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# Effects of Seeding Dates on Yield and Feed Value of Italian Ryegrass in Paddy Field Cultivation

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**ABSTRACT**

This study was carried out to investigate the influence of the seeding dates on the yield and feed value in cultivating Italian rye grass on paddy soil. The field experiment was designed in a randomized block design of 3 repetitions with seeding dates of Oct. 19 (T1), Oct. 26 (T2), Nov. 2 (T3), Nov. 9 (T4), and Nov. 16 (T5) treatments. Plant length, fresh yield, dry matter yield and TDN yield were increased with early seeding dates ($p<0.05$). Crude protein, Crude fat and crude ash were increased with early seeding dates ($p<0.05$). On the other hand, NDF, ADF and Crude fiber were decreased with early seeding dates ($p<0.05$). Total mineral contents were higher in the order of T4 > T3 > T5 > T1 > T2 ($p<0.05$). The total composition amino acid content was decreased significantly ($p<0.05$) as the seeding dates delayed. Total free sugar content was highest in T1, whereas the lowest in T5 treatment ($p<0.05$). Nutrition yields (crude protein, crude fat, amino acid and free sugar) were increased significantly with early seeding dates ($p<0.05$).

The above result indicated that it is favorable to seed soon after rice harvest to increase dry matter yield and nutrition yield of Italian ryegrass in the midlands

(**Key words :** Italian ryegrass, Seeding dates, Dry matter yield, Nutritional yield)

## Ⅰ. INTRODUCTION

As domestic Hanwoo and beef cattle breeding herd number reaches 3,100,000, there is an increased demand for roughage and concentrate. However, because there is a limited production capability for roughage and grains, dependancy on foreign import is rising. Because imported hay and grain has a high price fluctuation depending on international supply capacity, it is a difficult situation for farmers to reliably maintain the livestock industry (Lee and Kim., 2013). Therefore, expanding the base for domestic roughage to create a production infrastructure to make it possible to stock breed reliably. Especially, using abandoned farmlands after rice crop cultivation in a country with small land mass like Korea is a very important method in increasing roughage production (Kim et al., 2006). The crop fit for this is Italian rye grass which has strong moisture tolerance for paddy fields (Kim et al., 2007), has a high hay yield (Kim et al., 2009), and has a high palatability which makes it recommended as a winter crop (Choi et al., 2006a). Also Italian rye grass has a higher ratio of leaves to stems which makes it high silage quality. It is a plant that can produce dry hay in spring season (Seo et al., 2013). While until now it was only cultivated in the southern because of its low cold tolerance, there recently has been new varieties that have high cold tolerance that made it possible to cultivate it in the midlands (Kim et al., 2007; Kim et al., 2009). About research in Korea for Italian rye grass, there are many results of selection test through new varieties adaptiveness (Kim et al., 1998; Choi et al., 2005, 2006a, 2006b, 2007, 2008) and dry matter yield and nutritive value test (Chae et al., 1996; Kim et al., 2007; Seo et al., 2013). However, studies on the mineral contents, amino acid compositions, free sugars and nutrient yields were not reported. Therefore this research was done to investigate the effects on yield and nutritive value that seeding date after rice cultivation has. For the basic data, yield, TDN yield, mineral elements, amino acid composition, free sugar content, and nutrition yield was investigated. Also the results of this study will be used in figuring out the adequate seeding date for Italian rye grass to provide

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basic data for establishing a safe cultivation technique in paddy field.

## Ⅱ. MATERIALS AND METHODS

This field experiment was performed from October 19th 2009 to May 21th 2010 at a paddy field in the northwestern inland of Gyeongbuk. The field experiment design was randomized complete block in five factors with three replicates (see Table 1).

The conditions of the field experiment were a paddy field with higher organic matter and nitrogen content and lower phosphate content than the general upland soil as shown in Table 2. And the weather conditions during the experimental period are shown in Table 3.

The application rates of chemical fertilizer were calculated in total nitrogen (200 kg/ha), phosphorus (150 kg/ha) and potassium contents (150 kg/ha). The method of chemical fertilizer application was applied nitrogen and potassium with 40% as basis of fertilizer, and 60% as added fertilizer and entire phosphorus as the basis of fertilizer. The seeding method of Italian ryegrass was broadcasted on the soil at the rate of 50 kg/ha. The test plot area was 3m × 5m = 15 $m^2$. Fresh yield was counted after cutting of 9 $m^2$ each repetition. The samples were dried for 5 days at 55℃ to use as analysis samples. Nutritive values were analyzed using the AOAC method (1995); ADF and NDF were analyzed by Goering and Van Soest method (1970). TDN was obtained by the formula of Menke and Huss (1980): TDN = 88.9−(0.79 × ADF). The mineral composition was analyzed from of the pre-treated samples using ICP (Inductively Coupled Plasma, Iris Intrepid, Thermo Elemental Co., UK). The analysis of composition amino acid was done in the following sequence: 1 g of the pulverized sample was precisely taken and put in to a test tube; 10 mL of 6N-HCl was added, pressure reduced and

Table 1. Experimental design

| Item | Treatments | | | | |
|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | T5 |
| Seeding date (2009) | Oct. 19 | Oct. 26 | Nov. 2 | Nov. 9 | Nov. 16 |
| Harvest date (2010) | May 21 | May 21 | May 21 | May 21 | May 21 |
| Cultivation period | 215 days | 208 days | 201 days | 194 days | 187 days |

Table 2. Chemical properties of the soil before experiment

| pH | OM | T-N | Av. $P_2O_5$ | Ex. cation ($cmol^+kg^-$) | | | | CEC |
|---|---|---|---|---|---|---|---|---|
| (1:5) | (%) | (%) | (mg/kg) | K | Na | Ca | Mg | ($cmol^+kg^-$) |
| 6.34 | 2.62 | 0.15 | 102.67 | 0.58 | 0.18 | 3.68 | 0.87 | 13.4 |

Table 3. Monthly meteorological data during the experimental period

| Year | Month | Mean Temp. (℃) | Duration of sunshine (hr) | Precipitation (mm) | Rainy or snowy days (day) |
|---|---|---|---|---|---|
| 2009 | October | 13.9 | 212 | 17.3 | 4 |
| | November | 6.6 | 130 | 43.1 | 9 |
| | December | −3.0 | 155 | 38.7 | 12 |
| 2010 | January | −2.6 | 186 | 23.2 | 11 |
| | February | 1.1 | 128 | 78.4 | 18 |
| | March | 4.6 | 127 | 80.7 | 18 |
| | April | 9.8 | 177 | 58.9 | 9 |
| | May | 17.6 | 228 | 118.2 | 9 |

sealed; hydrolysis at 110℃ in a dry oven for 24 hours; pre-treated and filtered by 0.45 μm membrane filter; and the filtered sample was analyzed by amino acid automatic analyzer (Biochrom 30, Biochrom Ltd, Cambridge, England). Free sugar was analyzed in the following order: exactly 5g of sample was taken per Wilson et al. method (1981); 100mL of 80% ethanol solution was added; sugar composition was extracted repetitively for 2 hours at 80℃ from the heating mantle in the reflux cooling extraction unit; filtered by Whatman No. 5 and pre-treated; and was analyzed with HPLC analyzer (Waters 2414, Waters Co, USA) respectively. Mean values and standard deviations of the experimental results were obtained using SAS (Statistics Analytical System, USA) Program (2010); Duncan's multiple comparison test was used to identify differences among the treatments, which is considered significant when $p<0.05$.

## Ⅲ. RESULT AND DISCUSSION

### 1. Growth characteristics and dry matter yield

The growth characteristics by seeding date is shown on Table 4. Plant length showed a high result in the order of T1 > T2 > T3 > T4 > T5 ($p<0.05$). Like the kim et al. (2009) report, it was shown that Italian rye grass plant length was shorter at delayed seeding dates. Stem diameter did not show a significant difference. Fresh yield and dry matter yield was higher when seeding date was earlier ($p<0.05$), and especially there was a trend of rapidly decrease in yield after November in seeding dates (T3, T4, T5). The results liked the report from Kim et al. (2009) and Suh (1981) which said that when cultivating winter crops after rice cultivation, there was a difference in yield according to the seeding dates. Kim et al. (2008) reported that when seeding date is delayed in the autumn, the average temperature drops and it winter survival average rates rapidly decreases, which result in a reduced dry matter yield. It was shown that TDN yield was significantly higher in T1 than other treatments and especially in T3, T4 and T5 with late seeding dates showed a very low yield ($p<0.05$). These results were consistent with the report of Kim et al. (2009) which described that TDN yield, and dry matter yield, increased with earlier seeding dates.

### 2. Chemical compositions

The chemical composition in accordance to seeding date for Italian ryegrass is shown on Table 5. While the crude protein, crude fat, crude ash content of Italian ryegrass significantly decreased with earlier seeding dates ($p<0.05$), while NDF, ADF and crude fiber content increased with earlier seeding dates ($p<0.05$). This is because as cultivation period increases, maturity stages develop and the leaf ratio of the plant decreases and stems harden (Kim et al., 2007; Kim et. al., 2008; Lim and Kim; 1996). The chemical compositions of forage crop were reported represent significant differences depending on cutting times (Hwang et al., 2008), maturity stage (Seo et al., 2013), varieties

Table 4. Effects of seeding times on growth characteristics and yield of Italian ryegrass in the paddy field cultivation

| Items | Treatments | | | | |
|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | T5 |
| Plant length (cm) | 84.5±4.4$^{a}$ | 73.5±2.0$^{b}$ | 70.7±0.8$^{bc}$ | 66.9±2.4$^{c}$ | 61.8±1.8$^{d}$ |
| Stem diameter (mm) | 2.6±0.1$^{ns}$ | 2.6±0.2 | 2.4±0.3 | 2.5±0.1 | 2.7±0.1 |
| Fresh yield (kg/ha) | 21,152±1,512$^{a}$ | 16,213±2,001$^{b}$ | 12,626±1,385$^{c}$ | 9,845±1,110$^{d}$ | 9,722±996$^{d}$ |
| Dry matter yield (kg/ha) | 4,076±290$^{a}$ | 3,056±377$^{b}$ | 2,315±254$^{c}$ | 1,784±209$^{d}$ | 1,712±176$^{d}$ |
| TDN[1)] yield (kg/ha) | 2,311±165$^{a}$ | 1,769±218$^{b}$ | 1,351±148$^{c}$ | 1,061±120$^{c}$ | 1,090±112$^{c}$ |

TDN[1)]: total digestible nutritions.
TDN yield = [ 88.9 − (0.79 × ADF) ] × dry matter yield/ha.
Data are expressed as means ± SD.
ns : not significant.
[a,b,c,d] Means in a row with different superscripts are significantly different ($p<0.05$).

Table 5. Effects of seeding times on chemical compositions of Italian ryegrass silage in the paddy field cultivation (DM, %)

| Items | Treatments | | | | |
|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | T5 |
| Crude protein | 15.4±0.5$^{d}$ | 16.0±0.3$^{d}$ | 18.5±0.5$^{c}$ | 20.1±0.6$^{b}$ | 21.3±0.4$^{a}$ |
| Crude fat | 2.3±0.1$^{d}$ | 2.1±0.1$^{d}$ | 2.4±0.2$^{bc}$ | 2.6±0.2$^{b}$ | 3.0±0.2$^{a}$ |
| Crude ash | 10.0±0.2$^{b}$ | 10.1±0.3$^{b}$ | 10.4±0.8$^{b}$ | 11.6±0.4$^{a}$ | 11.3±0.4$^{a}$ |
| NDF[1)] | 53.7±1.6$^{a}$ | 53.4±1.3$^{a}$ | 48.2±1.8$^{b}$ | 47.3±0.4$^{b}$ | 47.0±0.9$^{b}$ |
| ADF[2)] | 40.8±1.3$^{a}$ | 39.3±2.6$^{a}$ | 38.6±1.3$^{a}$ | 37.2±2.4$^{a}$ | 31.9±3.2$^{b}$ |
| Crude fiber | 31.0±1.4$^{a}$ | 32.3±1.7$^{a}$ | 26.7±2.3$^{b}$ | 24.4±1.5$^{b}$ | 24.3±1.1$^{b}$ |

NDF[1)]: neutral detergent fiber, ADF[2)]: acid detergent fiber.
Data are expressed as means ± SD.
[a,b,c,d] Means in a row with different superscripts are significantly different ($p<0.05$).

(Kim et al., 1998), seeding dates (Kim et al., 2009) and manure conditions (Lee, 2012). Feed value was shown to be high in the late seeding group (T4, T5), but as shown in Table 4, when seeding date is late, yield significantly decreases. Thus, seeding dates should be determined by considering dry matter yield and nutritional value at the same time.

### 3. Mineral contents

Mineral content according to seeding date is shown on Table 6. Irregardless of seeding date, the mineral contents of Italian rye grass were higher in the order of K > Ca > Na > Mg. This result had the same trend as the report from Lee (2012). Excluding trace minerals (Co, Cu, Mn, Mo, Zn), Ca, K, Mg contents were the highest in T3 and

Table 6. Effects of seeding times on mineral contents of Italian ryegrass in the paddy field cultivation (DM, mg/kg)

| Items | Treatments | | | | |
|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | T5 |
| Ca | 12,806.2±999.3$^{b}$ | 12,570.9±1,008.8$^{b}$ | 14,171.7±1,047.6$^{ab}$ | 14,990.1±751.2$^{a}$ | 13,958.4±748.9$^{b}$ |
| Co | 0.2±0.0$^{ns}$ | 0.2±0.1 | 0.3±0.1 | 0.1±0.0 | 0.1±0.0 |
| Cu | 5.8±1.0$^{b}$ | 6.9±0.6$^{ab}$ | 8.0±0.7$^{a}$ | 7.1±0.4$^{ab}$ | 5.9±1.1$^{b}$ |
| Fe | 270.8±16.7$^{bc}$ | 293.9±16.7$^{ab}$ | 311.3±18.3$^{a}$ | 241.0±21.8$^{c}$ | 177.0±22.2$^{d}$ |
| K | 29,491.1±1,207.2$^{ns}$ | 29,068.9±1,453.6 | 30,513.9±1,273.7 | 31,889.4±1,882.7 | 28,601.0±720.7 |
| Mg | 984.2±135.5$^{b}$ | 989.7±147.8$^{b}$ | 1,299.5±70.8$^{a}$ | 1,261.4±120.9$^{a}$ | 768.4±23.7$^{c}$ |
| Mn | 40.9±5.8$^{b}$ | 48.7±2.9$^{a}$ | 55.6±3.4$^{a}$ | 33.2±4.2$^{c}$ | 33.8±1.7$^{c}$ |
| Mo | 0.6±0.1$^{ns}$ | 0.4±0.1 | 0.4±0.1 | 0.5±0.1 | 0.5±0.1 |
| Na | 944.9±103.5$^{d}$ | 1,160.8±67.6$^{c}$ | 1,324.5±65.4$^{c}$ | 1,510.2±156.1$^{b}$ | 1,855.7±81.6$^{a}$ |
| Zn | 20.9±1.9$^{b}$ | 23.1±1.9$^{b}$ | 33.0±3.4$^{a}$ | 23.5±1.1$^{b}$ | 21.1±1.9$^{b}$ |
| P | 388.5±63.5$^{a}$ | 314.0±21.6$^{b}$ | 248.6±21.7$^{b}$ | 252.2±28.8$^{b}$ | 274.7±14.4$^{b}$ |
| Total | 44,954.1±887.1$^{bc}$ | 44,477.5±769.5$^{c}$ | 47,966.8±1,801.1$^{ab}$ | 50,208.6±2,229.5$^{a}$ | 45,696.6±1,058.5$^{bc}$ |
| RI[1)](%) | 100.0 | 98.9 | 106.7 | 111.7% | 101.7% |

RI[1)] : relative index, ns : not significant.
Data are expressed as means ± SD.
ns : not significant.
[a,b,c,d] Means in a row with different superscripts are significantly different ($p<0.05$).

T4. Also, Na content was the highest in T5. P content was the highest in T1 which had the earliest seeding date ($p<0.05$). For total mineral content, T4 had the highest content with 50,208.6 mg/kg and T2 had the lowest with 44,477 mg/kg. This is a lower result than the report from Lee (2011), which followed the liquid manure and chemical fertilizer application method, that reported 55,198.7~68,771.6 mg/kg mineral content in Italian ryegrass. Generally it is being reported that mineral content is affected by weather conditions, soil conditions, manure conditions and other various conditions (Reid et al., 1970; Kim, 1991; Lee and Lee, 2010). However, it was a higher yield than the reports from Kim et al. (2012) which reported that mineral content in 10 varieties of silage corn had a content range of 6,790 ~9,775 mg/kg, and Jeon et al. (2012) which reported that the 9 varieties of Sorghum × Sudangrass hybrids had a content range of 6,222.6~15,020.5 mg/kg.

## 4. Composition amino acid contents

Composition amino acid by seeding dates is listed in Table 7. First looking at essential amino acids, there was a high content of valine, phenylalanine, lysine in all treatments, but methionine content was low. The total essential amino acid content showed a trend of T5 > T4 > T3 > T2 > T1 ($p<0.05$). For nonessential amino acids, all treatment groups had high glutamic acid, proline and aspartic acid content. Like the essential amino acids, the nonessential amino acid content trend was T5 > T4 > T3 > T2 > T1 ($p<0.05$). Total amino acid content which ranged from 8,680.9~ 12,047.3 mg/100g showed a similar result with the report from Lee (2012). Also, the total amino acid content was the highest in T5, lowest in T1. Result like this is considered to be attributable to the high crude protein content in T5, as shown in Table 5 (Ching et al., 1972; Lee, 2012). It was reported that forage crop amino acid content was 5,971 ~6,499 mg/100g in barley (Lee and Kim, 2013), 3,653~5,433 mg/100g in silage corn (Kim et al., 2012), and 2,324~3,908 mg/100g in Sorghum × Sudangrass hybrids (Jeon et al.,

Table 7. Effects of seeding times on composition amino acid contents of Italian ryegrass in the paddy field cultivation (DM, mg/100g)

| Items | Treatments | | | | |
|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | T5 |
| Threonine | 397.1 | 447.7 | 522.1 | 554.3 | 571.3 |
| Valine | 524.1 | 625.8 | 715.6 | 783.4 | 795.2 |
| Methionine | 37.7 | 37.3 | 39.3 | 54.1 | 57.8 |
| Isoleucine | 327.5 | 377.3 | 433.6 | 490.7 | 511.5 |
| Leucine | 404.1 | 511.9 | 571.5 | 656.9 | 725.2 |
| Phenylalanine | 526.7 | 609.1 | 700.5 | 750.5 | 768.5 |
| Histidine | 281.7 | 331.0 | 355.4 | 361.8 | 379.3 |
| Lysine | 442.0 | 503.2 | 579.2 | 601.5 | 638.4 |
| Arginine | 339.1 | 388.0 | 477.3 | 472.2 | 451.7 |
| **Sum of EAA** | **3,280.0±305.6$^{c}$** | **3,831.3±335.2$^{b}$** | **4,394.5±200.8$^{a}$** | **4,725.4±196.1$^{a}$** | **4,898.9±403.2$^{a}$** |
| Serine | 389.7 | 397.8 | 432.8 | 452.3 | 465.2 |
| Glutamic acid | 1,148.9 | 1,311.0 | 1,339.1 | 1,390.3 | 1,383.3 |
| Proline | 1,463.2 | 1,598.2 | 1,832.4 | 2,151.2 | 2,353.8 |
| Glycine | 319.4 | 387.4 | 436.5 | 465.8 | 458.9 |
| Alanine | 525.8 | 618.9 | 669.1 | 727.2 | 765.4 |
| Tyrosine | 118.3 | 118.5 | 130.6 | 123.5 | 125.3 |
| Aspartic acid | 1,435.6 | 1,543.5 | 1,545.4 | 1,553.3 | 1,596.5 |
| **Sum of NEAA** | **5,400.9±290.9$^{d}$** | **5,975.3±235.9$^{c}$** | **6,385.9±433.1$^{bc}$** | **6,863.6±342.2$^{ab}$** | **7,148.4±195.5$^{a}$** |
| **Total (EAA+NEAA)** | **8,680.9±376.0$^{d}$** | **9,806.3±395.7$^{c}$** | **10,780.4±583.9$^{bc}$** | **11,589.0±844.5$^{ab}$** | **12,047.3±622.2$^{a}$** |

EAA: essential amino acid, NEAA: non-essential amino acid.
Data are expressed as means ± SD.
$^{a,b,c,d}$ Means in a row with different superscripts are significantly different ($p<0.05$).

2012). Therefore, it was shown that compared to barley, corn, and sorghum × sudangrass hybrids, Italian ryegrass had significantly higher amino acid content.

## 5. Free sugar contents

The free sugar content in Italian ryegrass by seeding dates is shown on Table 8. The free sugar content in Italian ryegrass was in the order of glucose > sucrose > fructose > lactose. For fructose, T2 had the highest content with 877.4 mg/100g and T5 had the lowest with 665.2 mg/100g ($p<0.05$).

Glucose content was the highest in T5 which had the latest seeding date. Sucrose and lactose content was shown to be the highest in T1 and T4 respectively ($p<0.05$). Total free sugar was the highest in T4, whereas the lowest in T5 ($p<0.05$). However there was no differences in total free sugar content among T1, T2, T3 and T4. Total free sugar content is lower than that of silage corn, as reported by Lee (2012), and shows a similar content as barley, reported by Lee and Kim (2013). Generally, forage crop's free sugar content is a very important ingredient because it affects the silage fermentation (Lee and Lee, 2010; Lee 2012). Especially, higher free sugar content decrease butyric acid and ammonia generation rate, and increase lactic acid yield by faster promoting fermentation of microbes. It is also reported that pH is maintained low so that silage stabilizes quickly (Davies et al., 1998).

## 6. Nutrition yield

The nutrition yield for Italian ryegrass is shown on Table 9. Crude protein yield showed a trend of significantly decreasing as seeding dates was delayed ($p<0.05$). T1 with the early seeding date showed an additional increase effect of about 42~43%. Crude fat yield, mineral yield, amino acid yield, and free sugar yield were the highest in T1 which had the earliest seeding date ($p<0.05$). Although the T1 treatment has a lower crude protein, crude fat (Table 5), mineral (Table 6) and amino acid content (Table 7) than T2,

Table 8. Effects of seeding times on free sugar contents of Italian ryegrass in the paddy field cultivation (DM, mg/100g)

| Items | Treatments | | | | |
|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | T5 |
| Fructose | 819.9±26.2$^{b}$ | 877.4±22.2$^{a}$ | 718.6±39.2$^{c}$ | 832.1±18.2$^{ab}$ | 665.2±33.3$^{d}$ |
| Glucose | 1,323.9±147.2$^{ns}$ | 1,284.5±142.5 | 1,313.1±76.9 | 1,331.9±44.3 | 1,432.8±39.5 |
| Sucrose | 996.3±64.8$^{a}$ | 809.9±40.7$^{bc}$ | 878.7±32.0$^{b}$ | 768.7±43.3$^{c}$ | 851.2±35.9$^{bc}$ |
| Lactose | 748.1±63.3$^{b}$ | 909.7±90.9$^{ab}$ | 935.4±53.7$^{ab}$ | 1,048.5±65.6$^{a}$ | 618 ±23.2$^{c}$ |
| **Total** | 3,888.2±148.6$^{a}$ | 3,881.5±73.7$^{a}$ | 3,845.8±88.1$^{a}$ | 3,981.2±97.4$^{a}$ | 3,549.5±120.2$^{b}$ |

Data are expressed as means ± SD.
ns : not significant.
$^{a,b,c,d}$ Means in a row with different superscripts are significantly different ($p<0.05$).

Table 9. Effects of seeding times on nutrition yield of Italian ryegrass in the paddy field cultivation (DM, kg/ha)

| Treatments | Nutrition yield (kg/ha) | | | | |
|---|---|---|---|---|---|
| | Crude protein | Crude fat | Mineral | Amino acid | Free sugar |
| T1 | 627.7±44.7$^{a}$ | 93.7±6.7$^{a}$ | 183.2±13.1$^{a}$ | 353.8±25.3$^{a}$ | 158.4±11.2$^{a}$ |
| T2 | 489.0±60.4$^{b}$ | 64.2±8.1$^{b}$ | 135.9±16.7$^{b}$ | 299.7±36.9$^{b}$ | 118.6±14.7$^{b}$ |
| T3 | 428.2±47.1$^{bc}$ | 55.6±6.2$^{bc}$ | 111.0±12.2$^{bc}$ | 249.5±27.4$^{c}$ | 89.0±9.8$^{c}$ |
| T4 | 358.6±40.3$^{c}$ | 46.4±5.2$^{c}$ | 89.6±10.1$^{c}$ | 206.7±23.2$^{c}$ | 71.0±8.0$^{cd}$ |
| T5 | 364.6±37.4$^{c}$ | 51.3±5.3$^{c}$ | 85.3±19.6$^{c}$ | 206.2±21.2$^{c}$ | 60.5±6.2$^{d}$ |

Data are expressed as means ± SD.
ns : not significant.
$^{a,b,c,d}$ Means in a column with different superscripts are significantly different ($p<0.05$).

T3, T4, and T5, but the high nutrition yield of T1 is caused by the result of the significantly higher dry matter yield. Kim et al. (2012) reported that even if crude protein, crude fat, and minerals are higher, nutrition yield will be lower if dry matter yield is low. It is reported that the yield of Italian ryegrass which is grown after rice harvest at the paddy is higher as seeding date is sooner (Kim et al., 2009). Therefore, to increase yield of Italian ryegrass in the midlands after rice cultivation, it is favorable to seed soon after rice cultivation.

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