ha. In 2018, the average fresh matter yield was 77.61 t/ha; the fresh matter yield of HybriForce-2410 was higher (P <0.05) than that of all other cultivars at 126.77 t/ha and Vernal had the lowest at 48.73 t/ha. HybriForce-2410 presented the highest fresh matter yield for three years (P <0.05), with an average of 118.78 t/ha. The average fresh matter yield of WL319HQ and Shockwave BR was 104.95 and 104.00 t/ha over the three years, respectively, which is an excellent level of productivity in the Pyeongchang area.

The average dry matter yield of the 26 alfalfa cultivars grown in the Pyeongchang area in 2016 was 22.28 t/ha, ranging from 8.62 to 29.13 t/ha (Table 2). HybriForce-2410, WL319HQ, Xun Lu, and Shockwave BR were the best cultivars in terms of dry matter yield. GanNong No. 3 was superior to all other cultivars (P <0.05).

Regarding the secondary dry matter yield of the 26 alfalfa cultivars, Vernal presented the lowest yield (10.27 t/ha), whereas Alfalfa-short presented the highest yield (34.26 t/ha) (P <0.05). The dry matter yield of Alfalfa-short was higher (P <0.05) than that of the other cultivars in the second year, although it did not differ (P <0.05) from that of HybriForce-2410, which had the highest dry matter yield in the first year. Additionally, 4030, GanNong No. 3, WL319HQ, and Xun Lu presented higher (P <0.05) secondary dry matter yields than the other cultivars, and the values did not differ (P <0.05) from that of Alfalfa-short. The average dry matter yield of the 26 cultivars in the third year was 20.64 t/ha, which was the lowest for the three years. Thus, some cultivars showed an increase in the fresh matter yield and dry matter yield over the three years, but the yield of most cultivars tended to decrease year-on-year.

The average dry matter yield of ShanBei for three years was 12.47 t/ha, which was lower (P <0.05) than that of the other cultivars tested, except Vernal, which showed seed problems. The dry matter yield of HybriForce-2410 was higher (P <0.05) than that of the other cultivars, with an average of 28.87 t/ha for three years. Alfalfa-short, Shockwave BR, WL319HQ, GanNong No. 3, and Algonquin showed excellent productivity when cultivated in the Pyeongchang area.

Table 3. Feed Values of 26 Cultivars of Alfalfa (*Medicago sativa* L.) Cultivated in Pyeongchang-Gun, Gangwon-Do, South Korea

Cultivar	ADF[1] (%)	NDF[2] (%)	CP[3] (%)	IVDMD[4] (%)
HybriForce-2410	37.56^{a}	48.05^{ab}	19.64^{ab}	71.92^{ab}
4030	41.44^{ab}	52.03^{ab}	18.09^{ab}	68.31^{defgh}
4020MF	41.31^{ab}	52.21^{ab}	17.78^{ab}	65.46^{hi}
Shock wave BR	39.66^{ab}	49.31^{ab}	18.29^{ab}	67.97^{defgh}
Radar II Brand	40.02^{ab}	51.16^{ab}	17.80^{ab}	68.72^{cdefgh}
Adrenalin	39.51^{ab}	49.91^{ab}	18.09^{ab}	69.63^{bcdef}
Algonquin	40.21^{ab}	51.72^{ab}	18.03^{ab}	67.77^{defgh}
Meritbrand	40.15^{ab}	51.23^{ab}	17.53^{ab}	67.98^{defgh}
Alfalfa-short	40.42^{ab}	51.50^{ab}	16.90^{b}	67.71^{defgh}
Certified organic	37.95^{a}	49.71^{ab}	19.64^{ab}	71.66^{abc}
ShanBei	41.32^{ab}	51.15^{ab}	16.97^{b}	65.80^{ghi}
XinJiangDaye	40.57^{ab}	51.12^{ab}	17.58^{ab}	66.25^{ghi}
AoHan	42.40^{ab}	51.49^{ab}	17.39^{ab}	66.55^{fghi}
GanNong No.3	44.65^{b}	52.39^{ab}	15.78^{b}	64.32^{i}
Zhong Mu No.1	43.29^{ab}	51.21^{ab}	17.56^{ab}	66.11^{ghi}
LaoBo	41.14^{ab}	49.39^{ab}	18.12^{ab}	70.95^{abcd}
San De Li	41.92^{ab}	50.56^{ab}	18.02^{ab}	67.78^{defgh}
42IQ	39.92^{ab}	48.79^{ab}	17.80^{ab}	67.32^{efghi}
WL319HQ	39.71^{ab}	49.41^{ab}	19.10^{ab}	70.69^{abcd}
HuangHou	41.06^{ab}	49.81^{ab}	18.52^{ab}	68.77^{bcdefg}
Jin Huang Hou	42.70^{ab}	51.02^{ab}	17.14^{b}	66.23^{ghi}
Xun Lu	40.50^{ab}	49.16^{ab}	18.93^{ab}	70.14^{bcde}
A Er Gang Jin	42.04^{ab}	53.33^{b}	17.03^{b}	66.24^{ghi}
Burgaltai	38.54^{ab}	47.24^{a}	21.33^{a}	73.33^{a}
Vernal	39.44^{ab}	51.64^{ab}	17.88^{ab}	67.88^{defgh}
Natsuwakaba	39.00^{ab}	50.85^{ab}	18.85^{ab}	69.64^{bcdef}
SEM	1.61	1.47	1.04	0.73

[a-i] Variables with different superscripts in the same rows are significantly different (P <0.05).
ADF[1] – acid detergent fibre; NDF[2] – neutral detergent fiber; CP[3] – crude protein; IVDMD[4] – *in vitro* dry matter digestibility.

The results of the feed value analysis of the 26 alfalfa cultivars are presented in Table 3 and Table 4. The ADF content ranged from 37.56% to 44.65%, and the differences among cultivars were relatively small. HybriForce-2410, with the lowest ADF content of 37.56%, was the best among all cultivars, but there was no significant difference relative to the ADF content of most cultivars tested. Contrarily, the cultivar with the highest ADF content was GanNong No. 3 (44.65%) and was thus the lowest-ranked variety (P <0.05). The ADF content from the early bud stage to the early bloom stage, when alfalfa was harvested in this study, ranged from 41.7% to 48.0%.

The average NDF content of the 26 alfalfa cultivars was 50.59%, and the best was Burgaltai, with the lowest value of 47.24%, whereas A Er Gang Jin was the worst variety, with 53.33% (P <0.05). The three-year average CP content in the 26 cultivars ranged from 16.90% to 21.33%, with an average of 18.07%. Burgaltai presented the highest value (21.33%), whereas GanNong No. 3 and Jin Huang Hou showed the lowest (15.78% and 17.14%, respectively) (P <0.05).

The average digestibility of the 26 cultivars here was 68.27%, which was significantly different from the average ADF, NDF, and CP content. The digestibility of alfalfa is related to the ageing of leaves and stems. When grown during the same period, varietal differences are considered to be caused by the differences in maturity and ability to adapt to the growing environment. The cultivar-specific TDN content tended to be the same as the ADF content, and HybriForce-2410 presented the best TDN at 59.23% (P <0.05). Among the 26 cultivars of alfalfa, the RFVs, calculated based on the ADF and NDF content, of HybriForce-2410 and Certified organic were the best (115.46 and 111.04, respectively); the average relative feed value was 105.38.

4. Discussion

The higher the alfalfa plants, the stronger their uprightness. Santos *et al*. [22] reported a strong relationship between height and productivity of alfalfa. Although alfalfa shows rather weak uprightness, it is a bunch-type pasture grass, with longer plants having higher productivity.

In a typical growing environment, alfalfa generates many tillers, as it is repeatedly mowed. Moreover, crop productivity has been shown to significantly decrease in the second year due to the fixation of atmospheric nitrogen in the soil, [23] with the establishment of nitrogen-fixing bacteria. However, considering the humid domestic climate in the cultivation area, alfalfa productivity may decrease depending on the year. For example, in 2017, precipitation occurred from June to September, and the temperature during these months, except July, was higher than that in 2016; this may also have accounted for the observed decrease in productivity in the second year.

The dry matter yield of eight alfalfa varieties grown in India was 12.87–16.36 t/ha. [24] Contrarily, Arashad *et al*. [25] reported a significant difference in dry matter productivity according to the level of fertilization, and the best yield was 5.33 ton/ha per mowing. The dry matter productivity of alfalfa varies with the cultivar, management, mowing time, and cultivation environment. Here, the dry matter yield was significantly higher than that reported in a previous study. This was likely due to sowing in the fall and mowing four times starting in early spring.

Although there have been studies on Vernal worldwide, [26] the reason for the poor performance observed here is most likely seedling vitality. In this study, various cultivars with no history of cultivation in South Korea were introduced, and Vernal did not initially grow well because year-on-year accumulated seeds were used. Consequently, the ability of the plant to become properly established in the soil was insufficient, and this might cause a decrease in productivity.

Here, side dressing (additional fertilization) was performed when cultivating alfalfa for three years, considering the cultivation environment immediately after mowing, and the productivity decreased because our field experiment was performed without supplemental seeding and renewal.

Stavarache *et al*. [27] showed that alfalfa differed in feed values depending on the growth stage. They reported that the NDF content of alfalfa tended to increase with a delay in mowing; when mowed in the early bud stage, the NDF content was 48.4%, which is consistent with our findings.

Aponte *et al*. [28] reported that the CP content was 21.0%–22.6% in seeding alfalfa grown for four years at the North Dakota State University in the United States, and this was considerably higher than our values, except for the CP content of Burgaltai (21.33%). This indicates that the feed value of alfalfa cultivated in South Korea will likely not be limiting.

Table 4. Feed Values of 26 Cultivars of Alfalfa (*Medicago sativa* L.) Cultivated in Pyeongchang-Gun, Gangwon-Do, South Korea

Cultivar	DDM[1] (%)	DMI[2] (%)	RFV[3]	TDN[4] (%)
HybriForce-2410	59.64[a]	2.50[ab]	115.81[ns]	59.23[a]
4030	56.62[ab]	2.31[ab]	101.45	56.16[ab]
4020MF	56.72[ab]	2.30[ab]	101.15	56.26[ab]
Shock wave BR	58.00[ab]	2.43[ab]	108.45	57.57[ab]
Radar II Brand	57.72[ab]	2.35[ab]	103.71	57.28[ab]
Adrenalin	58.12[ab]	2.40[ab]	109.57	57.68[ab]
Algonquin	57.58[ab]	2.32[ab]	105.08	57.13[ab]
Meritbrand	57.62[ab]	2.34[ab]	104.97	57.18[ab]
Alfalfa-short	57.41[ab]	2.33[ab]	104.81	56.97[ab]
Certified organic	59.34[a]	2.41[ab]	111.95	58.92[a]
ShanBei	56.71[ab]	2.35[ab]	103.26	56.26[ab]
XinJiangDaye	57.30[ab]	2.35[ab]	104.63	56.85[ab]
AoHan	55.87[ab]	2.33[ab]	101.13	55.41[ab]
GanNong No.3	54.12[b]	2.29[ab]	96.57	53.62[b]
Zhong Mu No.1	55.18[ab]	2.34[ab]	100.35	54.70[ab]
LaoBo	56.85[ab]	2.43[ab]	108.21	56.39[ab]
San De Li	56.24[ab]	2.37[ab]	103.51	55.78[ab]
42IQ	57.80[ab]	2.46[ab]	110.52	57.37[ab]
WL319HQ	57.97[ab]	2.43[ab]	110.45	57.53[ab]
HuangHou	56.91[ab]	2.41[ab]	106.99	56.46[ab]
Jin Huang Hou	55.64[ab]	2.35[ab]	101.53	55.17[ab]
Xun Lu	57.35[ab]	2.44[ab]	108.84	56.91[ab]
A Er Gang Jin	56.15[ab]	2.25[b]	97.94	55.69[ab]
Burgaltai	58.88[ab]	2.54[a]	116.40	58.45[ab]
Vernal	58.18[ab]	2.32[ab]	104.83	57.74[ab]
Natsuwakaba	58.52[ab]	2.36[ab]	107.36	58.09[ab]
SEM	1.53	0.07	5.08	1.27

[a,b] Variables with different superscripts in the same rows are significantly different (P <0.05).
[ns] Means are not significant.
DDM[1] – digestible dry matter; DMI[2] – dry matter intake; RFV[3] – relative feed value; TDN[4] – total digestible nutrient.

5. Conclusions

The productivity and feed values of HybriForce-2410 were superior to those of all other cultivars, demonstrating a greater ability to adapt to the domestic environment than the other cultivars evaluated in this study. The cultivation of alfalfa varieties with excellent adaptability to South Korean local environments will contribute to the production of domestic livestock products.

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Conflict of Interests

The authors have no conflict of interests to declare.

List of Abbreviations

acid detergent fiber (ADF), relative feed value (RFV), crude protein (CP), digestible dry matter (DDM), dry matter intake (DMI), neutral detergent fiber (NDF), total digestible nutrient (TDN)

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