

Full Length Research Paper

Growth characteristics and productivity of tall fescue new variety 'Purumi' in South Korea

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A new tall fescue variety (*Festuca arundinacea* Schreb.) named 'Purumi' was developed by the National Institute of Animal Science, Rural Development Administration, South Korea from 1999 to 2007. For synthetic seed production of this new variety, 5 superior clones: EFa9108, EFa0010, EFa0020, EFa0108 and EFa0202 were selected and polycrossed. The agronomic growth characteristics and forage production capability of the seeds were studied at Cheonan from 2004 to 2005, and regional trials were conducted in Cheonan, Pyungchang, Jeju and Jinju from 2008 to 2010. Purumi showed enhanced winter hardiness, disease resistance, and regrowth ability as compared to Fawn. The dry matter yield of Purumi was about 5.6% (16.821 kg/ha) higher than that of Fawn. However, the nutritive value of both varieties was similar. Since this new variety of tall fescue, Purumi has been developed and distributed with its most remarkable adaptability for Korean climates and superior value as a livestock feed, it is expected to play an important role in restoration of the pasture industry in Korea.

Key words: Tall fescue, Purumi, variety, forage, grassland.

INTRODUCTION

Tall fescue (*Festuca arundinacea* Schreb.) is a *graminaceous* perennial and temperate species, which grows optimally at temperatures between 15 and 21°C, as in temperate regions in Asia, Europe and North America. It is also a grass species that has been commonly used as a forage crop and developed to be used for soil retention or as lawn for cutting areas, antierosion works, parks and golf courses (Buckner et al., 1979). Moreover, it is a major forage crop in Korea because it is well adapted to poor soils, wetlands, shady places and other environmental stresses and its yield is high when used as forage (Choi et al., 2010). However, it has a few drawbacks; it is likely to be encumbered in growth due to summer depression when high temperatures above 25°C continue, and its palatability is low

as domestic animals do not enjoy eating its relatively hard leaves as compared to other Gramineae crops. Moreover, its forage quality falls sharply after the heading time (Fieser and Vanzant, 2004). In order to overcome these drawbacks, there are ongoing worldwide studies aiming to enhance the quality of tall fescue through a traditional breeding method by selection and hybridization (Sleper and West, 1985; Sleper et al., 2002; Van Wijk et al., 1993).

In Korea, utilizing information on traditional-breeding-based techniques, which has been accumulated since the 1970's, the National Institute of Animal Science, Rural Development Administration (RDA) is actively conducting studies aimed at developing a new variety of forage grass with suitability for Korean climate, high persistence and forage quality, through selection of various superior parental variety for breeding and synthesis (Choi et al., 2010).

The development of a new variety of tall fescue, in particular, is crucial for the advancement of the grassland industry in Korea. The growth of temperate forage grasses, which are suitable for a cool climate, has recently slowed due to the effects of global warming. Such effects of climate changes have created an urgent

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Abbreviations: CP, Crude protein; TDN, total digestible nutrients; IVMD, *in vitro* dry matter digestibility; ADF, acid detergent fiber; NDF, neutral detergent fiber.

need for the development of a new variety of tall fescue with outstanding environmental adaptability.

Accordingly, this study developed a new variety of tall fescue with excellent environmental adaptability, aiming to make contribution to the vitalization of the Korean grassland industry. The new variety was selected and named Purumi from 'Fa-8' by the Rural Development Administration in September, 2010, and the application of the new variety protection by the Korea Seed and Variety Service is currently pending. Purumi is well adapted to all parts of Korea, exhibiting excellent disease resistance, high forage quality and superb regrowth ability and persistence.

MATERIALS AND METHODS

This study was conducted by the Grassland and Forage Division of the National Institute Animal Science, RDA from 1991 through 2010, with the purpose of developing a new high-yielding, good quality variety of tall fescue.

Selection and crossing combinations of superior lines

By building superior nutritive lines of tall fescue collected nationally from 1991 and developing high-yielding, good-quality tall fescue lines from 1991 to 2010, we selected five superior nutritive lines (EFa9108/ EFa0010/ EFa0020/ EFa0108/ EFa0202) with excellent growth characteristics and a similar harvest time and made crossing combinations (Figure 1).

Synthesis of seeds

In order to produce synthetic seeds, we bred the nutritive lines of the crossing combinations through asexual propagation and created synthetic covering with a polycross design that utilized a 5-line triangle polycross method in 2005, based on method described by Choi et al. (2010). We then cultivated rye around and blocked any movement of the pollen.

Agronomic and botanical characteristics

We conducted an investigation into the characteristics of the breeding lines of tall fescue in Cheonan, Korea in 2007 by employing the tall fescue test guideline, including ploidy of chromosome, leaf color, leaf width, leaf quality, plant type, heading time, heading stage, length of longest stem, length of upper internode and inflorescenc length (Korea Seed and Variety Service, 2000).

Evaluation of the regional adaptability

We carried out a test on regional adaptability in Cheonan, Pyeongchang, Jinju and Jeju through a cooperative research project on new variety development by RDA, from 2008 through 2010. We tested the regional adaptability by using Fawn as the contrast variety and then examined the growth characteristics. Tall fescue seeds were sown in Cheonan and Pyeongchang on September 17, 10 and Jeju and Jinju on October 17, 9 in 2004, respectively.

The seeding rate was 30 kg/ha, and the seeding method was 20 cm drill seeding. The experimental plots were replicated three times in the randomized block design. As for the fertilizer application, the first fertilizer of 80(N), 200(P₂O₅) and 70(K₂O) kg/ha was applied in the process of seeding, and the maintaining fertilizer of 210(N), 150(P₂O₅) and 180(K₂O) kg/h was applied. Nitrogen fertilizer was applied, divided into 30, 30, 20 and 20% in early spring, after the first, second and third harvest, respectively. In addition, phosphorus and potassium fertilizer was applied in early spring and after harvest, 50% each. The morphological characteristics of the variety were examined in Cheonan, and its yield was investigated by gathering the yields in all the four areas for the regional adaptability test.

Investigation of feed value

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 as described by Choi et al. (2010). A 500 g sample of green forage was dried at 60 °C 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 and the *in vitro* dry matter digestibility (IVDMD) were analyzed through the AOAC method (1990) and the Tilley and Terry method (1963), respectively. The acid detergent fiber (ADF) and the neutral detergent fiber (NDF) were analyzed through the method of Goering and Van Soest (1970). Analysis of variance of the dry matter yield of this experiment was carried out with an SAS (1999) package program (ver. 6.12), and the significance of the differences ($p < 0.05$) was verified through Duncan's multiple range test.

RESULTS AND DISCUSSION

Characteristics

The key growth characteristics of Purumi, the new tall fescue variety, are shown in Table 1. Purumi is a hexaploid variety with green leaves. In the heading time, its branches and leaves are 19.1 cm in length, which is moderate, 6.8 mm in width, which is rather narrow. Its ears and longest stem are 29 and 114 cm in length, respectively, which is rather long. Moreover, Purumi is a medium-late maturity variety, the heading time of which is around May 18, which is seven days later than that of Fawn.

Yield

This study tested the regional adaptability of tall fescue in Cheonan, Pyeongchang, Jeju and Jinju for three years. Table 2 shows the dry matter yield of tall fescue in each region. The average dry matter yield of Purumi in the four regions was 16.821 kg/ha, which is greater than that of Fawn by 5.6%. Moreover, Purumi exhibited higher productivity than Fawn in all of the four regions. These differences show that Purumi is more resistant to environmental stresses than Fawn and that this growth

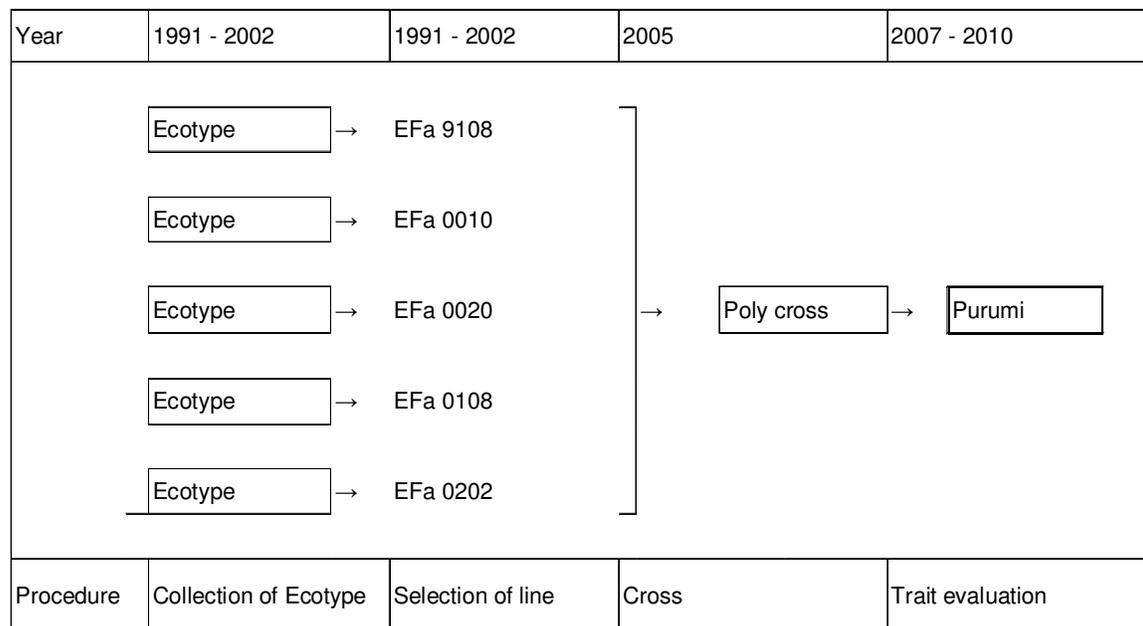


Figure 1. Pedigree diagram of a new tall fescue variety, Purumi.

Table 1. Agronomic and botanical characteristics of Purumi in Cheonan, 2007.

| Characteristic | Fawn | Purumi |
|---------------------------|------------|-----------|
| Ploidy of chromosome | Hexaploid | Hexaploid |
| Leaf color | Green | Green |
| Leaf width | Medium | Medium |
| Leaf quality | Medium | Medium |
| Plant type(Heading stage) | Half-erect | Medium |
| Heading time | May 11 | May 18 |
| Heading stage | | |
| -Flag leaf length | 18.9 cm | 19.1 cm |
| -Flag leaf width | 5.9 mm | 6.8 mm |
| Length of longest stem | 116 cm | 114 cm |
| Length of upper internode | 37.4 cm | 30.3 cm |
| Inflorescence length | 24.1 cm | 29.0 cm |

characteristic directly led to dry matter yield (Figure 2). Thus, Purumi is a suitable variety for the establishment of grasslands as it has enhanced regrowth ability, disease resistance, winter hardiness and persistence, compared to Fawn.

Feed value

The forage quality of Purumi, a new tall fescue variety, is shown in Table 3. The forage quality of Purumi proved to be similar to that of Fawn. This experiment was conducted by the Grassland and Forage Division of the

National Institute Animal Science, RDA from 2005 through 2010, with the purpose of developing a new variety of tall fescue. Purumi, a new tall fescue variety, is a hexaploid variety with green leaves and outstanding leaflet. Its heading time is around May 18. The average dry matter yield of Purumi in four regions was 16.821 kg/ha, which is greater than that of Fawn, the contrast variety, by 5.6%. Purumi also exhibited higher productivity than Fawn in all the four regions. A new variety of tall fescue named Purumi has a superior environmental adaptability and high values as a livestock feed which might contribute to the activation of the pasture industry in Korea.

Table 2. Dry matter yield of tall fescue variety cultivated in Cheonan, Pyeongchang, Jeju and Jinju from 2008 to 2010.

| Trial year | region | Dry matter yield (kg/ha) | |
|--------------------|--------|--------------------------|--------|
| | | Fawn | Purumi |
| Cheonan | | | |
| 2008 | | 20.2 | 21.2 |
| 2009 | | 15.6 | 15.7 |
| 2010 | | 11.1 | 12.9 |
| Average | | 15.7 | 16.6 |
| Pyeongchang | | | |
| 2008 | | 16.9 | 16.8 |
| 2009 | | 16.1 | 21.7 |
| 2010 | | 18.1 | 19.8 |
| Average | | 17.0 | 19.4 |
| Jeju | | | |
| 2008 | | 16.5 | 17.6 |
| 2009 | | 20.7 | 19.8 |
| 2010 | | 18.0 | 18.4 |
| Average | | 18.4 | 18.6 |
| Jinju | | | |
| 2005 | | 9.6 | 9.7 |
| 2006 | | 13.1 | 12.6 |
| 2007 | | 15.2 | 15.7 |
| Average | | 12.6 | 12.6 |

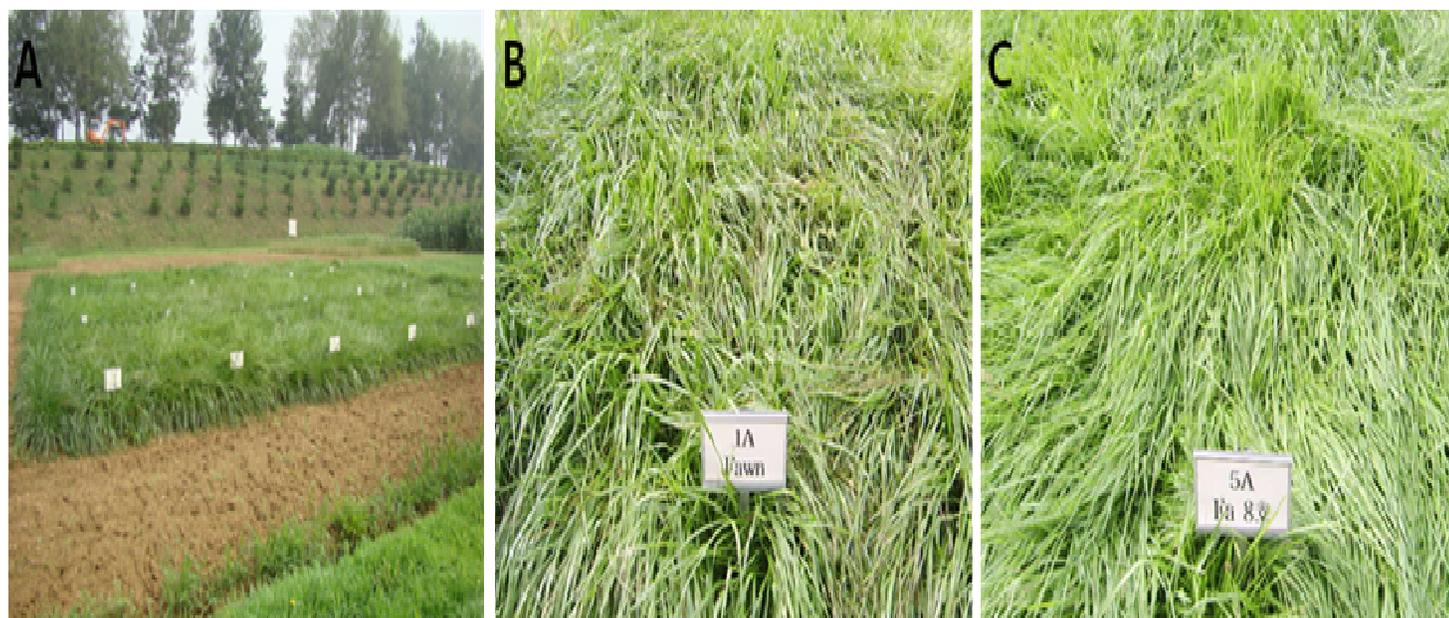


Figure 2. Comparison of tall fescue growth and development at Cheonan in 2008 and 2009. A. Evaluation of the regional adaptability of tall fescue; B. Contrast variety Fawn (more blights in summer); C. New variety Purumi (less blights in summer).

Table 3. Crude protein (CP), *in vitro* dry matter digestibility (IVDMD), acid detergent fiber (ADF), neutral detergent fiber (NDF) and total digestible nutrient (TDN) of tall fescue variety cultivated in Cheonan in 2010.

| Variety | CP (%) | IVDMD (%) | NDF (%) | ADF (%) | TDN (%) |
|---------|--------|-----------|---------|---------|---------|
| Fawn | 10.7 | 66.3 | 66.4 | 36.7 | 59.9 |
| Purumi | 11.2 | 66.6 | 65.6 | 35.9 | 60.5 |

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