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Effect of Fertilizer and Straw Mulching on Winter Discoloration and Spring Regrowth of Lawn Grasses

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ABSTRACT : This experiment evaluates wintering ability to maintain green color of lawn grasses during winter and investigates the effects of top dressing of fertilizer on improving green color during regrowth. Kentucky bluegrass could maintain green color and leaf chlorophyll content better than tall fescue and creeping bentgrass in winter. All three grasses in this experiment have shown the excellent wintering ability. In enhancing the recovery of green color at the early stage of regrowth, the mulching effect with rice straw was highly significant for creeping bentgrass. Green color recovery in grasses during its regrowth was better at the top dressing plots than at the plots without top dressing, but when fertilizer application levels were increased, green color in lawn grass did not significantly change. Although green color in tall fescue, Kentucky bluegrass, and Korean lawngrass could be maintained during summer, the green color of creeping bentgrass is reduced significantly with high temperature. Top dressing after winter and mowing improved leaf chlorophyll content and green color in tall fescue and Kentucky bluegrass significantly. However, Korean lawngrass did not respond significantly with increased levels of fertilizer.

***Keywords* :** tall fescue, Kentucky bluegrass, creeping bentgrass, Korean lawngrass, green color, chlorophyll content, wintering

Lawn has been covered extensively with zoysiagrass, called Korean lawngrass (*Zoysia japonica* Steud), in Korea. Since Korean lawngrass is well adapted to warm, humid summer and tolerates cold weather well, it has been used widely. Its dense fibrous root prevents erosion from wind and water, binding soil particles. The protective cover of aerial shoots further stabilizes the soil, as well as providing a cooling effect during hot weather. Furthermore, its uniform and green appearance enhances landscape. Lawns provide arenas for recreational activities and relaxation. However, Korean lawngrass can only maintain its green color for about five months, from the middle of May to the middle of September (Chang & Kim, 1986; Kim, 1990).

Mechanical methods used to retain and extend leaf green color of lawn grasses include top dressing (Beard, 1973; Turgeon, 1991) and mulching practices (Shashikumar & Nus, 1993; Sowers, 1988). In fertilizer practices, the color responses to nitrogen were positive and strongly linear, and root weight and mat weight were significantly increased with top dressing (Dunn *et al*, 1995). Moreover, the green period in the last ten days of October was extended possible at a slow rate in proportion to increment of N-P-K fertilization (Chang & Kim, 1986). However, overall response of plant growth did not continue indefinitely with increased nitrogen levels. Considered as the other important mechanical method, mulch reduces erosion and provides more favorable micro-environment for germination and seedling. Of mulching materials, straw is a common mulching material for grass establishment from seed and has been utilized effectively for many years. A 60% reduction in evaporation loss from the soil surface has been achieved by using a straw mulch (Beard, 1973).

The objectives of this study were to determine how the wintering is for tall fescue, Kentucky bluegrass, and creeping bentgrass as cool season grass; to evaluate the mulching effect of rice straw and; to investigate the effect of top dressing on improving green color in lawn grasses such as Korean lawngrass during their regrowth.

MATERIALS AND METHODS

This experiment was carried out on clay loam soil at the College Farm, Seoul National University (Suwon) from September 1998 to July 1999. The grasses were 'Fawn' tall fescue (*Festuca arundinacea* Schreb), 'Award' Kentucky bluegrass (*Poa prantensis* L.), 'Putter' creeping bentgrass (*Agrostris paulustris* Huds.), and Korean lawngrass (*Zoysia japonica* Steud). Five grasses species were sown in a row, 15 cm spacing on 5 September 1998. Seeding rate consisted of 43.98 kg/10a for tall fescue, 7.33 kg/10a for Kentucky bluegrass, and 4.89 kg/10a for creeping bentgrass. However, Korean lawngrass failed to establish by seed and then sods of Korean lawngrass were placed in plots at the same spacing

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Table 1. Soil properties of the field experiment.

Soil particle distribution (%)			Texture (USDA)	pH†	Exchangable cations (cmol/kg)‡			Organic matter (%)§	Total N content (mg/g)¶
Sand	Silt	Clay			Ca^{2+}	K^+	Mg^{2+}		
26.2	35.2	38.2	Clay loam	5.3	0.43	0.8	0.07	1.48	0.76

†1:5, w/v H_2O; ‡1N-Ammonium acetate; §Walkley-black method; ¶Kjeldal method.

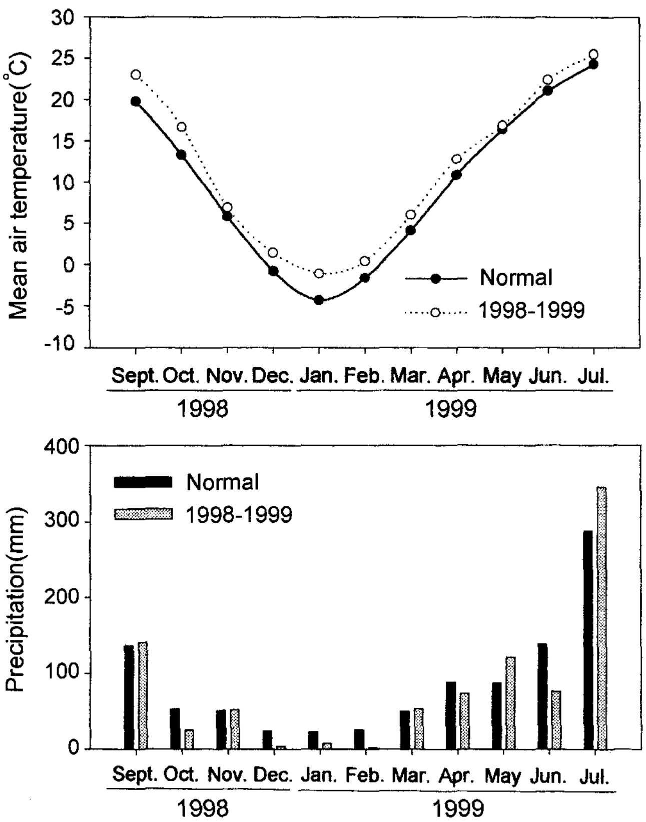

Fig. 1. Mean air temperature and precipitation from September 1998 to July 1999.

on 15 March 1999. Soil properties of the field experiment were shown in Table 1. Mean air temperature and precipitation from September 1998 to July 1999 were shown in Fig. 1.

Basal fertilizer was applied at a rate of 8-20-7 kg/10a (N-P_2O_5-K_2O) on 29 August 1998. Plant height, tiller number, and dry weight in lawn grasses were measured in order to compare wintering ability of lawn grasses before (18 November 1998) and after wintering (15 March 1999). The whole plants including those root within 15 cm soil depth were sampled, washed, dried at 70°C oven for 48 hours, and then weighted for their dry weight. For testing the mulching effect during winter, rice straw was used to cover half of each plot on 18 November 1998. Scores of green color were visually estimated and then recorded every 3 days. Scores ranged from a perfect rating of 10, representing uniform and dense dark green, to a low score of 0, representing completely light brown color when the grass appear dead. A score of 6.5 or above was considered to be an acceptable green color (Aronson *et al.*, 1987; Huang *et al.*, 1998; Sartain, 1993). Leaves of each plot were sampled every ten days to measure leaf chlorophyll content and then stored in zipper bags at the field. Each leaf samples were cut into pieces and mixed well. The 2 g of fresh leaves was taken to extract with 80% acetone. The homogenate was filtered through Whatman No. 2 filter paper and then the decant put into a 100 ml volumetric flask. The leaf chlorophyll content was measured spectrophotometrically at 645 and 663 nm (A. O. A. C., 1990). After wintering, top dressing was split-applied into four times with three different application levels of N-P_2O_5-K_2O, that is 0-0-0 kg/10a (F0), 15-7.5-7.5 kg/10a (F1), and 30-15-15 kg/10a (F2) on 15 March 1999. Plots were laid out in a randomized complete block design with three replications.

Tall fescue was mowed on 30 April, 30 May, 30 June, and 30 July. On those days, appropriate level of top dressing was also applied, followed by enough water. Kentucky bluegrass, creeping bentgrass, and Korean lawngrass were mowed on 30 May, 30 June, and 30 July, given different levels of top dressing, and were supplied with enough water. During their regrowth that follows wintering, the green color was measured every five days, and leaf chlorophyll content was measured every ten days. The grasses were mowed to the height of 5 cm by a mower.

RESULTS AND DISCUSSION

Growth characteristics before and after wintering

Plant heights of tall fescue, Kentucky bluegrass, and creeping bentgrass were reduced more significantly after wintering than before wintering. However, tiller number, and dry weight of three lawn grasses increased after wintering (Table 2). The increase of tiller number and dry weight in Kentucky bluegrass was more significant than that of tall fescue and creeping bentgrass as well. Gusta *et al.* (1980) reported that LT_{50} of creeping bentgrass was -35°C, Kentucky bluegrass cultivars from -21°C to -30°C, and the fescues from -12°C to -27°C, respectively, in the order of their ability to resist freezing. Cold tolerance of grasses was

Table 2. The comparison of growth characteristics in tall fescue, Kentucky bluegrass, and creeping bentgrass before wintering, after wintering, and after mulching with rice straw.

Growth Characteristics	Treatment	Tall fescue	Kentucky bluegrass	Creeping bentgrass
Plant height (cm)	BW†	35.1a	7.4a	9.3a
	AW‡	26.9b	6.2b	6.6c
	MS§	24.7c	7.8a	7.9b
	F value	53.9**	13.3**	29.3**
Tiller number (No./m^2)	BW	7225.9c	3422.2c	14104c
	AW	8222.2b	7288.8b	21919b
	MS	9762.9a	9177.7a	29659a
	F value	24.9**	74.5**	24.7**
Dry weight (g/m^2)	BW	484.4b	47.4c	193.3c
	AW	553.3a	285.9a	279.9b
	MS	580.7a	163.7b	391.8a
	F value	17.4**	86.2**	59.9**

†BW: before wintering (18 November 1998)
‡AW: after wintering (15 March 1999)
§MS: mulching with rice straw;
ns: not significant at P=0.05
**: significant within same column at the 0.01 probability level.

higher in the order of creeping bentgrass, Kentucky bluegrass, and tall fescue (Turgeon, 1990). In this experiment, wintering of three grasses was excellent even though wintering among those grasses could not be compared.

Covered with rice straw, the mulching effect in plant height of Kentucky bluegrass and creeping bentgrass was significant when compared with that of control plots without mulching after wintering. Rice straw mulching in tall fescue was not effective due to tall plant height. Tiller number in tall fescue, Kentucky bluegrass, and creeping bentgrass after wintering increased more significantly than the control plot. Furthermore, the mulching effect to dry weight was highly significant except Kentucky bluegrass. Shashikumar & Nus (1993) reported that the presence of spun-bonded covers improved cold acclimation and increased crown moisture content from 100 to 200 g/kg of all bermudagrass cultivars tested. August and September plantings remaining under plastic throughout the winter exhibited a high ability to survive winter in comparison to unmulched or straw mulched turf, and were nearly 100% established by July 1st of the following year (Sowers & Welterlen, 1988). Therefore, those results suggest that the use of covers significantly enhance winter survivability.

Discoloration and chlorophyll content during winter

During the winter, the green colors of tall fescue, Kentucky bluegrass, and creeping bentgrass were reduced grad-

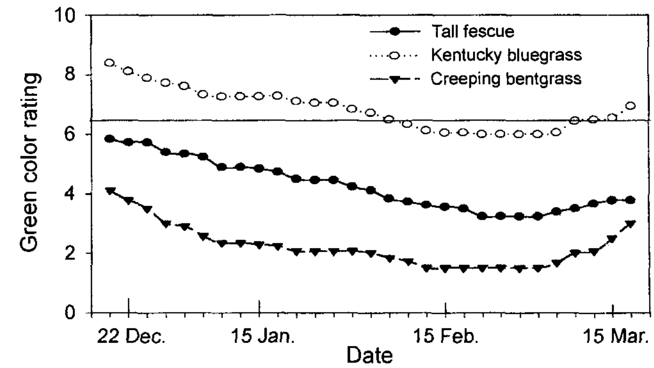

Fig. 2. Changes of green color in tall fescue, Kentucky bluegrass, and creeping bentgrass during winter, Scores ranged from a perfect rating of 10, representing uniform and dense dark green, to a low score of 0, representing completely light brown when the grass appear to dead. A score of 6.5 or above was considered as an acceptable green color.

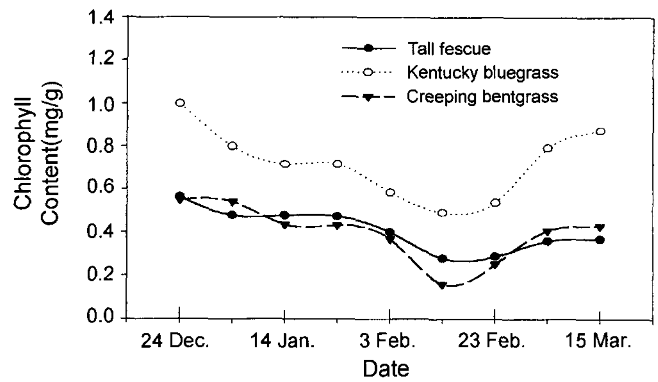

Fig. 3. Changes of leaf chlorophyll content in tall fescue, Kentucky bluegrass, and creeping bentgrass during winter.

ually until the early February and then improved sharply in the late February or the early March. Among three grasses, only Kentucky bluegrass could barely maintain acceptable scores level of green color. However, tall fescue contained remaining to the brown discoloration during the whole winter season. Especially, creeping bentgrass completely changed to the perfect brown foliage (Fig. 2).

Leaf chlorophyll content showed a similar tendency as green color. Leaf chlorophyll content in Kentucky bluegrass was higher than that in the other grasses. However, leaf chlorophyll content between tall fescue and creeping bentgrass was not remarkably different, like the green score (Fig. 3). In order to maintain an acceptable green color, lawn grasses should hold above 0.6 mg/g fresh weight of leaf chlorophyll content in winter. Moreover, when mulched with rice straw, leaf chlorophyll content in tall fescue and creeping bentgrass could be improved to the level of Kentucky bluegrass without mulches (Fig. 4). According to Turgeon (1990), mulch reduces evaporation from the soil surface and provides a more humid micro-environment in and above the soil.

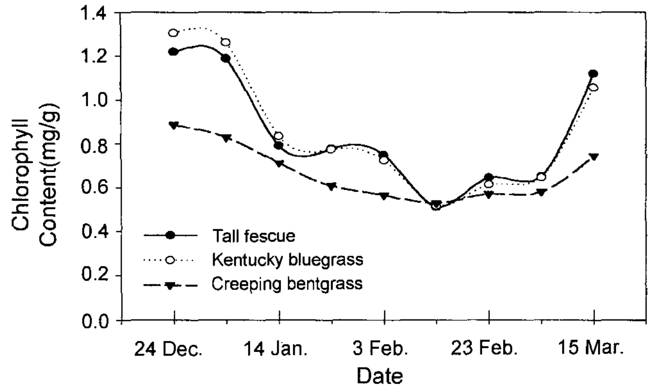

Fig. 4. Changes of leaf chlorophyll content of tall fescue, Kentucky bluegrass, and creeping bentgrass mulched with rice straw during winter.

Top-dressing effect on green color and leaf chlorophyll content during regrowth

After wintering, changes of green color and leaf chlorophyll content during regrowth in tall fescue, Kentucky bluegrass, creeping bentgrass, and Korean lawngrass with different levels of top dressing are presented in Fig. 5 and 6. Three grasses except Korean lawngrass did recover the green color to the minimum acceptable level right after wintering regardless of their fertilizer. The top dressing was significant in increasing green color in tall fescue and Korean lawngrass as well, although Korean lawngrass transplanted on 15 March 1999 was slow to establish. However, different levels of fertilizer did not affect their green color significantly. Nevertheless, fertilization during regrowth is considered to have played an important role in enhancing leaf green color (Fig. 5). This result agrees well with the conclusion of Yeam *et al.* (1985) that nitrogen fertilizer greatly affects top growth, leaf color, and chlorophyll content. Furthermore, application of 40 g/m^2/year of nitrogen and phosphorous is considered to be most effectives with potassium being considered to have an additive effect as well. Similar result was also reported that turfgrass color responses to nitrogen were positive and strongly linear (Dunn *et al*, 1995). During summer season, green color in Kentucky bluegrass and creeping bentgrass declined due to high temperature while tall fescue and Korean lawngrass could maintain uniformal and dense dark green color. Huang *et al.* (1998) recently reported the same result that growth, quality, leaf chlorophyll content, and net photosynthetic rate decline with increasing temperature for

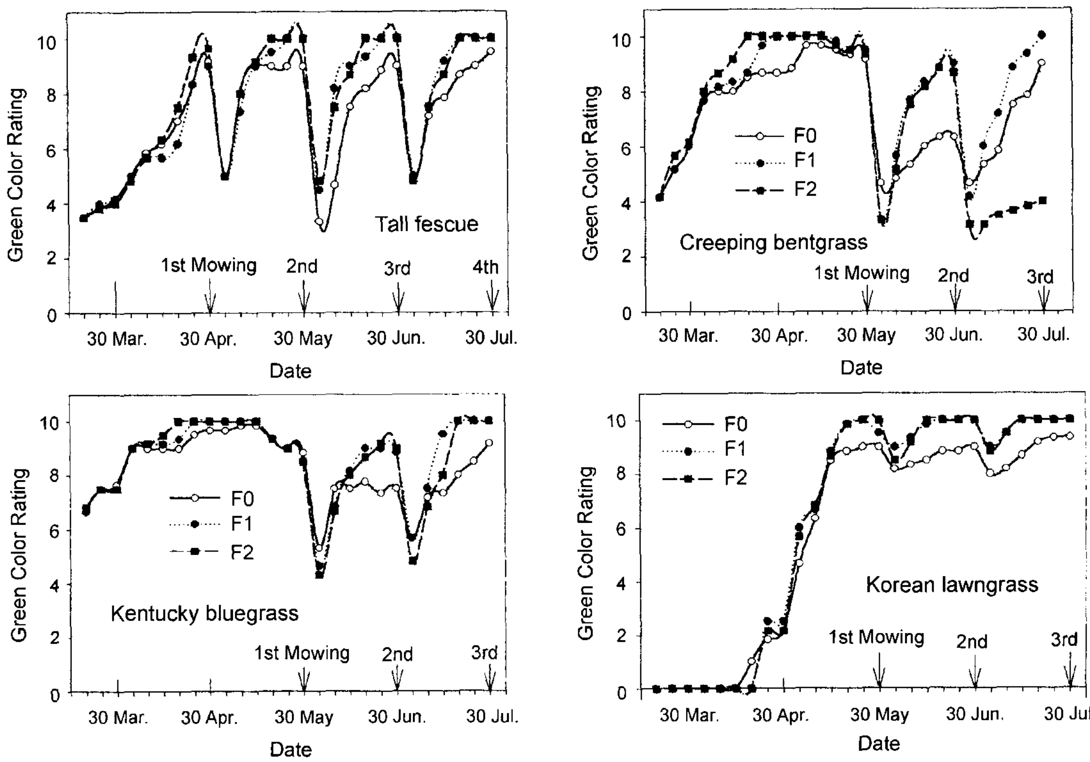

Fig. 5. Changes of green color in tall fescue, Kentucky bluegrass, creeping bentgrass, and Korean lawngrass when covered with top dressing of three different application levels of N-P_2O_5-K_2O, 0-0-0 kg10a (F0), 15-7.5-7.5 kg/10a (F1), and 30-15-15 kg/10a (F2) during regrowth. The grasses were mowed to the height of 5 cm by a mower. Scores ranged from a perfect rating of 10, representing uniform and dense dark green, to a low score of 0, representing completely light brown color when the grass appear to be dead. A score of 6.5 or above was considered to be an acceptable green color.

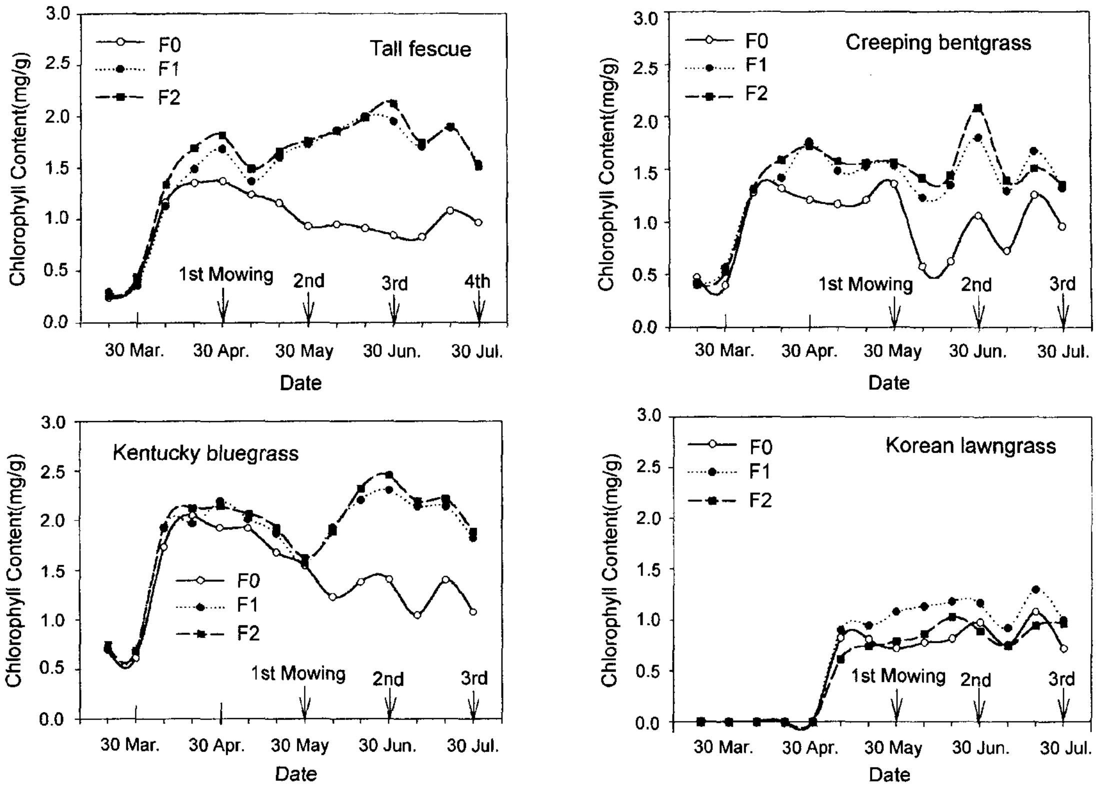

Fig. 6. Changes of leaf chlorophyll content in tall fescue, Kentucky bluegrass, creeping bentgrass, and Korean lawngrass when covered with top dressing of three different application levels of N-P_2O_5-K_2O, 0-0-0 kg/10a (F0), 15-7.5-7.5 kg/10a (F1), and 30-15-15 kg/10a (F2) during regrowth. The grasses were mowed to the height of 5 cm by a mower.

creeping bentgrass.

The changes of leaf chlorophyll content showed similar tendency as the green color (Fig. 6). Especially, fertilizer affects lawn grasses significantly during the summer season. However, fertilizer effect was not significantly different between fertilizer application levels. In June and July, leaf chlorophyll content fluctuated considerably. The fluctuation of leaf chlorophyll content was severe in the order of creeping bentgrass, Kentucky bluegrass, tall fescue, and Korean lawngrass. This result agrees with the result of their heat tolerance (Turgeon, 1991).

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