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Effect of Nitrogen Fertilization on Quality Characteristics of Four Turf Mixtures Under Different Wear Treatments

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ABSTRACT

The effect of three nitrogen (N) application regimes on the color, turf quality, cover, and clipping weights of four different sports type mixtures were evaluated under different wear frequencies for three years in an irrigated field. Nitrogen was applied monthly at rates of low (2.5 g N m^{-2}), medium (5.0 g N m^{-2}), and high (7.5 g N m^{-2}). The turf mixtures were subjected to four different wear treatments at frequencies of zero (control), once per week, once biweekly, and once per month for approximately eight months each experimental year. Wear treatments reduced turf color and quality, cover percentage, and clipping yield. Application of wear every week was detrimental to turf characteristics, whereas wear once every month generally had no significant effect. Nitrogen fertilization resulted in improved color and quality, and increased cover percentage and clipping yield.

Keywords: wear damage, turf quality, color, cover, clipping yield

INTRODUCTION

Wear damage is one of the major problems on sports and recreational turf used in athletic fields. It is defined as injury on the plant tissues in a turfgrass stand due to tearing and scuffing pressure (Carrow and Petrovic, 1992). Previous studies have reported that wear causes reduction of visual turf quality, percent turf cover, and clipping yield (Carrow and Petrovic, 1992; Taivalmaa et al., 1998; Trenholm et al., 2000). The wear tolerance of turf depends on species

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used, intensity, and factors causing the wear, and intensity of cultural practices (Shearman et al., 1974).

Cool-season turf species differ in their recuperative ability and tolerance to wear. Sevcikova et al. (2000) tested 77 turfgrass varieties of 10 species for wear tolerance. It was found that final ground cover after wear was the highest in tall fescue (*Festuca arundinacea* Schreb.) and the lowest in annual bluegrass (*Poa annua* L.). Shearman et al. (1980) indicated that 'Merion' Kentucky bluegrass (*Poa pratensis* L.), 'Manhattan' perennial ryegrass (*Lolium perenne* L.), 'Kentucky 31' tall fescue were the most wear tolerant grasses tested, whereas 'Fairway' crested wheatgrass (*Agropyron cristatum* L. Gaertn.) and 'Highlight' Chewings fescue (*Festuca rubra* var. *commutata* Gaud.) had the poorest wear tolerance in this study.

Nitrogen (N) application significantly improves turfgrass color and turf quality (Beard, 1973). Several studies have been conducted to determine the effects of N application time and rates on turf quality and plant growth (Wilkinson and Duff, 1972; Spangenberg et al., 1986; Wehner et al., 1988; Moore et al., 1996). However, the effect of N fertilization on the wear tolerance and recuperative ability of the turfgrass varieties was not studied in detail in these studies. Canaway (1984) indicated that wear tolerance increased with increasing of N from low to intermediate rates in perennial ryegrass turf. The turf receiving high N rates deteriorated more rapidly than low and intermediate N applications; the critical level where N application favored wear tolerance on cool-season grasses fell between 200 to 300 kg of N $ha^{-1}yr^{-1}$. Cockerham et al. (1989) rated fifty-three perennial ryegrass cultivars for wear tolerance between mid-May and mid-July 1988. Turf quality rating was highest, for all wear treatments, with the highest N fertilization rate. In contrast, increasing N application from 96 to 192 $ha^{-1}yr^{-1}$ improved creeping bentgrass (*Agrostis stolonifera* var. *palustris* Huds.) wear tolerance only in the 4th year, but had no effect on Kentucky bluegrass wear tolerance.

The objective of this study was to evaluate wear tolerance for three years and recovery from wear frequencies under different nitrogen fertilization programs in four sports type turf mixtures consisting of perennial ryegrass (*Lolium perenne* L.), tall fescue (*Festuca arundinacea* Schreb.), Kentucky bluegrass (*Poa pratensis* L.), Chewings fescue (*Festuca rubra* var. *commutata* Gaud.), creeping red fescue (*Festuca rubra* var. *rubra*), slender red fescue (*Festuca rubra* var. *trichophilla*), and Colonial bentgrass (*Agrostis tenuis* L.) under a Mediterranean-type environment of Turkey.

MATERIALS AND METHODS

The detailed information on soil and climatic conditions of this study, the turf mixtures, N treatments used, and data collection procedures were presented in a previous study (Bilgili and Acikgoz, 2005). Therefore, only applications and

experimental procedures not mentioned in the previous study were reported in this paper.

The studies were conducted on turfgrass experimental plots of the Uludag University Agricultural Faculty in Bursa, Turkey, from 1998 through 2001. In this field trial, treatments were arranged in a split-split plot design with three replications. Wear frequencies were placed into main plots, turf mixtures into subplots, and nitrogen rates into subplots.

Four different turf mixtures, mixture I (40% perennial ryegrass, 40% tall fescue, and 20% Kentucky bluegrass), mixture II (50% perennial ryegrass, 50% Kentucky bluegrass), mixture III (50% perennial ryegrass, 30% Kentucky bluegrass, 20% Chewings fescue), mixture IV (30% perennial ryegrass, 15% Kentucky bluegrass, 15% Chewings fescue, 15% creeping red fescue, 15% slender red fescue and 10% Colonial bentgrass) were used in this study. Nitrogen was applied monthly at rates of low (2.5 g N m^{-2}), medium (5.0 g N m^{-2}), and high (7.5 g N m^{-2}), in the form of ammonium nitrate (Oral and Acikgoz, 2001).

In the first year, wear treatments were not applied to plots in order to establish the stand. Wear treatments were initiated on August 15, 1999 and continued to April 22, 2000, and from August 14, 2000 to May 7, 2001. These dates represent the soccer season in Turkey. The turf mixtures were subjected to four different wear treatments periodically to each main plot with a manual 70 kg, 60 cm wide and 20 cm diameter football-type studded roller at frequencies of zero (control), wearing per week, per two weeks and per month. All passes were made on the same day of the week. A single wear treatment consisted of 10 rolling across a plot in one direction, and then back in the opposite direction.

Clipping yield, color and turf quality ratings were taken regularly for each clipping date from all plots. Turfgrass color was visually rated using a scale of 1 to 9, with 1 completely yellow and 9 dark green (visual quality ratings: 1 poorest; 9 excellent). Percent cover was established monthly both visually and using a line transect method. Visual percent cover was based to an estimate of vegetative cover per unit areas of soil surface. Two diagonal 1-m samples were taken in a line transect method, owever, cover percentages measured by two different methods gave very similar results. Therefore, only visual cover estimates were presented in this paper. Cover percentage data (%) was analyzed without any transformation.

All the characteristics measured were subjected to an analysis of variance for each sampling date. Analysis of variance and least significant difference (LSD) tests among means were conducted using the Statistical Analysis System (SAS Institute Inc., Cary, NC, USA) statistical analysis package. Statistically significant means were separated by the LSD test at the 0.05 level. In the first year, wear treatments were not applied during emergence and establishment of plants. Therefore, only turf mixtures and nitrogen applications and their interactions were analyzed in split block design with 12 replications. In the second and third years, all treatments including wear treatments were analyzed using a split-split block design with three replications.

RESULTS AND DISCUSSION

Although Mixture IV, mainly consisting of Kentucky bluegrass, fine fescues, and colonial bentgrass established slowly, excellent turf stands were obtained in all mixtures. In the first year, the differences in turf color and quality among the mixtures at some individual sampling dates were statistically significant, whereas seasonal averages were similar and differences were not significant. Clipping yields and cover percentages showed small but significant differences in certain seasons (Table 1). N application had a significant effect on turf color and quality, cover percentages and clipping yield. An analysis of variance indicated that differences of those characteristics among the N applications were statistically significant both at all the individual sampling dates and seasonal averages. The mixtures exhibited improved turf color and quality, cover percentages and increased clipping yields, at the 5 and 7.5 g m^{-2} N rates throughout the growing seasons (Table 2).

An analysis of variances indicated that the interactions of wear treatments x N rates were statistically significant at certain individual sampling dates, but that seasonal averages were not significant in all traits measured with the exception of cover percentages. Therefore, the discussions were mainly confined to the wear treatments and N rates. In order to summarize the data and for easier presentation, averages of color, quality, clipping weight, and cover percentage during wearing and recovery period were tabulated in Tables 3 and 4.

During the establishment period, all plots particularly those fertilized with 5.0 and 7.5 g m^{-2} N rates exhibited high color and quality ratings. Before starting wear treatments in the 1999–2000 season, the plots averaged 8.1 color rating with a range of 7.5 to 8.3, and 8.2 quality with a range of 7.7 to 8.1. In the 2000–2001 season, the corresponding values were 8.1, 7.5, 8.6, and 7.8, 7.2, and 8.4, respectively. However, those ratings gradually declined for all mixtures as wear treatments started, and the harmful effects of wear increased with time during the approximately 8-month wear period.

Wear effects varied significantly among wear intensities. Analysis of variance indicated that turf color and quality ratings of plots with wear once every month did not differ significantly from the uninjured control plots, both at individual sampling dates and seasonal averages (Table 3). High wear frequencies diminished turf color and quality ratings, with wear every week being the most detrimental to those turf characteristics. Wear every week produced significantly lower color and quality ratings compared with controls at all individual sampling dates and when the observations were averaged. Turf color and quality on the plots with wear every week compared with the control was 23 and 37% lower in 2000, and 28 and 51% lower in 2001. The color and quality ratings drastically reduced to 2.5 and 2.9, respectively, at the end of the wear periods under the lowest N fertilization regime. The decline in turf color and quality as wear increased was similar to trends observed by several researchers (Youngner, 1962; Cockerham et al., 1989; Carrow and Petrovic, 1992).

Table 1
Color and quality ratings, turf cover and clipping weights of turf mixtures in establishment period of 1998–1999

Turf Mixtures[1]	Spring	Summer	Fall	Winter
		Color[2]		
I	7.8	7.4	6.8	6.6
II	7.8	7.3	6.5	6.5
III	7.9	7.1	6.7	6.9
IV	7.8	7.2	6.7	6.6
LSD (0.05)	ns	ns	ns	ns
		Quality[3]		
I	8.1	7.7	6.1	6.8
II	8.0	7.6	6.1	6.7
III	8.1	7.5	6.4	7.1
IV	8.1	7.5	6.3	7.1
LSD (0.05)	ns	ns	ns	ns
		Cover (%)		
I	85.7	83.6 ab	70.7	74.4 b
II	85.2	82.4 ab	68.9	73.3 b
III	86.3	82.0 ab	73.4	78.3 a
IV	86.3	80.3 b	73.3	79.2 a
LSD (0.05)	ns	**	ns	**
		Total Clipping Weights (g m^{-2})		
I	1118.9 b	533.0	245.9	76.9
II	1020.6 c	502.8	198.2	73.3
III	1156.9 b	507.5	229.1	82.6
IV	1276.4 a	544.4	235.4	83.8
LSD (0.05)	**	ns	ns	ns

[1]Mixture I (40% perennial ryegrass, 40% tall fescue, and 20% Kentucky bluegrass), mixture II (50% perennial ryegrass, 50% Kentucky bluegrass), mixture III (50% perennial ryegrass, 30% Kentucky bluegrass, 20% Chewings fescue), mixture IV (30% perennial ryegrass, 15% Kentucky bluegrass, 15% Chewings fescue, 15% creeping red fescue, 15% slender red fescue, and 10% Colonial bentgrass).

[2]Color ratings made on 1–9 basis. 1: Completely yellow, 9: Dark green.

[3]Quality ratings made on 1–9 basis. 1: Poorest, 9: Excellent turf.

**: F-test significant at $P \leq 0.01$. ns, not significant.

Significant effects of N treatments on turf color and quality characteristics were detected in both experimental years. An analysis of variance indicated that color and quality ratings among the N treatments were statistically significant both at all the individual sampling dates and seasonal averages without exception in two wear periods. Increasing N clearly enhanced the color and quality

Table 2
Color ratings, quality ratings, turf cover and clipping weights of turf mixtures at three nitrogen levels in establishment period of 1998–1999

Nitrogen levels (g m^{-2})	Spring	Summer	Fall	Winter
		Color[1]		
2.5	7.0 c[2]	6.3 c	5.6 c	5.8 c
5.0	8.0 b	7.3 b	6.9 b	6.7 b
7.5	8.6 a	8.0 a	7.6 a	7.4 a
LSD (0.05)	**	**	**	**
		Quality[3]		
2.5	7.4 c	6.9 c	5.4 c	6.3 c
5.0	8.1 b	7.7 b	6.4 b	6.9 b
7.5	8.6 a	8.0 a	7.0 a	7.5 a
LSD (0.05)	**	**	**	**
		Cover (%)		
2.5	81.9 c	77.5 c	70.2 c	67.1 c
5.0	86.9 b	83.7 b	72.3 b	73.5 b
7.5	89.4 a	85.0 a	76.7 a	79.1 a
LSD (0.05)	**	**	**	**
		Clipping weights (g m^{-2})		
2.5	404.0 c	278.1 c	94.6 c	28.4 c
5.0	1099.6 b	522.1 b	195.5 b	66.0 b
7.5	1925.9 a	765.6 a	391.4 a	143.0 a
LSD (0.05)	**	**	**	**

[1]Color ratings made on 1–9 basis, 1: Completely yellow, 9: Dark green.

[2]Differences between means with the same letters in each trait are not statistically significant by the LSD test (0.01).

[3]Quality ratings made on 1 to 9 basis. 1: Poorest, 9: Excellent.

**: F-test significant at $P \leq 0.01$.

ratings in all turf mixtures and wear treatments. The 5 and 7.5 g m^{-2} N rates provided darker green turf throughout the wear periods in all wear treatments. The trends in turf quality ratings were similar to those of the color rating data. This is consistent with previous observations on the effect of N fertilization on different turfgrasses (Schou and Tesar, 1977; Sills and Carrow, 1983; Garling and Boehm, 2001).

Across all N treatments, the clipping yield and cover percentages of plots averaged 225 g m^{-2} and 69% in 1999–2000, respectively, and 335 g m^{-2} and 77% in 2000–2001, respectively, before starting the wear treatments. Wear treatments reduced cover percentages of the turf mixtures and decreased clipping dry weight. The results indicated that the practice of wear once per month did

Table 3
Effect of different wear levels and N fertilization programs on color and quality ratings during wear and recovery period (Average of 4 mixtures)

Nitrogen levels (g/m^2)	Wear levels					Wear levels				
	Control	Monthly	Biweekly	Weekly	Average	Control	Monthly	Biweekly	Weekly	Average
					Color[1]					
	1999–2000 Wear period (11 observations)					1999–2000 Recovery period (4 observations)				
2.5	7.0	6.7	6.2	5.2	6.3 C[2]	7.0	7.1	6.9	6.4	6.9 C
5.0	8.2	8.1	7.4	6.6	7.6 B	8.2	8.2	8.1	7.7	8.1 B
7.5	8.8	8.7	8.2	7.4	8.3 A	9.0	9.0	8.9	8.9	8.9 A
Average	8.0 a	7.8 a	7.3 b	6.4 c		8.1 a	8.1 a	8.0 a	7.7 b	
	2000–2001 Wear period (12 observations)					2000–2001 Recovery period (3 observations)				
2.5	6.5	6.3	5.7	4.7	5.8 C	6.7	6.5	6.1	5.5	6.2 C
5.0	8.0	8.0	7.3	6.7	7.5 B	8.4	7.8	7.5	7.0	7.7 B
7.5	8.9	8.8	8.5	8.2	8.6 A	9.0	8.8	8.8	8.4	8.8 A
Average	7.8 a	7.7 a	7.2 b	6.5 c		8.0 a	7.7 a	7.5 a	6.9 b	

(Continued on next page)

Table 3
Effect of different wear levels and N fertilization programs on color and quality ratings during wear and recovery period (Average of 4 mixtures) *(Continued)*

Nitrogen levels (g/m^2)	Wear levels					Wear levels				
	Control	Monthly	Biweekly	Weekly	Average	Control	Monthly	Biweekly	Weekly	Average
					Quality[3]					
	1999–2000 Wear period (11 observations)					1999–2000 Recovery period (4 observations)				
2.5	7.5	7.2	6.9	5.8	6.9 C	7.6	7.6	7.1	6.4	7.2 C
5.0	8.2	8.2	7.9	6.9	7.8 B	8.5	8.6	8.4	7.6	8.3 B
7.5	8.8	8.6	8.4	7.7	8.4 A	8.9	9.0	8.9	8.9	8.9 A
Average	8.2 a	8.0 a	7.7 a	6.8 b		8.3 a	8.4 a	8.1 b	7.6 c	
	2000–2001 Wear period (12 observations)					2000–2001 Recovery period (3 observations)				
2.5	6.5	6.5	5.3	4.1	5.6 C	6.2	6.0	6.1	4.9	5.8 C
5.0	7.9	7.7	6.8	6.1	7.1 B	8.3	7.6	7.6	6.1	7.4 B
7.5	8.9	8.8	8.1	7.6	8.4 A	8.9	8.8	8.8	7.2	8.4 A
Average	7.8 a	7.7 a	6.7 b	5.9 c		7.8 a	7.5 a	7.5 a	6.1 b	

[1]Color ratings made on 1–9 basis, 1: Completely yellow, 9: Dark green.

[2]Means of the wear levels followed by the same lower case letter and nitrogen levels followed by the same upper case letter was not significantly different at 0.05 level using LSD test.

[3]Quality ratings made on 1 to 9 basis. 1: Poorest, 9: Excellent.

Table 4
Effect of different wear levels and N fertilization programs on clipping yield (g m^{-2}) and cover percentages (%) during wear and recovery period (Average of 4 mixtures)

Nitrogen levels (g/m^2)	Clipping weight									
	Wear levels					Wear levels				
	Control	Monthly	Biweekly	Weekly	Average	Control	Monthly	Biweekly	Weekly	Average
	1999–2000 Wearing period (9 clippings)					1999–2000 Recovery period (4 clippings)				
2.5	68.8	52.8	39.0	23.3	45.9 c[1]	229.4	240.9	240.0	206.0	229.1 c
5.0	164.6	146.4	97.6	64.7	118.3 b	376.4	393.7	419.9	393.7	395.9 b
7.5	279.5	241.1	205.3	134.5	215.1 a	487.8	542.9	592.9	556.7	545.1 a
Average	170.9 a	146.8 b	113.9 b	74.2 c		364.5	392.5	417.6	385.5	
	2000–2001 Wear period (10 clippings)					2000–2001 Recovery period (2 clippings)				
2.5	84.2	72.2	58.4	38.2	63.3 c	225.0	191.9	195.4	143.5	189.0 c
5.0	259.0	214.5	162.9	134.6	192.8 b	376.2	347.8	338.7	292.8	338.9 b
7.5	343.8	341.8	312.5	243.8	310.5 a	519.5	479.3	465.3	417.2	470.3 a
Average	229.0 a	209.5 a	177.9 a	138.9 b		373.6	339.7	333.1	284.5	

(Continued on next page)

Table 4
Effect of different wear levels and N fertilization programs on clipping yield (g m^{-2}) and cover percentages (%) during wear and recovery period (Average of 4 mixtures) *(Continued)*

Nitrogen levels (g/m^2)	Cover									
	Wear levels					Wear levels				
	Control	Monthly	Biweekly	Weekly	Average	Control	Monthly	Biweekly	Weekly	Average
	1999–2000 Wear period (11 observations)					1999–2000 Recovery period (4 observations)				
2.5	86.1	81.8	86.8	63.9	77.2 c	89.8	88.6	88.1	82.9	87.4 c
5.0	87.0	87.0	84.6	73.9	83.1 b	90.0	90.0	89.8	88.5	89.6 a
7.5	87.8	88.3	86.9	80.6	85.9 a	90.0	90.0	90.0	89.8	89.9 a
Average	86.9 a	85.7 a	82.8 b	72.8 c		89.9	89.5	89.3	87.1	
	2000–2001 Wear period (13 observations)					2000–2001 Recovery period (4 observations)				
2.5	90.0	88.0	82.1	69.9	82.5 c	90.0	90.0	87.8	77.2	86.3 c
5.0	90.0	89.7	87.1	82.1	87.2 b	90.0	90.0	90.0	87.8	89.5 a
7.5	90.0	90.0	89.1	86.6	88.9 a	90.0	90.0	90.0	87.8	89.5 a
Average	90.0 a	89.2 a	86.1 b	79.5 c		90.0 a	90.0 a	89.3 b	84.3 c	

[1]Means of the wear levels followed by the same lower case letter and nitrogen levels followed by the same upper-case letter was not significantly different at 0.05 level using LSD test.

not affect turf cover. But, cover percentage significantly declined with increasing wear intensity (Table 4). The plots with wear every week were substantially reduced by approximately half pre-wear cover at the end of the wear season under the 2.5 g m^{-2} N fertilization regime. Clipping yield was widely reported to be affected by wear treatments. Several researchers have shown that wear on different turfgrass species or mixtures reduced clipping yield (Agnew and Carrow, 1985; Carrow and Petrovic, 1992). As expected, wear consistently reduced clipping yield during the wear period across 2-year of this study. Reduced clipping yield was particularly apparent in weekly wear applications. Total clipping yield was reduced by 30% in plots for this wear treatment compared with those of control plots.

In this study, the most detrimental effects of wear were on the cover percentage and clipping yield under the low N fertilization regime. It is well known that N fertilization stimulates shoot growth, increases cover percentage, and clipping yield (Beard, 1973). Increased N rates, were shown to improve cover percentages of the mixtures. Significant differences in clipping yield occurred among wear treatments at each N rate. The significantly greatest clipping yield was observed at the 7.5 g m^{-2} N rate followed by 5.0 g m^{-2} N rate. Turf response to wear and N fertilization was similar to those noted by several researchers (Sills and Carrow, 1983; Cockerham et al., 1989; Carroll and Petrovic, 1991) who reported that N increased cover percentage and clipping yield of different turfgrasses. However, Canaway (1984) indicated that low or intermediate N levels increased wear tolerance but wear tolerance at high N rates deteriorated rapidly. In our Mediterranean-type environment, temperature and rainfall conditions, and mild winters are suitable for turf development during fall and winter months. Therefore, N fertilization positively affected an actively growing turf. As indicated in previous studies (Oral and Acikgoz, 2001; Bilgili and Acikgoz, 2005), fall and winter N fertilization results in improved color and quality ratings as well as increased clipping yield in those areas under wear treatments.

Perennial ryegrass and tall fescue are widely seeded in many sport turfs because of their excellent wear tolerance. Moreover tall fescue is better adapted for dry and warm conditions. Kentucky bluegrass has superior recuperative ability under heavy wear conditions due to its aggressive rhizomatous growth habit (Beard, 1973). Contrarily, bentgrass and fine fescues are known to be poor tolerance to football type wear (Shearman et al., 1980; Canaway, 1984). Despite this information, differences in turf characteristics among mixtures within wear treatments were less defined and mostly non-significant in our study. However, mixture 1 containing high percentage of tall fescue and perennial ryegrass had slightly higher color and quality ratings, cover percentage and even clipping yield compared to the other mixtures.

Recovery of turf characteristics just at the start of recovery program was evident for all plots in both experimental years. In May 2000 and 2001, a month after the last wear treatment, the worn plots started to recover, particularly with

the higher N fertilization rates. Turf cover and clipping weight on the wear plots did not differ from the control plots in the approximately 4-month recovery period. The plots with wear every week showed significantly lower color and quality ratings, particularly with the low N fertilization rate. However, those plots recovered quickly under medium and heavy N fertilization rates. Several reasons may be offered for the quick recovery after the 8 months wear period. Firstly, the studded roller we used mainly caused pressure and a punching effect on the turf cover. Its tearing, scuffing and crushing effects on the plant tissues were less than wear machines or simulators which generally provide pressure, scuffing, punching, tearing and crushing effects simultaneously (Younger, 1961, 1962; Shearman et al., 1974). In addition, the recovery period occurred in the spring. It is well known that the optimum temperature for growth of cool-season turfgrasses is in the range of 15 to 24°C (Beard, 1973). In the spring, a natural flush of growth was seen due to increasing air temperature and longer days (Lawson, 1996). Therefore, less damaged turf plant recovered in a short time in the spring with suitable climatic conditions and N fertilization regimes.

This study demonstrated that wear influenced turf color and quality ratings, cover percentage and clipping yield of four different turf mixtures. Visual color and quality ratings, percent turf cover and clipping yield declined for all mixtures as wear intensity increased. After eight months of wear, all turf mixtures exhibited reduced turf characteristics particularly on plots with wear every week. The plots with weekly wear had significantly lower color and quality ratings, ground cover and clipping weight than control plots. However, the moderate and high N fertilization regimes (5.0 and 7.5 g m^{-2} N) had clear effects on the wear tolerance of the turf mixtures. Desirable color and quality ratings, high cover percentage and clipping weight could be obtained under those N regimes in all turf mixtures without any winter damage in the Mediterranean-type climate of Turkey.

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