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Research Article

Feed Value of Whole-Crop Silage Rice by Cultivars and Plant Parts at Different Transplanting and Harvest Dates

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ABSTRACT

This study was carried out to find out the changes in the growth characteristics and feed value of the three different whole-crop silage rice cultivars of whole-crop silage rice such as Jonong, Yeongwoo and Mogwoo to develop an efficient double cropping system. This study showed that there were significant differences biomass and feed values among cultivars but no clear difference among transplanting dates. Dry weight and height were in order of Mogwoo, Yeongwoo, Jonong (p<0.05). Dry weight and feed value of Jonong showed no significant difference after 21 days after heading (DAH), it was expected to be harvested before DAH 30 days. Yeongwoo showed a lower dry weight than Mogwoo, but heading date was earlier than Mogwoo, so one can expect a higher feed value than Mogwoo. Mogwoo had lower crude protein and total digestible nutrient than the other two cultivars but relative feed value in stem was higher than that of the other cultivars, but had higher dry weight than other cultivars so it was considered to take an advantage as a silage rice. Therefore, the results of this study suggest that the selection of whole-crop silage rice on the cropping system be made comprehensively by considering the heading characteristics of the cultivars and the feed value.

(**Key words**: Feed value, Harvest date, Transplanting date, Whole crop silage rice, Plant parts)

Ⅰ. INTRODUCTION

As Korea's rice consumption continues to decrease, the government is implementing operation policy aiming to reduce rice production by providing support to farmers cultivating crops other than rice. However, growing field crops such as corn, soybean, and sorghum are a challenge due to poor drainage and high humidity. In addition, domestic feed crop self-sufficiency is stagnant at 80%. The need for silage rice research to satisfy these two situations has been proposed.

Studies about rice for feed use had begun in the 1990s. However, the studies conducted and the introduction of foreign cultivars that have high potential on feed value was not conducted systematically. In addition, the measurements were taken to investigate the biomass of forage by harvest date according to cultivation method, not for silage use, but no research was conducted to increase or improve the feed value (Lee, 2004).

The Rural Development Administration began research on stable production of rice for total feed as an agenda task from the mid-2000s, and utilizes the large biomass and the tropical japonica rice developed by the International Rice Research Institute. 'Nokyang' (Lee *et al*., 2011), which was first developed in Korea for whole-crop silage rice (1996 to 2006), had low biomass and needed to be supplemented. Subsequently, whole-crop silage rice cultivars that introduced biomass augmentation, direct seeding-approved cultivars, and pest and disease resistant cultivars were bred (Ahn *et al*., 2018; Lee *et al*., 2013).

Recent studies were conducted to productivity according to the cultivation practice of silage rice (Yang *et al*., 2018), and double cropping system of main whole-crop silage rice and winter feed crops (Ahn *et al*., 2019; Kim *et al*., 2018). There was a report that the feed value of cereal crops was affected by sowing and harvest dates (Ju *et al*., 2009; Lee, 2013; Yun *et al*., 2009). Although research has been conducted, the results of research on the feed value of whole-crop silage rice were inadequate.

When paddy rice is used as the basis to produce high feed value, it is important to link them with winter forage crops. This study evaluated the growth and feed value of whole-crop silage rice for double cropping with winter forage crops to provide

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basic data on the selection of appropriate silage rice cultivars and the research on the crop system.

Ⅱ. MATERIALS AND METHODS

1. Location of this study and cultivars used

This study was carried out in 2019 at the rice field of the Department of Central Area Crop Science of the National Institute of Crop Science (Suwon City, 37°27'N, 126°99E, 34m above sea level). The test cultivars were Jonong (early-maturing), Yeongwoo (mid-late maturing), and Mogwoo (late-maturing).

2. Cultivation method

The planting distance was 30 cm × 14 cm with three to four seedlings per hill. Standard fertilizer of N-P_2O_5-K_2O (18-9-11 kg/10a) was used for cultivation. Nitrogen application was split into three (50%-20%-30%), at basal, tillering stage, and at panicle initiation stage. Potassium application was split into two (70%-30%) at basal and panicle initiation stage. Phosphorus was applied once at basal. The transplanting dates were divided into two (24-May, 5-June) such that the overlap in the harvesting date of cereals and transplanting date of rice was divided. Other cultivation method was based from the standard cultural practices by Rural Development Adminstration.

3. Growth investigation and sampling

Growth investigation and sampling were conducted every 7th-day from the start of heading until the 35th-day. We considered harvesting dates based on sowing date limitation of winter cereal crops. If it did not reach 35 days after heading, it was harvested on eighth October. Plant height was investigated from 20 plants, and among them, three plants were separated into stems, leaves, and panicles to measure the fresh weight. After drying sufficiently in a dryer at 70 ℃ for 72hrs, the weight was measured, and converted into dry weight per m^2. The dried plants were crushed and parts and used as samples for the analysis of feed value.

4. Feed value analysis

The samples for the evaluation of feed value were separated by plant parts, The analysis items were analyzed by requesting of department of test and analysis of the Foundation of Agricultural technology Commercialization and Transfer (FACT) for crude protein (CP), neutral detergent fiber (NDF), and acid detergent fiber (ADF). The crude protein content was calculated by multiplying value by 6.25 after obtaining the total nitrogen content by the Kjeldahl method after wet decomposition, and the ADF and NDF were analyzed using the Van Soest method (Van soest *et al*., 1991). The total digestible nutrient (TDN) was estimated as the ADF content and calculated using the formula 88.9 – (0.79 × ADF %). Digestible dry matter (DDM) was calculated using the formula 88.9 – (0.779 × ADF %), and dry matter intake (DMI) was obtained by 120 / NDF %, and then relative feed value (RFV) was DDM × DMI / 1.29 (Lee *et al*., 2005).

5. Statistical Analysis

The obtained values were statistically analyzed using R (Ver. 3.5.1, 2018, The R Foundation for Statistical Computing Platform) and then statistical analysis between treatment means was performed at a 5% significance level using Duncan's multi-range test (DMRT).

Table 1. Dates of harvest of the three whole-crop rice silage cultivars at different transplanting date from heading stage to 35 days after heading

Cultivar	Transplanting date	Heading date	7[a)]	14	21	28	35
Jonong	5.24.[b)]	8. 5.	8.12.	8.19.	8.26.	9. 2.	9. 9.
	6. 5.	8. 9.	8.16.	8.23.	8.29.	9. 5.	9.10.
Yeongwoo	5.24.	8.23.	8.29.	9. 5.	9.10.	9.19.	9.26.
	6. 5.	8.29.	9. 5.	9.10.	9.19.	9.26.	10. 4.
Mogwoo	5.24.	9.10.	9.16.	9.23.	9.30.	10. 8.	-
	6. 5.	9.23.	9.30.	10. 8.	-	-	-

[a)]Days after heading, [b)]m.d.

Ⅲ. RESULTS AND DISCUSSION

In this study, dry weight and height were investigated to the three cultivars (Jonong, Yeongwoo, Mogwoo) of rice from different trasplanting dates (24-May, 5-June) at interval of every 7 days after heading date. The yellow ripe period is appropriate to harvest the whole crop rice (Sung *et al*., 2004), however, the heading date of Mogwoo was late and had to be harvested last at 28 DAH and 14 DAH before the yellow ripe period. At the last harvest, plant height follows the order Mogwoo > Yeongwoo > Jonong (Fig. 1). There were no clear differences in height among transplanting dates, but there were significant differences among cultivars.

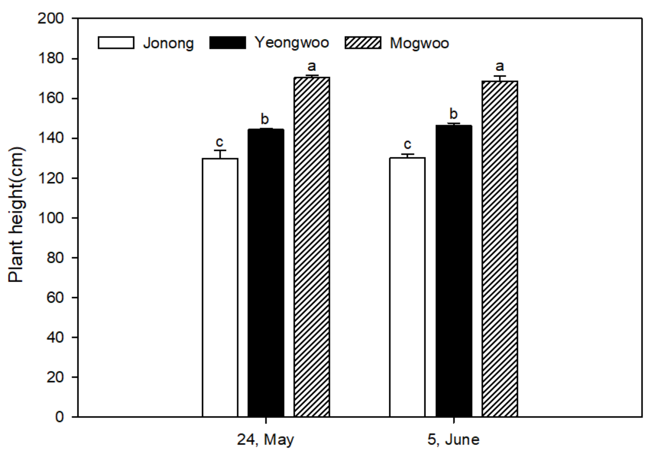

Fig. 1. Plant height of the three whole-crop rice silage cultivars at last harvest date. Vertical bars indicate ± Standard Deviation (SD). Different letters are significantly different (p<0.05).

Dry weight of three cultivars follows the order of Mogwoo > Yeongwoo > Jonong (Fig. 2). Mogwoo showed higher dry weight than other cultivars at all harvest dates. Dry weights at the last harvest date according to the two transplanting date were Jonong (1,562, 1,482 g/m^2), Yeongwoo (1893, 1765 g/m^2), and Mogwoo (2,341, 2,493 g/m^2), respectively. Yeongwoo's dry weights showed similar to those of Ahn *et al*. (2018), but dry weights of Mogwoo were higher than the results from that. Jonong and Yeongwoo transplanted on May 24 had a slightly higher dry weights as compared to those of the same cultivars planted on June 5, but there was no significant difference. Dry weight of Jonong increased rapidly until DAH 21 after then the increase was not noticeable. Dry weight of Yeongwoo slightly increased and Mogwoo tended to increased even after DAH 21. This result seems to be due to the Mogwoo's characteristics of developing strong stem and long flag leaf in the late growth (Lee *et al*., 2013).

Fig. 3 shows the change in stem, leaves and panicle ratios over time. Jonong and Yeongwoo's stem and leaf ratios decreased while panicle ratios increased regardless of transplanting date. The panicle ratio differed among cultivars. Jonong had the highest panicle ratio of 47.4% and 50.4% at May 24 and June 5 transplanting dates respectively. Yeongwoo was transplanted

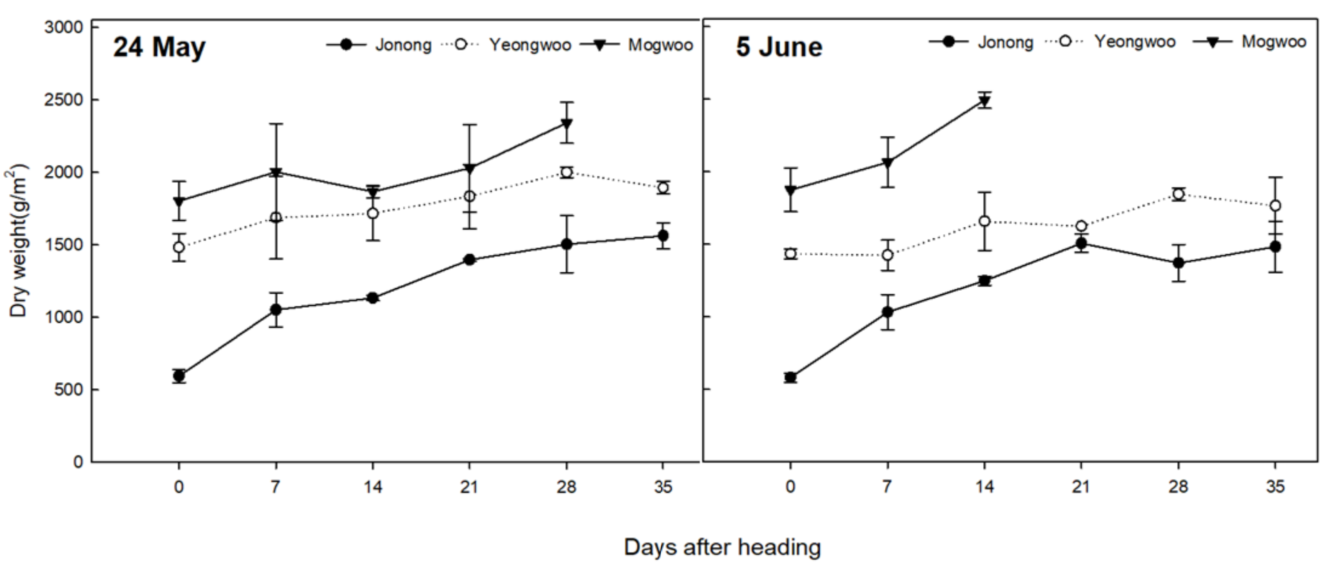

Fig. 2. Biomass production of the three whole-crop rice silage cultivars from heading date to 35 days after heading. Vertical bars indicate ± SD.

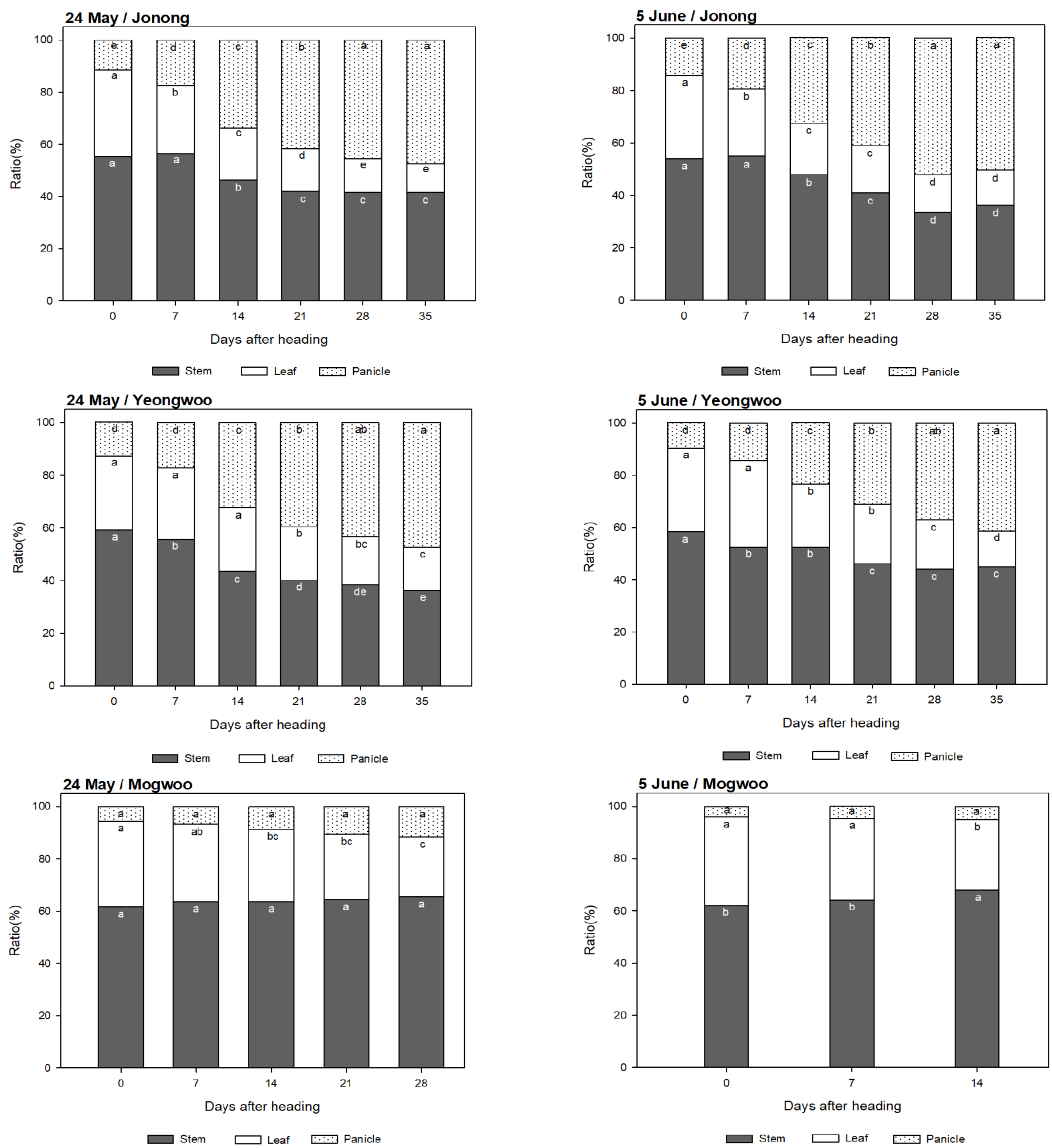

Fig. 3. Changes in leaf-stem-panicle ratio of the three whole-crop rice silage cultivars from heading date to 35 days after heading. Plant parts for each cultivar in the same transplanting date with different letters are significantly different (p<0.05).

on May 24, 35 days after heading had a panicle ration of 47.3%. For the same cultivar transplanted on June 6, panicle ratio was 41.2% showing that the date of transplanting affected the panicle ratio. The panicle ratio increased slightly as the number of days passed after transplanting on May 24. However, it was 11.8% at last harvest (28DAH). Mogwoo was transplanted on June 5 had only 5% panicle ratio at last harvest (14DAH). Thus, the panicle ratio was the lowest among the three cultivars. It is however noteworthy that Mogwoo had the highest stem ratio with a value of over 60%. In a similar study, Kim *et al.* (2018) compared a fully matured Mogwoo to an early-maturing cultivar, Suwon 605, mid-late maturing, Yeongwoo. In terms of panicle ratio, the order was

Suwon 605 > Yeongwoo > Mogwoo. While in terms of leaf and stem ratio the order was Mogwoo > Yeongwoo > Suwon 605, showing similar results.

Table 2 shows the crude protein (CP) content in each cultivar according to harvest date. The leaf crude protein content was the highest at heading regardless of the cultivars and transplanting dates and then decreased gradually over time. Stem crude protein content was different for each cultivar, however, it tended to decrease over time after heading. Panicle crude protein content did not show any trend. Comparing the crude protein by part, data showed crude protein in leaves (11.2~19.6%) > panicle (7.88~10.4%) > stem (4.25~6.79%). In a study conducted by Ahn *et al*. (2018), it was shown the crude protein content was the highest at heading. This seemed to be due to leaf proportion being highest at heading stage and gradually decreases thereafter. Kwon *et. al*. (2008) reported that the change in total plant crude protein content was largely dependent on the ratio of crude protein content in the leaves which was consistent with what was reported earlier. There have been reports that Mogwoo has lower protein content than other cultivars by Ahn *et al*. (2018) and Kim *et al*. (2018). This may be due to the low leaf and panicle ratio (Fig. 3) in which Mogwoo has higher protein content (Table 2).

Neutral detergent fiber (NDF) content refers to cell wall components such as cellulose, hemicellulose, lignin and silica, and the intake can be predicted through NDF content. It was known that higher NDF content reduces animal feed intake and that NDF increased cell wall matter as the crop approaches ripening (Ju *et al*., 2009). NDF also increases as the harvest date is delayed. The change in NDF content according to harvest date after heading is shown in Table 3. Jonong did not show a difference in the NDF contents in stem and leaf. NDF contents in panicle decreased over date after heading. Yeongwoo had a significantly increase in NDF content at last harvest relative to that in heading in the stem. However, it did not exhibit difference in the leaves. Also in Yeongwoo, the NDF content decreased over time after heading as was observed in the panicles of Jonong. Mogwoo showed difference in NDF content according transplanting date. NDF content in the stems, leaves and panicles of Mogwoo was less in crops transplanted on May 24 but showed no significant difference in crops transplanted on June 5. Mogwoo, unlike the other cultivars tended to have a higher NDF content in panicles but lower content was found on stem.

Acid detergent fiber (ADF) content is analyzed by getting the value of undigested portion (cellulose, lignin) of the crop after ingestion of animals. The lower the ADF content, the higher is the digestibility, which is a desirable trait as an animal feed. Table 4 shows the change in ADF content after heading. Jonong's ADF content was highest in the stem, followed by leaves and panicle. Panicle ADF content decreased significantly after heading over time. Yeongwoo had similar contents in the stem and leaves, less in panicles as compared to that of Jonong's. In the case of Mogwoo, NDF and ADF content in stem and leaves was similar to that of the other two cultivars but contents in panicle was higher. This was presumably because the panicle were not ripened.

Ahn *et al*. (2018) and Sung *et al*. (2004) reported that NDF and ADF of whole rice crop consistently decreased with maturity. However, it is difficult to compare the results of this study because it is not a value for the whole plant, not for each part. Further additional research is needed on the contribution of each part to the value of the whole plant.

Total digestible nutrient (TDN) is the total amount of food available for livestock to eat and digest. TDN are derived from ADF. In Jonong and Yeongwoo, there was no change in stem and leaf TDN content after heading (Table 5). However, TDN content in panicles increased. Ahn *et al*. (2018) showed a tendency to increase the TDN of the whole plant as time passed after heading, and Sung *et al*. (2004) reported that the highest TDN content appeared in the yellow ripe period. In terms of TDN content in Jonong, the order was panicle > leaf > stem. In the case of Yeongwoo, TDN was similar in stem and leaf and high in panicles. TDN content did not change in Mogwoo after heading. Stem TDN content was higher than that in the panicles. The TDN content in panicle in Mogwoo was far lower than that of Jonong and Yeongwoo. These results suggest that metabolites mobilized to the panicles as the leaves and stems mature in Jonong and Yeongwoo. However, in Mogwoo, it seemed that the process of metabolites mobilization was slower.

Relative feed value (RFV) was obtained by calculating the ADF related to digestibility and the NDF content related to the intake, which is a value for evaluating the feed quality based on the relative value of the feed with NDF of 53% and ADF of 41% relative to an arbitrary value of 100%. Table 6 shows the RFV in the three cultivars. Three cultivars had similar RFV in leaves, but RFV in the stems were in order to Mogwoo, Yeongwoo and Jonong. The RFV of panicles in Jonong and

Table 2. Changes in the crude protein (CP) contents in the three whole-crop rice silage cultivars from heading date to 35 days after heading

Transplanting Date	Cultivar	DAH[1)]	Crude protein (%)		
			Stem	Leaf	Panicle
24, May	Jonong	0	6.79	18.5	9.38
		7	6.55	19.0	8.75
		14	6.42	18.6	8.49
		21	6.23	17.3	7.95
		28	6.40	16.5	8.21
		35	6.42	15.1	8.59
		Mean	6.47±0.19[2)]	17.5±1.47	8.56±0.49
5, June	Jonong	0	5.88	19.6	9.54
		7	5.48	19.1	8.63
		14	5.52	18.8	8.41
		21	5.29	17.5	7.89
		28	4.88	13.3	7.98
		35	4.25	14.4	7.99
		Mean	5.22±0.58	17.1±2.65	8.41±0.63
24, May	Yeongwoo	0	5.74	16.6	7.98
		7	5.94	16.9	7.88
		14	6.33	15.2	7.94
		21	5.37	14.2	8.11
		28	5.25	13.3	8.26
		35	5.07	11.5	8.08
		Mean	5.62±0.47	14.6±2.04	8.04±0.14
5, June	Yeongwoo	0	6.09	17.2	7.94
		7	7.55	14.8	8.58
		14	5.89	15.2	8.51
		21	6.02	14.6	8.65
		28	5.92	12.5	10.40
		35	6.61	12.4	8.67
		Mean	6.35±0.65	14.4±1.78	8.79±0.83
24, May	Mogwoo	0	6.27	14.4	9.56
		7	5.83	14.4	8.84
		14	5.59	13.7	9.12
		21	6.13	11.8	8.88
		28	5.77	11.4	9.78
		Mean	5.92±0.28	13.2±1.46	9.24±0.42
5, June	Mogwoo	0	5.94	13.3	7.88
		7	6.19	12.4	8.31
		14	6.02	11.2	8.83
		Mean	6.05±0.13	12.3±1.06	8.34±0.48

DAH[1)] : Days after heading

[2)]Data are expressed as means ± S.D.

Table 3. Changes of the neutral detergent fiber (NDF) contents in the three whole-crop rice silage cultivars from heading date to 35 days after heading

Transplanting Date	Cultivar	DAH[1)]	NDF (%)		
			Stem	Leaf	Panicle
24, May	Jonong	0	60.9	64.5	68.6
		7	57.1	58.3	49.1
		14	67.3	62.9	29.0
		21	63.2	58.6	20.2
		28	54.2	61.5	17.8
		35	58.9	59.8	15.1
		Mean	60.2±4.61[2)]	60.9±2.47	33.3±21.2
5, June	Jonong	0	63.2	59.0	69.0
		7	65.1	59.4	63.6
		14	65.4	60.2	36.8
		21	66.6	59.9	26.8
		28	60.6	56.5	23.4
		35	65.9	62.0	20.5
		Mean	64.5±2.22	59.5±1.78	40.01±21.2
24, May	Yeongwoo	0	49.3	59.7	67.6
		7	51.3	58.2	49.4
		14	58.1	58.7	30.7
		21	57.9	61.8	23.6
		28	60.4	57.1	19.9
		35	58.7	56.2	19.0
		Mean	56.0±4.50	58.6±1.98	35.0±19.5
5, June	Yeongwoo	0	48.9	57.6	69.9
		7	56.5	59.4	55.8
		14	49.7	59.6	43.7
		21	56.0	58.6	23.9
		28	58.1	57.6	21.9
		35	58.9	54.2	20.4
		Mean	54.7±4.31	57.8±1.95	39.3±20.6
24, May	Mogwoo	0	54.4	63.0	70.3
		7	51.5	61.5	72.2
		14	46.7	59.4	68.6
		21	43.9	57.6	53.7
		28	43.0	58.0	47.7
		Mean	47.9±4.91	50.9±2.31	62.5±11.1
5, June	Mogwoo	0	49.1	57.3	74.0
		7	46.6	56.8	75.0
		14	46.4	55.0	73.1
		Mean	47.4±1.47	56.4±1.19	74.0±0.95

DAH[1)] : Days after heading
[2)]Data are expressed as means ± S.D.

Table 4. Changes of the acid detergent fiber (ADF) contents in the three whole-crop rice silage cultivars from heading date to 35 days after heading

Transplanting Date	Cultivar	DAH[1]	ADF (%)		
			Stem	Leaf	Panicle
24, May	Jonong	0	41.8	38.7	49.8
		7	40.5	36.8	37.9
		14	47.1	28.3	19.1
		21	45.0	36.7	13.5
		28	38.4	39.5	11.8
		35	41.8	37.3	9.9
		Mean	42.4±3.14[2]	36.2±4.06	23.7±16.4
5, June	Jonong	0	34.7	26.4	41.6
		7	37.1	26.8	39.8
		14	38.8	27.0	23.8
		21	39.3	28.8	19.3
		28	35.4	28.2	16.9
		35	39.4	28.6	14.8
		Mean	37.4±2.04	27.6±1.02	26.0±11.8
24, May	Yeongwoo	0	32.5	37.2	50.6
		7	33.7	35.8	38.5
		14	37.7	34.5	20.6
		21	38.5	35.5	15.9
		28	38.6	33.8	13.5
		35	37.6	32.8	13.0
		Mean	36.4±2.65	35.0±1.58	25.4±15.6
5, June	Yeongwoo	0	27.1	26.7	43.6
		7	31.1	29.1	35.2
		14	27.0	26.7	28.1
		21	30.5	26.1	17.7
		28	32.5	27.3	16.1
		35	31.6	27.1	15.0
		Mean	30.0±2.36	27.2±1.05	26.0±11.7
24, May	Mogwoo	0	32.4	36.7	47.1
		7	31.3	35.4	49.6
		14	28.8	35.0	47.7
		21	27.1	35.2	41.0
		28	27.5	36.1	36.2
		Mean	29.4±2.34	35.7±0.70	44.3±5.55
5, June	Mogwoo	0	26.3	28.0	43.9
		7	25.1	26.9	46.2
		14	24.1	28.9	46.7
		Mean	25.2±1.12	28.0±1.00	45.6±1.46

DAH[1] : Days after heading
[2]Data are expressed as means ± S.D.

Table 5. Changes of the total digestible nutrient (TDN) contents in the three whole-crop rice silage cultivars from heading date to 35 days after heading

Transplanting Date	Cultivar	DAH[1]	TDN (%)		
			Stem	Leaf	Panicle
24, May	Jonong	0	55.9	58.4	49.5
		7	56.9	59.8	59.0
		14	51.7	66.6	73.8
		21	53.4	59.9	78.2
		28	58.6	57.7	79.6
		35	55.9	59.4	81.1
		Mean	55.4±2.27[2]	60.3±2.92	70.2±11.8
5, June	Jonong	0	61.5	68.0	56.0
		7	59.6	67.7	57.4
		14	58.3	67.6	70.1
		21	57.9	66.1	73.6
		28	60.9	66.6	75.5
		35	57.8	66.3	77.2
		Mean	59.3±1.47	67.1±0.73	68.3±8.49
24, May	Yeongwoo	0	63.2	59.5	48.9
		7	62.3	60.6	58.5
		14	59.1	61.6	72.6
		21	58.5	60.8	76.3
		28	58.4	62.2	78.2
		35	59.2	63.0	78.6
		Mean	60.1±1.91	61.3±1.14	68.9±11.2
5, June	Yeongwoo	0	67.5	67.8	54.4
		7	64.3	65.9	61.1
		14	67.6	67.8	66.7
		21	64.8	68.3	74.9
		28	63.2	67.3	76.2
		35	63.9	67.5	77.1
		Mean	65.2±1.70	67.4±0.76	68.4±8.47
24, May	Mogwoo	0	63.3	59.9	51.7
		7	64.1	60.9	49.7
		14	66.2	61.3	51.2
		21	67.5	61.1	56.5
		28	67.1	60.4	60.3
		Mean	65.7±1.65	60.7±0.50	53.9±3.92
5, June	Mogwoo	0	68.1	66.8	54.2
		7	69.0	67.7	52.4
		14	69.9	66.1	52.0
		Mean	69.0±0.72	66.8±0.65	52.9±0.94

DAH[1] : Days after heading
[2]Data are expressed as means ± S.D.

Table 6. Changes of the relative feed value (RFV) in the three whole-crop rice silage cultivars from heading date to 35 days after heading

Transplanting Date	Cultivar	DAH[1]	RFV		
			Stem	Leaf	Panicle
24, May	Jonong	0	86.1	84.8	67.9
		7	93.4	96.1	112.5
		14	72.2	99.0	237.5
		21	79.3	95.8	361.5
		28	101.3	87.8	417.3
		35	89.0	93.1	498.9
		Mean	86.9±10.3[2]	92.8±5.43	282.6±172.2
5, June	Jonong	0	91.1	107.8	76.1
		7	85.8	106.5	84.7
		14	83.5	104.9	178.0
		21	81.4	103.2	256.2
		28	94.2	110.1	301.0
		35	82.2	100.0	351.6
		Mean	86.4±5.17	105.4±3.55	207.9±114.1
24, May	Yeongwoo	0	120.0	93.4	68.1
		7	113.5	97.4	110.9
		14	95.4	98.3	220.4
		21	94.6	92.2	301.6
		28	90.6	102.0	366.4
		35	94.5	104.9	385.0
		Mean	101.4±12.2	98.0±4.88	242.1±132.2
5, June	Yeongwoo	0	128.9	110.1	73.1
		7	106.5	103.7	102.4
		14	127.0	106.3	142.7
		21	108.2	108.9	292.7
		28	101.8	109.2	325.0
		35	101.4	116.3	352.5
		Mean	112.3±12.4	109.1±4.24	214.7±122.5
24, May	Mogwoo	0	108.9	89.1	69.1
		7	116.5	92.8	64.8
		14	132.4	96.5	70.1
		21	143.8	99.4	98.6
		28	145.9	97.5	118.5
		Mean	129.5±16.4	95.0±4.11	84.2±23.4
5, June	Mogwoo	0	129.6	108.9	68.7
		7	138.3	111.4	65.7
		14	140.5	112.2	66.8
		Mean	136.1±5.72	110.8±1.75	67.1±1.53

DAH[1] : Days after heading
[2]Data are expressed as means ± S.D.

Yeongwoo were lower in stems and leaves at heading date but the RFV increased rapidly over time and were significantly higher than in stems and leaves at the last harvest date. Mogwoo showed no significant difference in RFV values according to harvest date, with lower value on panicle (64.8~118.5) than stem (108.9~145.9). The reason for this result was expected to be because Mogwoo was late-maturing and thus the grain maturity was not completed. Mogwoo has a low ratio of panicle and a high ratio of stem (Fig. 3.), but it is expected that the high RFV of the stem compensate for that.

This study showed that there were significant differences biomass and feed values among cultivars but no clear difference among transplanting date. Dry weight (Fig. 2), CP (Table 2) and TDN (Table 5) of Jonong show no significant difference after 21 days after heading, so if early harvesting is required, it is expected to be harvested before DAH 30 days. Yeongwoo showed a lower dry weight than Mogwoo, but the yellow ripe period was earlier than Mogwoo, so one can expect a higher CP and TDN than Mogwoo. Mogwoo had lower CP and TDN than the other two cultivars but was the highest dry weight so it was considered to have an advantage as a silage rice. However, additional experiments are needed to determine the exact quantity and feed value of the whole rice.

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