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Research Article

Growth Characteristics and Productivity of Italian Ryegrass (*Lolium multiflorum* Lam.) New Variety, 'Green Call 2ho'

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ABSTRACT

This experiment was conducted to breed a very early maturing variety of Italian ryegrass (*Lolium multiflorum* Lam.) in Grassland and Forage Crops Division, National Institute of Animal Science, RDA, Cheonan 2015-2017. The new variety of Italian ryegrass, 'Green call 2ho' is a diploid variety with green in leaf color and has semi-erect growth habit in late autumn and erect growth habit in early spring, 'Green call 2ho' was in heading date as a early-maturing variety April 24. Also 'Green call 2ho' was narrower by 2 mm in flag leaf width, longer by 2.5 cm in flag leaf length and shorter by 3 cm in plant height than those of the control variety, 'Florida 80', respectively. 'Green call 2ho' was also thicker by 0.33 mm in stem thickness and strong in winter hardness. Dry matter (DM) yield (11,688 kg/ha) of 'Green call 2ho' was 7% higher than that of 'Florida 80'. Total digestible nutrient (TDN), crude protein (CP) and relative feed value (RFV) of 'Green call 2ho' were 61.3 %, 9.8 % and 98.2, respectively which are 2.6, 0.6, and 8.4 % higher, respectively than those of 'Florida 80', respectively. Acid detergent fiber (ADF) and neutral detergent fiber (NDF) of 'Green call 2ho' were 34.9 and 58.5 % which are 3.3 and 2.7 % lower than those of 'Florida 80', respectively.

(**Key words**: Italian ryegrass, New variety, Green call 2ho)

Ⅰ. INTRODUCTION

Forage is the essentials element for animals but most of the farmers did not know importance and only misunderstand about rice straw forage values. Due to Rice straw did not has enough nutrients, animals ate more rice straw or compound feed. The cost of meat production rises rapidly every year and farmer spend much money to buy compound feed. As a result of increase compound feed, a farmer will be difficult to good living conditions.

Italian ryegrass (*Lolium multiflorum* Lam.; IRG) is one of the most popular forage crops in South Korea, Because IRG is suitable for cultivation in paddy field with excellent moisture-tolerance, and also has high feed value, high productivity, and favorable forage crop for cows. However, imported IRG varieties were weak in the cold-tolerant and could only be cultivated in the southern part of Korea. Fortunately, new varieties of IRG have been developed in National Institute of Animal Science (NIAS) located in Cheonan, which are very strong in cold weather in South Korea, and the supply of domestic varieties is increasing every year. The Ko-variety (Korea developed variety) of IRG has high cold-tolerant and adaptability more than any other country developed variety, and expend to cultivation area from the southern area (below Daejeon) to middle-northern area (upper Han river). Development of a new variety of IRG had been beginning with cold-tolerance since 1995, and developed 15 varieties are available including extremely early maturity variety to include Green call (Ji et al., 2018), Green farm (Ji et al., 2011), Green farm 2 (Ji et al., 2013), Green farm 3 (Ji et al., 2015), early maturity variety include Kogreen (Choi et al., 2006a), Kowinearly (Choi et al., 2011), Kospeed (Choi et al., 2007), medium maturity variety include Kowinmaster (Choi et al., 2008) and late maturity variety include Hwasan 101 (Choi et al., 2000), Hwasan 102 (Choi et al., 2001a), Hwasan 103 (Choi et al., 2001b), Hwasan 104 (Choi et al., 2005), Kowinner (Choi et al., 2006b). Due to the development of these varieties and supply of domestic seeds, the IRG cultivation area has

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been expanded about 152,600 ha in South Korea in 2018, and the cultivation area of IRG has also been increasing until the central region of South Korea.

The seed supply system of domestic IRG with cold-tolerant and high productivity varieties has expanded in a foreign country and return to the South Korea market since 2004. The seed production of IRG is not only significantly affected by wintering rate, but also depends on the harvesting time of seeds in South Korea. The harvesting time of seeds of IRG was overlapped with the rainy season. However, recently developed domestic varieties of early maturity have early heading date from late-April to early-May, and seed harvesting can be carried out before the beginning of the rainy season in early-June that it can make dry and select them, which makes them attractive for seed production. This study was conducted to evaluate the growth characteristics and productivity of Green call 2ho, an Italian ryegrass species with high yielding and early maturing variety in South Korea.

Ⅱ. MATERIALS AND METHODS

1. Plant material

The Italian ryegrass varieties used in the experiment were Green call 2ho and Florida 80. Green call 2ho is early flowering variety that was developed by the National Institute of Animal Science (NIAS) at the Rural Development Administration (RDA) in 2017. Florida 80 is an early-maturing variety that has been widely cultivated on Korean farms as a recommended variety since 1992.

Green call 2 ho is an early-maturing variety with high cold tolerance and high yield that was developed by the breeding program at the NIAS in 2017 and consisted of 5 lines (09CR01, 09CR05, 09CR07, 09CR10, 09CR12)

2. Field test

Experments were conducted from 2015 to 2017 in Yunchun, Cheonan, Yesan, Iksan, Jeju. The experimental plots were laid out according to three replications of a randomized block design. The size of the experimental plot was 6 ㎡(2m x 3m). Each year, from 2011, Drill seeding was performed between September 20 and 25 in Yunchun and between September 25 and 30 in Cheonan. The seeding rate was 30 kg/ha, and the seeding method was 20 cm drill seeding. The fertilizers applied were N, P2O5, and K2O at the respective rates of 200, 150, and 150 kg/ha. In terms of the fertilizing schedule, 40 kg/ha of nitrogen was applied at the start of the growth period in early spring. Half of the phosphoric acid and potassium were applied as the basal dressing, and the remaining half were applied at the start of the growth period in early spring.

Winter hardness test was evaluated by visually inspecting the number of surviving and dead individual plants in early spring and calculating the survival rate of the field.

The day when 40 % of the plants in an experimental plot were headed was considered the heading date. When 80 % of the heading was complete. the entire experimental plot was harvested and the green forage weight was measured. Harvest method was second cutting in Cheonan, Yunchun and Jeju but Yesan and Iksan was only one cutting due to rice transplanting. A 500 g sample of green forage was dried at 60 ℃ for 48 h to calculate the dry matter rate. and the green forage weight was converted into dry matter yield using the dry matter rate. In terms of feed value analysis, crude protein (CP) was analyzed with the AOAC method (1990). Total digestible nutrients (TDN) were calculated using the Menke and Huss method (1980), and *in vitro* dry matter digestibility (IVDMD) was examined with the method proposed by Tilley and Terry (1963). Acid detergent fiber (ADF) and neutral detergent fiber (NDF) were analyzed using the Goering and Van Soest (1970) method. Analysis of variance of the dry matter yield of this experiment was carried out with an SAS(2004) package program and the significance of the differences(p<0.05) was verified through Duncan's multiple range test.

Ⅲ. RESULTS AND DISCUSSION

1. Winter climate conditions

The winter field survival plants of Italian ryegrass were affected by the lowest temperature and amount of precipitation during the coldest month of January. The average temperature and precipitation in the two areas during the winter months of experiments are shown in Table 1. The average low temperature in January in Yunchun, from 2015 to 2017, was between −9.3 and −16.4 ℃. whereas the temperatures in Cheonan did not cause much of a problem for Italian ryegrass's winter survival.

Table 1. Minimum average air temperature and amount of precipitation in January from 2015 to 2017

Trial region	Min. average air temp. (℃)				Amount of precipitation (mm)			
	2015	2016	2017	Mean	2015	2016	2017	Mean
Cheonan	-5.7	-12.7	-8.7	-9.0	12.7	8	13.9	11.5
Yunchun	-9.3	-16.4	-11.5	-12.4	16	1	9	8.7
Yesan	-4.7	-11.9	-7.2	-7.9	21.5	15.5	17	18.0
Iksan	-5.2	-11.5	-5.7	-5.7	30	15	15.5	20.2
Jeju	3.3	-3.0	2.1	2.1	82.4	125.8	50.7	86.3

2. Agricultural characteristics of the variety

As shown in Table 2, Green call 2ho is a diploid variety, semi-erect type in autumn and erect type in spring. Green call 2ho had green leaves, and its flag leaves were narrow and longer than that of Florida 80. Also 'Green call 2ho' was narrower by 2 mm in flag leaf width, longer by 2.5 cm in flag leaf length and shorter by 3 cm in plant height than those of control variety, 'Florida 80', As with Florida 80, the spikelets length of Green call 2 ho was 1.1cm longer than that of Florida 80. Green call 2ho is an early-maturing variety; its heading date is April 24, which is 8 days earlier than Florida 80.

3. Comparison of cold tolerance

The cold tolerance of Italian ryegrass, Green call 2ho was affected by the climate conditions of cultivation region (eg, Yunchun). As shown in Table 3, Winter survival degree difference of cold tolerance in Yunchun region showed very well between Green call 2ho and Florida 80. Green call 2ho in Yunchun displayed greater cold tolerance than Florida 80. As Pfahler et al. (1984) showed, cold tolerance of rye is dependent not upon chromosome polyploidy but upon the genetic properties of the breeding material. As a result of that, it can be inferred that Green call 2 ho is a cold tolerant variety that showed a consistent winter survival degree, during the three year.

Table 2. Agronomic characteristics and ear characters of Italian ryegrass 'Green call 2ho' varieties

Characteristics	Florida 80	Green Call 2ho
Ploidy	Diploid	Diploid
Growth habit in autumn	Semi-erect	Semi-erect
Growth habit in spring	Semi-erect	erect
Leaf color	Green	Green
Flag leaf width (mm)	10	8
Flag leaf length (cm)	23.6	26.1
Leafiness (1~9)*	1.6	1.8
Plant height (cm)	101	98
Stem thickness (mm)	2.47	2.80
Length of longest stem (cm)	76.7	72.7
Spikelets per ear	24.1	25.2
Length of ear	27.1	30.7
Lodging resistance (1~9)*	2.6	2.2
Regrowth (1~9)*	1.1	1.1
Heading date	May 02	April 24

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

Table 3. Winter survival degree of Italian ryegrass varieties cultivated in Cheonan, Yunchun, Yesan, Iksan and Jeju from 2015 to 2017

Regions	Years	Winter survival degree (1~9)*	
		Florida 80	Green Call 2ho
Cheonan	2015	2.5	1.2
	2016	3.5	1.0
	2017	5.0	1.0
	Mean	3.7	1.1
Yunchun	2015	7.0	2.7
	2016	8.0	1.2
	2017	7.0	1.0
	Mean	7.3	1.6
Yesan	2015	2.0	1.0
	2016	1.0	1.0
	2017	5.0	1.0
	Mean	2.7	1.0
Iksan	2015	3.0	3.0
	2016	1.0	1.0
	2017	1.0	1.0
	Mean	1.7	1.6
Jeju	2015	1.0	1.0
	2016	1.0	1.0
	2017	1.0	1.0
	Mean	1.0	1.0
Mean		3.3	1.3

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

Table 4. Dry matter yield of Italian ryegrass varieties cultivated in Cheonan, Yunchun, Yesan, Iksan and Jeju from 2015 to 2017

Regions	Cutting times	Dry matter yield (kg/ha)							
		Florida 80				Green Call 2ho			
Years		'15	'16	'17	Mean	'15	'16	'17	Mean
Cheonan	2nd	9,967	12,765	13,049	11,927	12,207	16,909	12,487	13,868
Yunchun	2nd	7,660	2,733	6,855	5,749	9,431	8,583	8,408	8,807
Jeju	2nd	14,455	19,180	30,737	21,457	14,602	16,313	29,021	19,979
Average		10,694	11,559	16,880	13,044^{ab}	12,080	13,935	16,639	14,218^{a}
Yesan	1st	5,631	9,988	6,512	7,377	7,740	5,990	7,351	7,030
Iksan	1st	6,543	12,862	5,197	8,201	10,959	6,648	8,662	8,756
Average		6,087	11,425	5,855	7,789^{a}	9,350	6,319	8,007	7,893^{a}
Mean		8,851	11,506	12,470	10,942^{a}	10,988	10,889	13,185	11,688^{a}

* Means within a column followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

Table 5. Crude protein (CP), *in vitro* dry matter digestibility (IVDMD), acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrient (TDN) and relative feed value (RFV) of Italian ryegrass varieties cultivated in Cheonan from 2015 to 2017

Varieties	CP (%)	IVDMD (%)	ADF (%)	NDF (%)	TDN (%)	RFV
Florida 80	9.2	69.7	38.2	61.2	58.7	89.8
Green Call 2ho	9.8	70.1	34.9	58.5	61.3	98.2

4. Dry matter yield

The dry matter yield of two varieties of Italian ryegrass showed in Table 4. Green call 2ho's dry matter yield was more than 746kg per ha that of Florida 80. The dry matter yield of Green call 2ho in 2015, 2016 and 2017 was 9,431, 8,583, 8,408 kg/ha, respectively, which was 123, 314 and 123 % greater than Florida 80's yields of 7,660, 2,733 and 6,855 kg/ha. The dry matter yield of the two varieties of Italian ryegrass differed according to cultivation region and year. The differences of dry matter yield between two variety in cold tolerances directly affected the dry matter yields as like Yunchun's.

5. Feed value

Table 5 showed crude protein (CP), *in vitro* dry matter digestibility (IVDMD), acid detergent fiber (ADF), neutral detergent fiber (NDF), total digestible nutrient (TDN) and relative feed value (RFV) of Italian ryegrass varieties cultivated in Cheonan from 2015 to 2017. Green call 2ho's CP was 9.8%, which was higher than that of Florida 80. Green call 2ho's IVDMD was 70.1%, which was 0.4% higher than Florida 80. Green call 2ho's TDN was 61.3%, which was 2.6% higher than Florida 80. Green call 2ho's RFV was 98.2, which was 8.4 higher than Florida 80.

Ⅳ. ACKNOWLEDGEMENTS

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