

Research Article

Growth Characteristics and Productivity of Sorghum–Sudangrass Hybrids in Jeju Island, Korea

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ABSTRACT

Sorghum-Sudangrass hybrids (SSH) is a grass cereal hybrid crop with a high yield potential under different climatic conditions. The aim of this study was to evaluate the growth characteristics, dry matter yield and nutrient content of the SSH cultivars such as Dairy Mens Dream, Superdan and Supergreen from 2021 to 2023 in Jeju Island, Korea. Among the three cultivars, Superdan grew significantly taller with a larger stem diameter at both harvest times. In contrast, Dairy Mens Dream had least height and less stem diameter, but the dry matter yield was greater for Dairy Mens Dream than other cultivars. Furthermore, the crude protein content at the first cut was higher than 8.5% compared to the second cut (6.5 – 7.0%). The neutral detergent fiber (NDF) and acid detergent fiber (ADF) content was higher in the second harvest of all cultivars compared to the first harvest of SSH in 2021. The SSH cultivation in 2021 and 2023 had higher ADF and NDF content than in 2022, possibly due to the average precipitation and optimum temperature suitable for SSH production in 2021 and 2023. The selected three SSH cultivars showed significant growth characteristics, dry matter content, and nutritional value. The overall data suggested that all three SSH showed significant productivity and nutritional content in the Jeju region of sub-tropical climatic condition.

(Key words: Sorghum-Sudangrass hybrids, Jeju, Climatic factors, Cultivars, Dry matter yield, Nutritional profile)

I. INTRODUCTION

Global climatic changes have manifested through the severity of high temperatures, changing the distribution of precipitation throughout the year that leads to crop yield reduction and challenge to the cultivation of silage fodder (Ji et al., 2010; IPCC, 2022). SSH are relatively better adapted to growing under humidity deficiency, high temperatures and low precipitation. SSH can be considered an alternative silage fodder crops in terms of quantity and quality of the yield at different environmental conditions (Dvořáčková et al., 2013). The yield and energy concentration of SSH is potential and it can be comparable to maize and higher than alfalfa legumes, especially in the perspective of the various climatic conditions (Peng et al., 2020). The SSH (*Sorghum bicolor* L. × *Sorghum Sudanense* Piper. Stapf) is a multipurpose crop that produce high quality forage for the livestock industry in many geographical regions

(Vendramini et al., 2018). Several Sorghum varieties are available to forage growers and dairy farmers with the most common being forage SSH (Lee et al., 2020; Shen et al., 2023).

Forage corn and SSH are typical summer annual forage crops in Korea. The cultivation of SSH has many advantages due to its flexibility management options and can be harvested multiple times in a year (Venuto et al., 2008). The headless type of SSH is more preferred for livestock forage because of its slow hardening of the stem and its suitability for warmer temperature (Kim et al., 2002). Also, it fits well into to the crop rotation system associated with winter crops such as Italian rye grass, barley, and rye as a good forage crop for the soil conditions in the Central region of South Korea (Jung et al., 2019).

The Intergovernmental Panel on Climatic Change (IPCC) has reported that Jeju's average temperature has increased over the past five decades by about 1.6°C and is still rising at an

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accelerating rate. In particular, the average temperature increase has greater in the south part of Korea and Jeju Island than the global average level (Hyun et al., 2020; KMA, 2020). Based on that, the forage and grasses production may face more fluctuations in the context of climatic and environmental changes. The Rural Development Administration (RDA) of Korea estimated that subtropical areas will steadily rise up more than 26% of Korea's Agricultural land by 2060. Hence, the number of farms growing subtropical agriculture crops steadily increased by 1.76% since January 2019 in southern part of Korea and the Jeju region (Chemere et al, 2018). The total cultivated area of crops in Jeju also increased by 40% from 45.2 ha to 63.6 ha (Industry Trends, 2021). Therefore, the statistical report shows that the number of farms and the total nurturing area are increasing in Jeju Island due to the successful cultivation of tropical and subtropical crops.

Recently, Seo et al. (2021) reported the growth characteristics of four SSH cultivar including P988, TE-Haygrazer, NC+855 and Jumbo. The plant height was significantly increased among cultivars including 220 cm in P988 and 232 cm in NC+855 cultivar. However, there were no differences in the contents of crude protein (CP) and dry matter (DM) yield between cultivars. Thus, the aim of this study was to analyzed the adaptability of SSH at different weather conditions (temperature and precipitation) in the Jeju Island from 2021 to 2023. In addition, we evaluated the plant morphology (crop height, stem diameter), DM yield and nutrient content of three SSH cultivars at different harvest times.

II. MATERIALS AND METHODS

1. Description of study location and experiment design

The experimental field located at latitude 33.465603 and Longitude 126.517519 was used in the Jeju region.

The main weather parameters such as monthly average temperature, minimum temperature and distributions of total rainfall were recorded through automated weather data obtained from the Korean Meteorological Administration (KMA) via an open Application Programming Interface (API) during the three years' of study. The data are presented in Table 1.

The average daily temperature and lowest temperature of the Jeju region in the last three years (2021- 2023) were recorded the ranging from 13.9°C to 27°C and 4.34°C - 20.8°C respectively. The average temperature in research years was noticed at 13.6°C, in both 2021 and 2023 and 14.0°C was registered in 2022. In general, the average temperature of Jeju is 26°C with a minimum of 14°C which is slightly varied in the Jeju region temperature compared to the southern part of the Korean Peninsula. The sum of accumulated temperature (Growing Degree Days - GDD) during the cultivation months was calculated by the formula published earlier by Qu et al. (2019). Monthly total precipitation was highest in the study period including 1495 and 1373 mm in April- September 2021 and 2023, respectively (Table 2). In 2022, the total precipitation amount was significantly lower (1088 mm), compared to the other two years. The average precipitation in the Jeju region from

Table 1. Monthly average temperature and the lowest average temperature during cultivation periods of Sorghum-Sudan hybrids in Jeju region

Study area	Years	Average temperature regimes (°C)						Lowest average temperature regimes (°C)					
		April	May	June	July	Aug.	Sep.	April	May	June	July	Aug.	Sep.
Jeju	2021	13.9	17.9	22.5	26.3	25.4	23.0	4.3	9.2	14.5	20.1	20.3	16.6
	2022	14.0	18.0	22.6	26.6	27.0	22.0	4.4	8.0	15.6	19.6	20.2	14.0
	2023	13.9	18.1	22.1	26.6	26.8	23.9	3.0	9.6	14.3	20.8	21.8	17.6

Table 2. Monthly average precipitation and accumulated temperature during cultivation periods of Sorghum-Sudan hybrids in Jeju region

Study area	Years	Average precipitation (mm)							Accumulated temperature (°C)					
		April	May	June	July	Aug.	Sep.	Total	April	May	June	July	Aug.	Sep.
Jeju	2021	60.0	112.5	148.0	247.5	345.0	581.5	1,495	587.14	986.35	1,510.26	2,171.55	2,804.92	3,343.35
	2022	107.5	11.0	165.0	201.5	178.5	424.5	1,088	920.61	1,479.52	2,159.06	2,983.05	3,816.10	4,477.35
	2023	92.5	354.0	180.0	335.0	270.5	141.0	1,373	1,028.30	1,589.84	2,253.41	3,077.49	3,907.22	4,624.31

May to September is 135.3 mm and this area experiences a mean precipitation of 1,500 mm per annum.

The seed sowing occurred in early April 2021, 2022, and 2023. Moreover, the first harvest was in mid-July, and the second harvest was in mid-September. Drill seeding was used at 30 kg/ha. A plot of 12 m², six rows of 3 M length were sown with each rows 50 cm apart from the other. The three varieties used in this study were purchased from Deokchang Co., Ltd. (South Korea). The nitrogen (100 kg/ha), phosphorus (150 kg/ha), and potassium (75 kg/ha) per hectare were applied as basal fertilizer. Additional fertilizer nitrogen (75 kg/ha) was applied at 30 cm of plant height and again, the nitrogen (75 kg/ha) and potassium (75 kg/ha) per hectare were applied after 1st harvest.

Three SSH cultivars were cultivated during a year's in the field experiment from 2021 to 2023 at Jeju Island. We have evaluated the quality of SSH cultivars, and they were studied at different harvest times, years, and climatic situations. Plant height (cm) was measured from ground level to the tip of the plant with the linear meter scale. During the harvest times, stem diameter, and plant height were measured from five plants randomly selected in each plot. Both fresh and DM yields were obtained from the net plot area converted to a hectare basis. Subsequently, the crops were hand-harvested and oven dried at 65°C for 4 days and fresh materials were used to determine the dry matter yield per hectare. DM concentration was measured by the following formula.

$$\text{DM \%} = \text{ODW of the sample} / \text{FW of the sample} * 100,$$

Where, DM% is the dry matter percent, ODW is the oven dry weight, and FW is the fresh weight of a sample (200 g).

2. Analysis of CP, ADF and NDF in Sorghum-Sudangrass hybrids

The CP, NDF and ADF analysis were performed for each sample. Firstly, the samples were dried in a forced air oven set at 65°C for 3 days. After that, the dried samples were ground to pass through a 4mm sieve in a cyclone Mill (Thomas Scientific) and shipped to the Laboratory. All analysis was undertaken at the Functional Chemical Laboratory, Grassland and Forage Division, NIAS, Korea. The CP content was determined by the standard procedure as described by AOAC (Association

of Official Analytical Chemists) (1990), and fiber fractions such as NDF, and ADF were assessed by the standard procedures of Van Soest et al. (1991).

3. Statistical analysis

The statistical analysis was used to evaluate the results. The numerical data is presented as the standard mean of each group and standard deviation. The results were compared to significance level of $p < 0.05$. Microsoft Excel 2010 was used to organize numerical data. After that, the three years' dataset of crop growth characteristics, harvest times, and DM yield of all cultivars was analyzed using SPSS 16.0 statistical software. One-way ANOVA was used and Duncan's method was carried out for the multiple comparisons of factors harvest time, years, cultivars and nutritional values, and their interactions.

III. RESULTS

1. Effect of temperature and precipitation in Sorghum-Sudangrass hybrid cultivars at Jeju region

Table 1, 2, and 3 show climatic information (monthly average temperature, lowest temperature, total precipitation, and accumulated temperature) of Jeju Island from 2021 to 2023. Monthly average precipitation and temperature are slightly varied between the years mainly, the changes in climatic conditions were noticed during the Monsoon season (May - August) in the Jeju region (Table 1). During April - September 2021, the highest average temperature recorded in July at 26.3°C, and the lowest temperature was 4.3°C in April, followed by the year 2022, the highest temperature was 27.0°C in August and the lowest temperature was 4.4°C in April. In 2023, the average temperature was similar to previous years, but the lowest temperature was recorded at 3.0°C in April. The accumulated temperature gradually increased every year in Jeju Island, particularly, from August to September 2021 steadily increasing from 2804.92 to 3343.35 GDD, respectively. Moreover, it consistently rose 3816.10, 4477.35 GDD and 3907.22, 4624.31 GDD from August to September in the respective years 2022 and 2023 (Table 2). In 2021, July - September month had significant rainfall (247.5, 345.0, and 581.5 mm) and uniform precipitation was registered in both

years 2021 and 2023. However, the total average precipitation was lowest in 2022, compared to the other years.

2. Growth characteristics and DM yield of different Sorghum-Sudangrass hybrids cultivars

The plant growth characteristics such as plant height, stem diameter, and DM yield during the study period of 2021 to 2023 were monitored in three different cultivars presented in Table 4. Plant height was significantly varied during the harvest time of three cultivars. The average plant heights of the three SSH cultivars range between 212 - 228 cm in the first cut and 208 - 231 cm in the second cut time. However, the lowest plant height was obtained in the three cultivars in 2022, both harvest times (Table 4). Significant differences in plant growth characteristics

were found in the three experimental years due to the weather patterns were not similar between 2021 - 2023. Plant height of three-year average is higher in Superdan and Supergreen cultivars. In 2023, the highest plant height was obtained which was 286±21, 263±24 and 263±24 cm, Superdan, Supergreen and Dairy Mens Dream, respectively. Meanwhile, the lowest plant growth was measured in the Dairy Mens Dream cultivar with 125±40 cm in 2022. The plant height and stem diameter significantly reduced in the first and second harvest time of 2022, in all the cultivars, as the effect of climatic conditions. Surprisingly, the dry matter yield was highest in all cultivars by 2022 compared to the other two years.

Stem diameter was strongly influenced by cultivars and years, and we found that the three-year average of stem diameter was around 9.5 - 11.5 mm in all three SSH cultivars. The stem

Table 3. Monthly average temperature, the lowest average temperature and average precipitation by harvest time of Sorghum-Sudan hybrids in Jeju region

Study area	Years	From sowing to first harvest			From the first harvest to second harvest		
		Average temperature (°C)	Lowest average temperature (°C)	Total precipitation (mm)	Average temperature (°C)	Lowest average temperature (°C)	Total precipitation (mm)
Jeju	2021	19.6	11.3	414.0	25.5	19.8	620.0
	2022	19.8	11.3	342.0	24.9	17.6	804.0
	2023	20.8	12.7	926.5	26.1	20.8	490.5

Table 4. Effect of growth characteristics and yields of Sorghum-Sudan grass hybrids cultivars in Jeju region from 2021 to 2023

Cultivars	Years	Plant height (cm)		Stem diameter (mm)		Dry matter yield (kg. ha ⁻¹)		
		1 st cut	2 nd cut	1 st cut	2 nd cut	1 st cut	2 nd cut	Total
Dairy mens Dream	2021	223±18	235± 6	11.0±1.4	9.5±1.0	10,548±1,677	9,457±2,092 ^b	20,005±2,930
	2022	180±21	125±40	7.7±1.5	8.1±0.8	12,920±4,592	10,269±2,952 ^{ab}	23,189±1,874
	2023	235±23	263±24	10.6±1.5	10.9±2.7	10,904±1,878	12,729±1,189 ^a	23,633±1,987
	Average	212±31	208±66	9.8±2.1	9.5±2.0	11,457±2,844 ^A	10,818±2,409	22,276±4,446
Superdan	2021	215±32	237±21	12.2±1.7	11.0±1.1	9,108± 893	7,157±2,745 ^b	16,265±2,199
	2022	198±28	116±34	9.9±1.9	8.6±0.9	7,452±2,274	13,466±2,872 ^a	20,918±4,252
	2023	238±20	286±21	12.3±1.5	10.5±1.5	10,830±4,701	10,691±3,483 ^b	21,522±8,166
	Average	217±32	231±77	11.5±2.0	10.1±1.5	9,130±3,026 ^B	10,438±3,805	19,568±5,058
Supergreen	2021	236±21	234±13	12.7±1.6	10.2±1.3	11,596±2,256	8,831±1,417 ^b	20,427±3,671
	2022	198±30	144±14	9.1±2.2	9.4±0.9	11,637±6,962	9,829±3,101 ^b	21,466±1,278
	2023	248±21 ^a	261±20	11.3±2.2	10.6±1.1	9,049± 418	12,015±2,154 ^a	21,064±2,095
	Average	228±32	213±53	11.0±2.5	10.1±1.2	10,761±3,884 ^{AB}	10,225±2,461	20,986±4,402

The data are represented as the mean ± STD of three replicates. Small alphabets within a column indicates significant differences among three years ($p < 0.05$); Capital alphabets within a column indicates significant differences among average dry matter yield of three cultivars ($p < 0.05$).

diameter was no significant differences between the two harvest times, while Superdan (11.5±2.0 mm) and Supergreen (11.0±2.5 mm) cultivars had the largest stem diameter at the first cutting time, followed by Dairy Mens Dream had the least stem diameter (9.8±2.1) in the first harvest time. The stem diameter is slightly higher in the first harvest than the second harvest due to the average temperature of 19.6 - 20.8°C during the sow to first harvest period (Table 3). Also, the total precipitation was uniform in 2021 and 2023 cultivation years, which resulted in a slightly higher stem diameter compared to the 2022 experiment time. The average DM yield was slightly varied between cultivars. However, Dairy Mens Dream had the highest total DM yield (22,276±4,446 kg ha⁻¹) compared to the other cultivars. In the first harvest, the yield of Dairy Mens Dream significantly increased compared to other cultivars (*p*<0.05). The Superdan cultivar had the lowest average DM yield (19,568±5,058 kg ha⁻¹) in 2021, which was significantly less than those of other cultivars in the same year.

3. Nutritional value of different Sorghum-Sudangrass hybrids cultivars

Here, we measured the nutrient content of different SSH cultivars from 2021 - 2023, with respect to temperature, precipitation, year, and harvest time. Table 5 shows the NDF increased 2-3% in the second cut of all cultivars from 2021 to

2023 compared to the first cut of SSH. The average NDF content for three years were 62.06±4.34, 61.48±3.63, and 61.11±3.44 DM, % in the Superdan, Dairy Mens Dream and Supergreen cultivars, respectively. Subsequently, we observed that the ADF amount was highest for all three cultivars harvested in the second cutting, including Superdan (38.70±3.32), Dairy Mens Dream (38.70±2.76) and Supergreen (38.01±3.19) DM %, compared to the first cutting time. Therefore, the variation of temperature and precipitation between years in Jeju Island had minimal impact on the cultivation of SSH. Among cultivars of SSH, there were no significant differences in the NDF and ADF contents during the 2021 to 2023 period. All three SSH have shown that NDF was 61 - 62% and ADF was 35 - 38% during the three-year experimental period. The average CP contents for three years were 8.91±1.58, 8.82±0.84 and 8.62±1.64 % in Supergreen, Dairy Mens Dream and Superdan, respectively, during the first cut time, which was slightly higher (~1.5%) CP content compared to the second cut time in all cultivar (Table 5). Also, CP contents were 7.64±2.07, 7.42±1.50 and 6.82±1.45 % in Supergreen, Dairy Mens Dream and Superdan, respectively, during the second cut of SSH forage which mean that CP content was approximately 7-10% in the whole crop forage. Therefore, the harvest time, cultivar and temperature plays key factor for CP content and yield.

Table 5. Nutritive values of Sorghum-Sudan grass hybrids cultivars in Jeju region from 2021 to 2023

Cultivars	Years	Nutritive values (%)					
		1 st cut			2 nd cut		
		NDF ¹⁾	ADF ²⁾	CP ³⁾	NDF	ADF	CP
Dairy mens Dream	2021	61.15±3.14	35.79±2.34	8.83±0.37	62.04±0.54	36.93±0.64	8.37±2.12
	2022	58.07±1.64	32.37±1.36	9.65±0.58	64.32±1.20	38.46±1.03	7.41±1.03
	2023	65.23±1.23	39.20±0.98	7.79±0.50	65.10±6.85	40.71±4.27	6.48±0.83
	Average	61.48±3.63	35.79±3.29	8.82±0.84	63.82±3.75	38.70±2.76	7.42±1.50
Superdan	2021	62.84±1.49	36.69±1.27	8.67±1.27	63.56±1.29	38.03±0.45	9.58±2.05
	2022	57.02±1.72	30.61±2.17	9.19±0.68	65.19±1.77	40.04±1.56	7.28±1.14
	2023	66.31±1.99	40.37±0.68	6.99±1.00	61.77±8.07	38.04±6.12	6.05±1.42
	Average	62.06±4.34	35.89±4.46	8.62±1.64	63.50±4.44	38.70±3.32	7.64±2.07
Supergreen	2021	62.21±1.44	36.33±0.81	9.94±0.69	62.93±0.26	37.32±1.10	8.41±1.54
	2022	56.84±0.66	30.89±1.02	9.26±2.20	62.42±3.79	38.66±2.85	5.71±0.13
	2023	64.27±0.69	39.14±0.40	7.53±0.23	60.87±8.26	38.06±5.48	6.34±0.14
	Average	61.11±3.44	35.45±3.70	8.91±1.58	62.07±4.64	38.01±3.19	6.82±1.45

¹⁾ NDF: Neutral detergent fiber; ²⁾ ADF: Acid detergent fiber; ³⁾ CP: Crude protein.

IV. DISCUSSION

The SSH are economically important varieties due to their resilience in various climatic conditions (temperature, precipitation), and it has valuable nutrients for livestock animals and commercial industries (Przybylska-Balcerak et al., 2020). Forage species have optimum temperatures (minimum and maximum ranges) essential for their growth and development (Kaplan et al., 2019).

The combined effect of cultivars, harvest time with climatic variation represents the production of SSH (An et al., 2018; Zhang et al., 2020). Temperature and rainfall patterns major impact the plant growth and development stage that can affect the yield significantly (Sowiński et al., 2011). During the experimental period from 2021 to 2023, weather conditions in Jeju Island was slightly varied from year to year. Notably, in July to September 2022 the average temperature was slightly higher at 1°C compared to the other years which is the average temperature regime is 25-26°C (Table 1). In 2021, 2022 and 2023 - September, the highest accumulated GDD was measured at 3343.35, 4477.35 and 4624.31°C GDD, respectively. From the three-year field experiment, September- 2023 has highest accumulated temperature compared to the previous two years (Table 2). From 2021 to 2023, the distribution of temperature was little beneficial due to the rainfall sums for April to September being average of more than 1,000 mm, that provided necessary environment for SSH. Previously, the optimum mean temperature for SSH cultivation was reported in the range of 23.8 - 26.6°C. The SSH production with correlation of GDD and rainfall did not affect the larger in terms of yield and production (Kim et al., 2023). The suitable precipitation ranges during the growth of SSH were between 500-800 mm, more than optimum level of rainfall might lead to significant yield reduction (Peng et al., 2020). Therefore, the over demanded precipitation can lead to the SSH production risk. However, the heavy rainfall and typhoons in Korean monsoon season did not impact SSH forage production (Choi et al., 2017).

Plant height is considered an accurate performance indicator of crops health. We found that the plant height was strongly influenced by different cultivars, harvest time and climatic conditions. In 2022, a reduction of approximately 20-30% in plant height was observed across all cultivars, attributed to high temperatures and lower precipitation from April to June

compared to normal ranges in previous years. The Superdan and Supergreen cultivars demonstrated highest plant height (231±77 cm- 2nd cut and 228±32 cm- 1st cut) respectively. The SSH growth differences can be attributed to climatic variation among years, cultivars and harvest time (Oten, 2017). Then, the average stem diameter was 11.5±2.0 mm (first cut) and 10.1±1.5 mm (second cut) in the Superdan cultivar, that they have highest stem level among other cultivars (Table 4). The average stem diameter of the Supergreen cultivars also have a good growth value in both 1st and 2nd cut including 11.0±2.5 and 10.1±1.2 mm, respectively. The lowest stem diameter was obtained from Dairy Mens Dream (9.8±2.1 and 9.5±2.0 mm) in the first and second harvest time respectively. The varieties including SSH can regrowth when used for multiple cuts, because the crop is inherited from grass. Thereby the crop can provide higher biomass yield than maize and Sorghum (Teck et al., 2017). Waani et al. (2023) suggested that the stem weight of the Super 2 cultivar was significantly higher than the Super 1 and Super 6 cultivars. Thus, the cultivar variety and harvest time may impact the stem diameter in SSH. The dry matter yield also varied between cultivars due to the environmental factors and harvest time. The greatest total average of dry matter yield was obtained from the Dairy Mens Dream cultivar (22,276±4,446 kg ha⁻¹), followed by Supergreen (20,986±4,402 kg ha⁻¹). The least dry matter yield was Superdan cultivar (19,568±5,058 kg ha⁻¹), nearly 1.5 metric ton lower than other two cultivars. The lower dry matter yield in the SSH is due to the uneven precipitation in the Monsoon season and the higher average temperature in the Jeju region. The moderate warming condition of 2°C resulted more than 15% yield reduction in SSH (Lasky et al., 2015). However, the Sorghum and their hybrids can ability to withstand high temperature exposure but may alter the productivity. Similarly, Jung et al. (2019) reported that the SSH maximizes the forage yield when harvested twice in the central region of Korean Peninsula due to the optimum temperature, and proper sow date plays a critical role in the forage cultivation.

Forage quality and nutrient values are important for livestock production and animal performance (Hatfield et al., 2008; Sirmon, 2023). In this work, the crude protein content obtained from the three cultivars such as Dairy Mens Dream, Superdan and Supergreen, were 8.82±0.84, 8.62±1.64 and 8.91±1.58%, respectively. The effect of cultivar on crude

protein levels showed slight variation, but no significant differences were found between cultivars during experimental years from 2021 to 2023. Thus, we suggest that no significant effect on climatic factor in the crop protein content for the designed experimental period. We measured the highest average crude protein concentration (8.0%) in all cultivars. Furthermore, we found highest amount of NDF and ADF in the second cut when compared to the first cut of SSH in 2021 to 2023. Similarly, Wang et al. (2023) explained that significant differences in CP, NDF and ADF among eight cultivars depending on the growth and maturity state of crops. The NDF and ADF content was highest at the heading stage of the varieties, indicating that timely harvesting of the SSH can maximize its nutritional values (Özyazıcı and Açıkbaş, 2020).

V. CONCLUSIONS

A study was conducted on potential cultivars and harvest times of SSH in the Jeju region from 2021 to 2023. The average total dry matter yield for Dairy Mens Dream was higher in both its first and second cuttings compared to the other cultivars. According to the data, the Dairy Mens Dream, Superdan, and Supergreen cultivars showed significant growth characteristics and yield productivity in Jeju island.

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