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Research Article

Development and Characterization of New Alfalfa Variety 'Alfaking'

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ABSTRACT

A new variety of Alfalfa (*Medicago sativa* L.), named 'Alfaking' was developed between 2015 and 2023 at the Grassland and Forages Division, National Institute of Animal Science, Rural Development Administration, Cheonan, Republic of Korea. The variety was produced through artificial hybridization, with 'Paravivo' serving as the maternal line and 'WL514' as the paternal line. 'Alfaking' underwent field tests across four regions (Cheonan, Pyeongchang, Jeongeup, and Jinju) to evaluate its agronomic characteristics and forage production over two years (2022-2023). The dry matter yield of 'Alfaking' reached 22,516 kg/ha, which is 11% higher than the control variety, 'Vernal.' 'Alfaking' exhibited 2.1% higher crude protein content than 'Vernal' in forage nutritive value. The development of this new alfalfa variety, which exhibits excellent adaptability to challenging environmental conditions, is expected to enhance forage cultivation and productivity in Korea.

(Key words: Grassland, Alfaking, Alfalfa, New Variety, Productivity)

Ⅰ. INTRODUCTION

Alfalfa (*Medicago sativa* L.) is a perennial legume forage crop characterized by a deep root system, purple flowers, and spiral pods (Mielmann, 2013). It is highly adaptable to diverse environments and demonstrates strong resistance to abiotic stresses such as cold, drought and salinity (Shi et al., 2017; Sălceanu et al., 2023). Known as the "Queen of Forages", alfalfa is valued for its high crude protein content, vitamins, and minerals, and a well-balanced amino acid profile, all contributing to its superior forage nutritive value (Wang et al., 2015; Bruma et al., 2023). Moreover, alfalfa enhances soil fertility through nitrogen fixation facilitated by rhizobia (Zhao et al., 2020; Elgharably and Benes, 2021), and its deep root system helps prevent soil erosion, making it an environmentally significant crop (Parajuli et al., 2021). Due to these benefits, alfalfa is cultivated worldwide, with the global market valued at 25.66 billion USD in 2023 (Fortune Business Insights, 2024). Alfalfa is also an essential forage crop in South Korea, with 147,000 tons imported in 2023, accounting for 16% of all imported forage. This represents an expenditure exceeding 100 billion KRW, based on the 2023 average market price of 773 KRW/kg (MAFRA, 2024). Alfalfa demand in Korea is expected to grow at an average annual rate of 2.3% (Kim et al., 2023), driving a continuous rise in domestic demand. However, Korea's alfalfa supply remains entirely dependent on imports, leaving the country vulnerable to price fluctuations caused by international market instability and potential yield reduction due to climate change. There is a pressing need for stable domestic alfalfa production to address the current imbalance in forage supply, which is heavily reliant on winter forage crops.

Alfalfa growth is highly sensitive to the physical and chemical properties of the soil (Orloff, 2007). In Korea, only 18% of agricultural land has a soil depth exceeding 90 cm, which is suitable for alfalfa cultivation (Orloff, 2007; NGII, 2020). Additionally, much of the land is acidic due to its granite-based parent rock (Kim et al., 2021). To optimize alfalfa growth and active nitrogen fixation, soil pH must be adjusted to a range of 6.8 to 7.5 (Choi and Chun, 1994). Climate also plays a crucial role in alfalfa production; in humid conditions, alfalfa is susceptible to root rot, which significantly reduces both yield and persistence (Alva et al., 1985; Malvick and Grau, 2016). In Korea, where most forage crops are

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cultivated in paddy fields and reclaimed lands, waterlogging presents another major limitation for alfalfa production.

Research aimed at promoting domestic alfalfa cultivation began in 1956 with the introduction of foreign alfalfa varieties to Korea. By 1965, regional adaptability trials were underway to assess these varieties’ suitability for local conditions (Park et al., 1973). Research efforts from the 1980s to the 2000s focused on refining cultivation techniques for the domestic environment (Kim et al., 2023). However, most initiatives were limited to trial cultivation and failed to achieve commercial success, primarily due to the poor adaptation of imported alfalfa varieties to Korean conditions. For example, U.S. alfalfa breeding efforts have primarily focused on fall dormancy and cold tolerance (Kim et al., 2023). While China has developed varieties with enhanced drought, salinity, and cold tolerance (Jin et al., 2021; Wang and Zhang, 2023). These examples underscore the importance of breeding alfalfa varieties tailored to specific environmental conditions for commercial viability. Recently, the National Institute of Animal Science (NIAS) has been actively collecting a diverse range of genetic resources from domestic and international sources. These genetic materials are being analyzed for agronomic traits, and new alfalfa varieties are being developed through artificial crossbreeding.

In this study, we aimed to contribute to the promotion of domestic alfalfa cultivation by evaluating the unique characteristics of a newly developed alfalfa variety, ‘Alfaking’, which is currently under application for new variety protection with the Korea Seed & Variety Service (KSVS). We assessed not only the agronomic and botanical characteristics of the ‘Alfaking’ but also its dry matter yield and forage quality under domestic cultivation conditions.

Ⅱ. MATERIALS AND METHODS

This study was conducted from 2015 to 2023 by the Grassland and Forages Division of the National Institute of Animal Science (NIAS), Rural Development Administration (RDA), to develop a new alfalfa variety with superior adaptability to the domestic climate.

1. Selection of superior individuals and creation of cross combinations

Alfalfa genetic resources preserved by NIAS, RDA, as well as various alfalfa varieties collected domestically and internationally since 2015, were evaluated for basic growth characteristics in the breeding greenhouse. The maternal variety, Paravivo, was crossbred with the paternal variety, WL514, through artificial hybridization in 2016, the F1 generation was cultivated, and from the F3 generation onward, lines were selected using the pedigree breeding method. In the yield trial conducted in 2021, a line with superior early growth and productivity was temporarily designated 'MsCB07.' Following regional adaptability trials conducted from 2022 to 2023, this line was confirmed to have outstanding productivity traits and was officially named 'Alfaking' by the New Variety Selection Committee in July 2023 (Fig. 1).

2. Investigation of inherent characteristics of ‘Alfaking’

A yield trial for the alfalfa breeding line ‘Alfaking’ was

Year	'16		'17	'18	'19	'20	'21	'22	'23
Generation	Cross	F_1	F_2	F_3	F_4	F_5	F_6	F_7	F_8
Paravivo × WL514	MsCB07	B	⑤ (1 … 15)	② (1 … 5)	③ (1 …)	①	①	Alfaking	
remark	Cross	Pedigree					AYT[y]	RYT[x]	

Fig. 1. Pedigree diagram of a new alfalfa variety, 'Alfaking'. [y]AYT: Advancedyieldtrial, [x]RYT: Regionalyieldtria.

conducted in 2021 at the experimental field of the Grassland and Forages Division of NIAS. The inherent characteristics of the new variety were investigated according to the guidelines for alfalfa characteristic evaluation provided by the Korea Seed & Variety Service (KSVS).

3. Regional adaptability trials

The regional adaptability trials were conducted from 2022 to 2023 over a period of two years in four locations, including Cheonan, Pyeongchang, Jeongeup, and Jinju, as part of a collaborative research project for new variety development by the RDA. The test variety, ‘Alfaking,’ was compared against the imported variety ‘Vernal’ to evaluate its regional adaptability and productivity, as well as to assess its basic growth characteristics. The sowing dates were September 28, 2021, in Cheonan, September 14 in Pyeongchang, September 23 in Jeongeup, and October 8 in Jinju. The seeding rate was 20 kg/ha, and the seeds were sown using drill sowing with a 20 cm row spacing. Fertilization rates and methods followed those outlined by Song et al. (2021), where compound fertilizers of N-P_2O_5-K_2O at 80-200-70 kg/ha were applied at the time of sowing, and maintenance fertilizers were applied at N-P_2O_5-K_2O rates of 210-150-180 kg/ha. Nitrogen was applied in split doses, with 30%, 30%, 20%, and 20% applied in early spring, after the first harvest, after the second harvest, and after the third harvest, respectively. Phosphorus and potassium fertilizers were applied in two equal splits, with 50% applied in early spring and the remaining 50% applied after the third harvest. Morphological characteristics of the variety were investigated in Cheonan, while yield measurements were taken by harvesting the entire plot at all four regional adaptability trial sites.

4. Evaluation of forage nutritive value

The forage nutritive value of the alfalfa breeding line ‘Alfaking’ was analyzed following the method outlined by Park et al. (2012). Crude protein (CP) content was determined using the Kjeldahl method (Kjeltec™ 2400 Autosampler System), according to the AOAC (1990) method. Acid detergent fiber (ADF) and neutral detergent fiber (NDF) contents were analyzed using an Ankom Fiber Analyzer (Ankom Technology, 2005a; 2005b) with reagents from the Goering and Van Soest (1970) method. In vitro dry matter digestibility (IVDMD) was analyzed using the modified method of Moore (1970), based on the technique of Tilley and Terry (1963).

5. Statistical analysis

The analysis was conducted using SAS 9.1.3 software and the difference in the means of the two varieties was compared using a Student's t-test at the $p<0.05$ level.

Ⅲ. RESULTS AND DISCUSSION

1. Inherent characteristics of the new alfalfa variety 'Alfaking'

The main agronomic and growth characteristics of the new alfalfa variety ‘Alfaking’ are shown in Table 1. ‘Alfaking’ exhibits an erect growth habit with green, elongated-oval leaves, and its flowers are a deep purple. The variety demonstrated strong regrowth ability after overwintering, with a regrowth and disease resistance rating of 1.3, indicating high resilience. Lodging resistance was rated at 2.1, reflecting minimal susceptibility to lodging. ‘Alfaking’ has an early flowering date of approximately May 11, only one day later than the control variety ‘Vernal.’ At early flowering, the plant length of ‘Alfaking’ measured 91.0 cm, which is 0.7 cm shorter than ‘Vernal’, while its plant height was 53.6 cm, 3.7 cm taller than ‘Vernal.’ Additionally, the average plant height from the second to fourth cuttings was 49.7 cm, 1.8 cm taller than ‘Vernal’ across all cutting stages (Table 1).

2. Dry matter yield of the new alfalfa variety 'Alfaking'

To evaluate the regional adaptability of the new alfalfa variety ‘Alfaking’, dry matter yield trials were conducted over two years at four regions, including Cheonan, Pyeongchang, Jeongeup, and Jinju (Table 2). The average dry matter yield for ‘Alfaking’ across all regions was 22.516 kg/ha, which is 11% higher than the control variety ‘Vernal’, which produced 20.236 kg/ha. In each region, ‘Alfaking’ consistently outperformed ‘Vernal’ in terms of dry matter yield.

These results suggest that the newly developed variety ‘Alfaking’ not only demonstrates superior adaptability to the Korean climate but also exhibits high persistence. In general, higher yielding crops were correlated with better persistence

(Putnam, 2021). ‘Alfaking’ maintains productivity over multiple years from a single sowing. This trait leads to a higher dry matter yield compared to the imported variety ‘Vernal.’ (Fig. 2).

3. Forage nutritive value of the new alfalfa variety 'Alfaking'

As shown in Table 3, the forage nutritive value of the new

Table 1. Agronomic and botanical characteristics of “Alfaking” in Cheonan, 2021

Characteristics	Vernal	Alfaking
Growth habit	Erect	Erect
Flower color	Dark purple	Deep dark purple
Leaf width	Medium	Medium
Leaf shape	Oval	ElongatedOval
Seed coat color	Brown	Brown
Regrowth after overwintering(1-9)*	1.4	1.3
Disease resistance (1-9)*	1.8	1.3
Lodgging resistance (1-9)*	2.5	2.1
Early flowering date	May10	May11
Early flowering stage		
- Plant length (cm)	91.7	91.0
Plant height after cutting		
- 1st cutting (cm)	50.9	53.6
- 2nd cutting (cm)	49.7	51.2
- 3rd cutting (cm)	45.5	47.6
- 4th cutting (cm)	48.4	50.2

*(1-9): 1 = Good(strong), 9 = Bad (weak).

Table 2. Dry matter yield of Alfalfa varieties cultivated in Cheonan, Pyeongchang, Jeongeup and Jinju from 2022 to 2023

Trial region	Cheonan	Pyeongchang	Jeongeup	Jinju	Mean
Vernal	18,404	17,735	24,875	19,929	20,236
Alfaking	22,522*	20,735*	25,612ns	21,196ns	22,516*

*significant effects between variety at $p<0.05$.
ns: not significant.

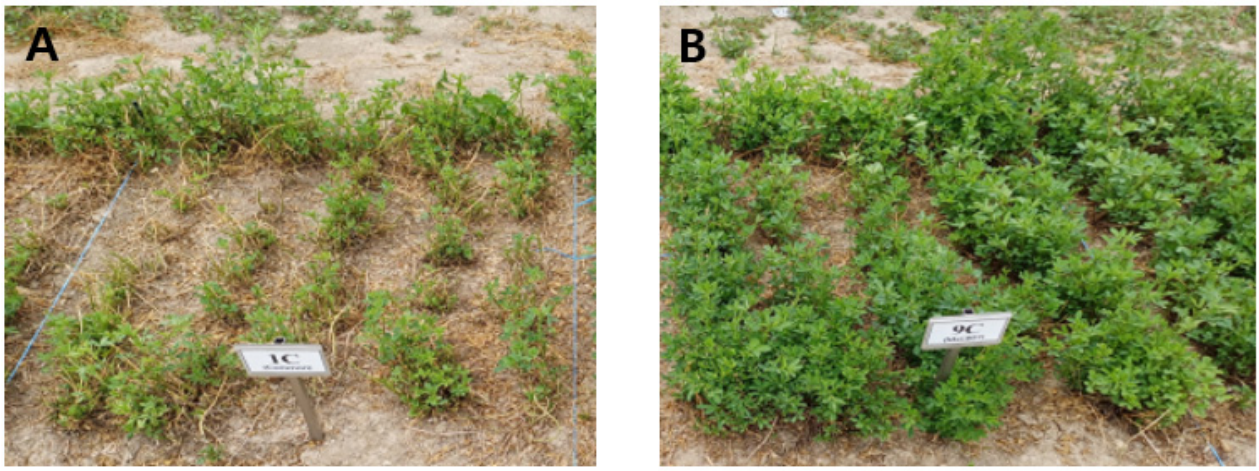

Fig. 2. Comparison of alfalfa growth and development at Jeongeup in 2022. (A) Control variety Vernal, after harvesting (2 weeks), (B) New variety Alfalking, after harvesting (2 weeks).

Table 3. Evaluation of forage nutritive value of alfalfa varieties cultivated in Cheonan and Jeongeup, 2023

Varieties	CP (%)	IVDMD (%)	NDF (%)	ADF (%)	TDN (%)
Vernal	18.0	71.5	39.8	26.4	68.0
Alfaking	20.1	79.5	41.3	26.0	68.4

*Forage nutritive value: average of two locations (2023, Cheonan and Jeongup).

alfalfa variety ‘Alfaking’ was superior to that of the control variety 'Vernal' in several aspects. ‘Alfaking’ had a crude protein (CP) content of 20.1%, in vitro dry matter digestibility (IVDMD) of 79.5%, and total digestible nutrients (TDN) of 68.4%. Additionally, the neutral detergent fiber (NDF) content was 41.3%, and acid detergent fiber (ADF) content was 26.0%, showing similar trend to 'Vernal.'

According to the USDA hay quality designation guidelines, the CP content of ‘Alfaking’ is classified within the Premium grade (20 - 22%) and its ADF content conforms to the Supreme grade (< 27%), both indicating its excellent quality. Feng et al. (2022) analyzed the productivity and forage value of alfalfa across 301 experimental sites in China. They reported a 95% confidence interval for CP content ranging from 18.92% to 19.19% and for ADF content from 30.90% to 31.68%. In comparison, ‘Alfaking’ demonstrated superior forage nutritive value with a higher CP content of 20.1% and a lower ADF content of 26.0%. Additionally, a study reported by Putnam (2021) in California compared forage nutritive value across different growth stages, showing a CP content of 21.3% and an ADF content of 32.2% at the early flowering stage. Although the CP content of ‘Alfaking’ is approximately 1% lower, its ADF content is over 6% lower, indicating a clear advantage in fiber composition. Feng et al. (2022) reported that alfalfa varieties with higher forage quality tend to exhibit lower productivity. Similarly, Hill and Barnes (1977) demonstrated a genetic negative correlation between yield and forage quality. These findings underline that overcoming the trade-off between yield and forage quality is a key breeding objective in alfalfa improvement. Several studies (Jia et al., 2018; Medina et al., 2021) have also emphasized that improving both yield and forage quality simultaneously is a critical challenge in alfalfa breeding. ‘Alfaking’ showed superior performance in both yield and forage quality compared to ‘Vernal,’ indicating that this variety successfully meets both breeding objectives.

Ⅳ. CONCLUSIONS

This study, conducted from 2015 to 2023 by the Grassland and Forage Division of the National Institute of Animal Science (NIAS), Rural Development Administration (RDA), aimed to develop a new alfalfa variety with superior adaptability to the Korean climate and enhanced productivity. The new variety, 'Alfaking,' exhibits an erect growth habit with green leaves and a flowering date around May 11, similar to the control variety 'Vernal.' At the early flowering stage, 'Alfaking' reaches a plant height of approximately 91 cm. In the regional adaptability trials conducted in four regions, the average dry matter yield of 'Alfaking' was 22.5 tons/ha, 11% higher than that of 'Vernal.' 'Alfaking' outperformed 'Vernal' in terms of productivity in all regions. In terms of forage nutritive value, 'Alfaking' had a crude protein content of 20.1%, in vitro dry matter digestibility of 79.5%, and total digestible nutrients of 68.4%. Its neutral detergent fiber content was 41.3%, and its acid detergent fiber content was 26.0%, either higher or comparable to those of 'Vernal.' With its superior adaptability to the Korean climate, 'Alfaking' is well-suited for forage production and pasture establishment and can be cultivated nationwide.

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