УДК 633.264:631.524.5

ОЦЕНКА КАЧЕСТВА ДЕРНОВЫХ ПОКРЫТИЙ, СОЗДАННЫХ НА ОСНОВЕ ВИДОВ И СОРТОВ ЗЛАКОВ-ПРЕДСТАВИТЕЛЕЙ ХОЛОДНОГО КЛИМАТА

Хасеева Ксения Александровна
РГАУ-МСХА имени К. А. Тимирязева, Москва, Россия

В целях оценки коллекции, состоящей из 4 видов и 15 сортов газонных трав, на качество, плотность, проективное покрытие и лабораторную всхожесть на территории Российского государственного аграрного университета в 2011-2012 гг был проведен ряд полевых и лабораторных исследований. В течение двух экспериментальных лет растения возделывались без дополнительных обработок. Качество газона оценивалось визуально с использованием 9-балльной шкалы. Для определения влияния генотипа на плотность, проективное покрытие и лабораторную всхожесть был применен двухфакторных дисперсионный анализ

Ключевые слова: ЗЛАКИ ХОЛОДНОГО КЛИМАТА, ДЕРНОВОЕ ПОКРЫТИЕ, КАЧЕСТВО, ПЛОТНОСТЬ, ПРОЕКТИВНОЕ ПОКРЫТИЕ, ЛАБОРАТОРНАЯ ВСХОЖЕСТЬ

UDC 633.264:631.524.5

EVALUATION OF TURF QUALITY FOR COOL SEASON SPECIES AND CULTIVARS

Khaseeva Kseniya Alexandrovna
Russian State Agrarian University, Moscow, Russia

Series of field and laboratory studies were conducted from 2011 to 2012 in Russian State Agrarian University to evaluate a collection of 4 turf grass species and 15 cultivars for quality, summer density, ground cover and germination percentage. During 2 experimental seasons the plants have been growing with the extensive treatments. Turf quality was evaluated visually using a 1 to 9 scale. The two-way analysis of variance was used to identify genotype's effects on density, ground cover and germination percentage

Keywords: COOL SEASON GRASSES, TURFGRASS, QUALITY, DENSITY, GROUND COVERAGE, GERMINATION PERCENTAGE

INTRODUCTION

"Cool season grasses" is a common term used to describe turf species that grow most vigorously at temperatures below 15° to 21°C and that turn brown in hot weather. These turf species do most of their growing in spring and fall. Cool season grasses are extremely tolerant to cold freezing winters and hot summers [7]. Red fescue (*Festucarubra* L.), perennial ryegrass (*Loliumperenne* L.), Kentucky bluegrass - KBG (*Poapratensis* L.) and creeping bentgrass (*Agrostisstolonifera* L.) are the most widely used cool season species for turf purposes because of their ability to produce an attractive lawn [4]. In addition, plant breeders developed cultivars that possess good green cover, fine leaf texture, high density and other superior features. These cultivars are often mixed with each other to produce different types of turf (ornamental lawns, golf courses *etc.*) [6].

Over the last decade, the study of turfgrass quality provided by different species and cultivars received increasing attention in Russia [1]. Nevertheless, there is still much to learn about the ability of different genotypes to form a good turf under the environmental conditions of the central part of Russia.

The objectives of this study, therefore, were to evaluate turfgrass quality of the cool season varieties over a 2-year period and to characterize the differences among species and cultivars in some features, such as density, ground cover and germination percentage. Knowledge of such differences should provide useful in assessing the potential value of these genotypes in Russian breeding programs for turf plants.

MATERIALS AND METHODS

Plant Materials

A total of 4 species and 15 cultivars were evaluated in an experimental field. Experimental grasses show good performance under different environmental conditions, nevertheless, there is some variability among the cultivars within the species (Table 1).

Species	Cultivar	Development	Features
Red fescue	Audubon	Jacklin Seed	Shade tolerance, early spring greenup, fall color retention, brown patch resistance, summer patch resistance, drought tolerance.
	SR 5210	Seed Research of Oregon	Improved dark green color, moderately fine leaf texture, dollar spot resistance, aggressive dense growth.
	Tatjana	DLF Trifolium	Medium slow spring growth, good green cover, good resistance to red thread
	Boreal		Rapid establishment, uniformity, good yields of herbage
Kentucky bluegrass	Impact	Jacklin Seed	Superior heat and drought tolerance, ideally adapted to tolerate cold winters, a deep rich color with little fertilizer
	Everest	Jacklin Seed	Dark green genetic color, good turf quality, good resistance to leafspot
	Award	Jacklin Seed	Shade tolerance, traffic and wear tolerance, top rated in spring density and ground cover
	NU Glade	Jacklin Seed	Drought tolerance, luxurious dark green color, sod stretch resistant
Perennial ryegrass	Goalkeeper	Jacklin Seed	Produces an attractive, dense turf for high wear situations, medium-fine leaf texture, improved pink snow mold resistance
	Top Gun	Jacklin Seed	Good summer and fall density, excellent dollar spot resistance, improved brown patch resistance
	Sakini	DLF Trifolium	Good spring green-up, rapid establishment
Creeping bentgrass	Penn A-1	Penn State University	Dark green coloration, fine leaf texture, tremendous heat and cold tolerance, very high density and superior disease resistance
	Pennlinks II	Penn State University	Upright growth habit (non-graining), finer foliar texture
	PennCross	Penn State University	Wide adaptability, tight, upright growth characteristics and fine leaf texture
	Seaside II	Penn State University	Excellent drought tolerance, excellent resistance to dollar spot

Table 1 – General features of experimental cultivars according to product brochures

Growth Conditions and Treatments

The experiment was set up in June 2011 at the shade-free experimental plots of the Russian State Agrarian University. The soil, a fine sandy loam, was plowed, disked, rototilled, and stones removed, prior to seeding. Microplots (1 m x 1 m) were seeded by hand at the rates of 15 g/m^2 for Kentucky bluegrass, 20

g/m^2 for red fescue, 30 g/m^2 for perennial ryegrass and 10 g/m^2 for creeping bentgrass.

Plots were regularly irrigated to maintain surface moisture until turf reached 60% cover, at which time the irrigation was reduced. No supplemental fertilization, or weed management, was imposed during the study. Standard practices for mowing at a height of 2.0 inches were used. The height of the turf was increased to 3.0 inches in October 2011 in order to increase leaf area and the carbohydrate storage in the crown region. This was done to minimize winter loss of turf grasses under experiment.

The mean summer temperature was 20° C during 2011 and 19° C during 2012. Relative humidity was averaged 78 and 75 %, respectively. The mean depth of frost penetration was 8,5 inches during winter 2011-2012. Snow depth was 7,1 inches during the same period.

Measurements

Turf quality was rated on a 0-to-9 scale, where 0 = brown, dead turf; 6 = acceptable quality for home lawn; and 9 = optimum color, density and uniformity. According to NTEP guidelines, turfgrass quality ratings reflect aesthetic and functional aspects of the turf. Quality ratings are based on a combination of color, summer density, spring green-up, leaf texture, seedling vigor and ground cover. For example, a quality rating value of 5 could be given to a turf based on overall color and density, while another may receive the same value of 5 due to a fine leaf texture and its widespread ground cover. The spring green-up evaluation was rated separately and based on a visual rating performed during the 2012 growing season, with 9 representing actively growing dark green turf and 1 representing dormant turf. The evaluation for genetic color type are best made when the turf is actively growing and not under stress. Therefore, chlorosis and browning from necrosis due to disease were not considered as a part of true color evaluation. The visual rating of texture was based on a rating scale with 1 equaling coarse and 9 equaling fine [5].

In addition, turf density was measured instrumentally and expressed in number of tillers per unit area (pcs/m^2). Ground cover was assessed using digital photography. Images of turf plots were analyzed with Autodesk AutoCAD 2011 to determine ground cover percentage for each image. Digital image analysis was more time consuming than visual cover ratings, but far less subjective.

To determine the germination percentage, random samples of seed were tested by subjecting them to favourable germination conditions. It was expressed as a percentage of seeds in the sample that has germinated probably over the germination period given. A germination test was made in covered Petri dish.

Experimental Design and Statistical Analysis

The experiment consisted of 15 genotypes with four replicates arranged in a completely randomized design with repeated measurements across time.

Seven agronomic characters listed above were recorded on discrete scale (0-9) and, therefore, no data transformation was need. To analyze turf density, ground cover and germination rate the analysis of variance (ANOVA) was used. It was carried out separately for the two experimental years, 2011 and 2012. Variation was partitioned into genotypes of species and cultivars as main effects without corresponding interactions. The least-significant difference (LSD) at the 0.05 probability level was used to detect the differences among the means [2,3].

RESULTS AND DISCUSSION

NTEP experiment

The following evaluation gives a general view on the quality of varieties in 2011-2012. Ratings for all 15 genotypes are shown in Table 2.

Table 2 –Turfgrass quality evaluations of 15 turfgrass cultivars established in 2011: color (1=light green, 9=dark green); spring green-up (1=low, 9=high); texture (1=coarse, 9=fine); seedling vigor (1=low, 9=high); summer density (1=low, 9=high), ground cover (1=0%, 9-100% cover). Data are the average of monthly ratings made during the 2011 and 2012 growing seasons.

Species	Cultivars	Genetic Color	Spring Green-up	Leaf Texture		Seedling Vigor	Summer Density		Ground Cover		Quality	
				2011	2012		2011	2012	2011	2012	2011	2012
Creeping bentgrass	Penn A-1	7	4	7,5	7	9	7,5	9	9	9	7	8
	Pennlinks II	7	4	7,5	7,5	9	7	8,5	8,5	9	7	8
	Seaside II	7,5	4	7	7	9	8	8	9	9	7	8
	Penncross	7	5	7	7,5	8,5	7	8,5	8,5	9	7	8
Perennial ryegrass	Top Gun	8	7	8	8	9	7	7	9	9	8	8
	Sakini	7,5	7	7	8	9	7	7,5	9	9	8	8
	Goalkeeper	9	7	8	8	9	8,5	8	9	9	9	9
Red fescue	Audubon	9	8	8,5	9	4,5	6,5	7	5	8,5	7	8
	Tatjana	9	9	8,5	9	6,5	7,5	7,5	7	9	8	8
	SR 5210	8,5	8	9	9	6	7	8	5,5	9	7	8
	Boreal	8	9	9	9	5	6	7,5	8	9	8	8
Kentucky bluegrass	Award	8	5	8	8	6,5	3	7,5	4,5	5,5	6	7
	Impact	8,5	7	8	8,5	6,5	5,5	6,5	3,5	7,5	7	8
	Everest	8,5	6	8	8,5	5,5	5,5	7,5	4	6,5	6	8
	NUGlade	8,5	6	8	8,5	8,5	4,5	6,5	3	6	6	8

Turfgrass quality. Quality ratings from NTEP trial ranged between 6 and 8 during 2011 and 7-9 during 2012. As there were no principal climatic distinctions, some differences in turfgrass quality between one growing season and another are mostly associated with the length of establishment period. For example, perennial ryegrass forms extremely good turf within weeks while Kentucky bluegrass needs months to establish due to its slow growth [6]. Therefore, Top Gun, Sakini and Goalkeeper showed the same score in 2011 and 2012. Similarly, red fescue cultivars Tatjana and Boreal exhibited high turfgrass quality in both growing seasons. On the contrary, there were significant differences between quality ratings demonstrated in 2011 and 2012 by KGB varieties Everest and NU Glade. Other cultivars showed no substantial distinctions in quality between two experimental years.

In 2012 Goalkeeper was the top-ranked variety for turf quality (9.0). Award showed the lowest but acceptable score (7.0).

Genetic color. Turf color is a key characteristic in the evaluation of NTEP quality ratings. A total of seven varieties of three experimental species demonstrated superior genetic color (8.5 or greater). This group included several species with perfect score of 9.0 (Goalkeeper, Audubon and Tatjana). Good color (7.0 to 8.0 points) was noted for the rest of the evaluated cultivars.

Spring green-up. Spring green-up is a measure of the transition from winter dormancy to active spring growth. For the 15 cultivars represented, ratings varied between 4 and 9. Bentgrass varieties assessed in this test, exhibited unsatisfactory results. Three cultivars (Penn A-1, Pennlinks II, Seaside II) scored 4.0 for spring regrowth and Penncross scored 5.0. There were no significant differences in spring green-up ratings between cultivars within red fescue and perennial ryegrass species. Furthermore, Tatjana and Boreal demonstrated extremely rapid transition between winter dormancy and spring growth. For the 4 KBG cultivars evaluated, ratings varied between 5.0 and 7.0.

Leaf texture. Turfgrass texture is a measure or estimate of a leaf width. Texture data appeared nearly consistent from 2011 to 2012 with the red fescue cultivars demonstrating far more fine leaf texture than the other experimental varieties. Creeping bentgrass cultivars were the most wide bladed, with scores of 7.0-7.5. This grass exhibited positive correlation between height of mowing and leaf width. Therefore, it is not unexpected that with the cultural practice for cutting at a height of 2.0, the four cultivars (Pennlinks II, Seaside II, Penncross, Penn A-1) demonstrated moderate coarse texture.

Seedling vigor. All of the varieties evaluated germinated within two weeks. It should be noted that red fescue and Kentucky bluegrass demonstrated significant differences in seedling vigor between cultivars within the species. Because vigor ratings were evaluated only in 2012, we can’t conclude that these differences are determined by genotypic or by climatic conditions. Audubon,

Boreal and Everest showed the lowest scores (4.5-5.5) while perennial ryegrass and creeping bentgrass cultivars demonstrated superior seedling vigor (8.5-9.0).

Summer density and *ground cover* ratings followed similar trends to those observed for turfgrass quality. In general, cultivars with high density and cover ratings exhibited higher overall turfgrass quality. Turf density is also an important factor influencing weed infestation as a well-established turf results in reduced weed establishment. Cultivars evaluated as most dense and well-established included all creeping bentgrass varieties, Goalkeeper and SR 5210. Good characteristics were also noted for Sakini, Tatjana and Boreal.

Genotype Differences in Turfgrass Quality Characteristics

Generally, density, ground cover and germination percentage are the key turf quality characteristics that can be measured instrumentally. Analysis of variance for turf density and ground cover was calculated for each growing season.

The ANOVA showed that for each experimental year (2011 and 2012) the main effects of both species and cultivar genotypes were significant at the 0.05 probability level for summer density (Table 3).

Table 3 – Effects of genotypes on turf density (2011-2012): Summary of ANOVA results

Sourceofvariance	Growing Season	SS	df	ms	F	F_{05}	p_{in} %	LSD_{05}
Total	2011	298349824,6	56	-	-	-	100	-
	2012	183049833,3	59	-	-	-	100	-
Species	2011	169642388,7	3	56547462,9	10,25	3,59	58	1280,8
	2012	91281291,7	3	30427097,2	9,59	3,59	51	1103,1
Cultivar	2011	60713269,2	11	5519388,1	3,41	2,04	16	2480,3
	2012	34886041,7	11	3171458,3	2,51	2,04	13	2136,2
Residual	2011	67994166,7	42	1618908,7	-	-	26	-
	2012	56882500,0	45	1264055,6	-	-	36	-

These results indicated that significant differences in turf density were more due to species' and less due to cultivar's effect. In 2011, the least significant

test (LSD) identified true statistical distinctions in average summer density between all experimental species except perennial ryegrass and creeping bentgrass. Differences in density between species during the first growing season were determined by the length of establishment period. Hence Kentucky bluegrass demonstrated the lowest average data in number of shoots per sq. m (4962 pcs/m^2), while perennial ryegrass, creeping bentgrass and red fescue showed much better results (9342, 9325 and 8013 pcs/m^2 respectively). In 2012, the average density increased for all experimental species. Still, KBG provided low but acceptable turf density (8413 pcs/m^2) that statistically differed from perennial ryegrass (9533 pcs/m^2) and creeping bentgrass(11675 pcs/m^2). According to the LSD test results, creeping bentgrass demonstrated density ratings truly superior to other grasses.

The mean values of turf density for the experimental cultivars are shown in Figure 1. Of the 15 varieties evaluated during the first year of establishment, 2 had high ratings (> 10000 shoots per sq. m), 9 provided moderate density (6000 to 10000 shoots per sq. m) and 4 demonstrated low ratings (<6000 shoots per sq. m).

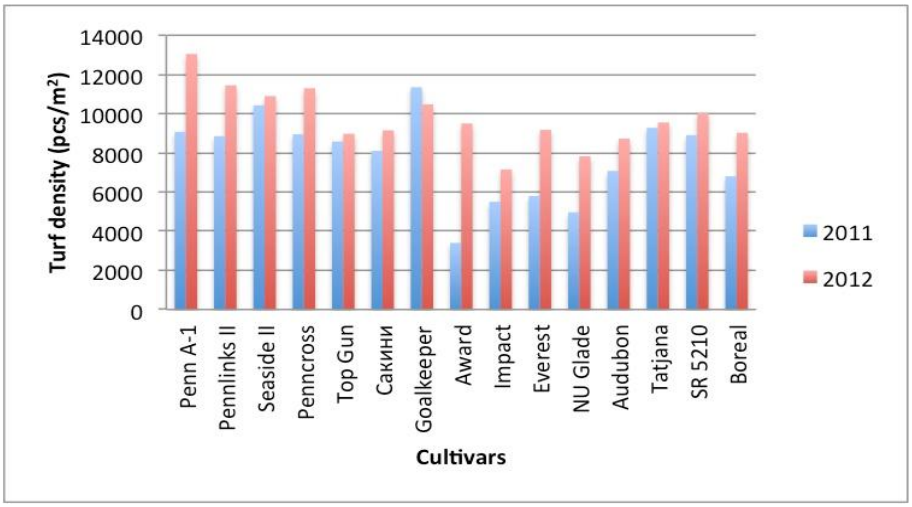

Figure 1: Turf density of 15 cultivars evaluated in 2011 and 2012

As described above, these results are typical for slow growing KBG and rapid germinating perennial ryegrass and creeping bentgrass cultivars. In 2012, turf density was substantially higher for all cultivars, except Goalkeeper.

Decrease of density could be potentially associated with winter conditions. Penn A-1 stood out in its high turf density in 2012. The LSD test showed statistical differences between Penn A-1 (13050 pcs/m^2) and other cultivars except Pennlinks II (11450 pcs/m^2) and Penncross (11300 pcs/m^2). There were not many significant differences in number of tillers among other cultivars during the second experimental year.

The results obtained from ANOVA of ground cover data* showed that for each experimental year (2011-2012) the main effect of species genotypes was significant at the 95 % confidence level (90% of total variance in 2011 and 67% in 2012). The LSD test revealed statistical differences in coverage between all species during the first year of establishment (Fig.2). Not surprisingly, perennial ryegrass demonstrated the best result, while KBG had the lowest percentage of the cover. Despite general increase in ground cover in 2012, Kentucky bluegrass also showed the lowest result, whereas values for other species were high and not significantly different.

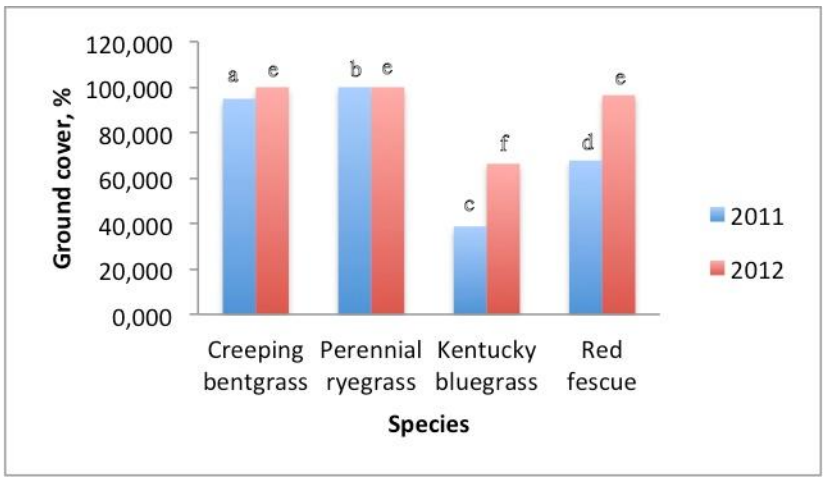

Figure 2: Percentage of ground cover of 4 species evaluated in 2011 and 2012. Values for each species represent the mean of its cultivars data. Letters above bars represent statistically significant differences as detected by Fisher's protected least significant difference test at the 5% significance level.

For the two experimental years, the cultivar effect on ground cover was not statistically significant. However, in our study, we expected greater

*p (%) were converted into φ=arcsin√p

correlation between turf coverage and density and, therefore, true statistical differences in cover data between the cultivars. This observation leads us to conclude that besides genotype there are other factors influencing the ability of cultivars to form turf cover, such as soil type or climatic conditions.

The ANOVA for geminating percentage† showed that all genotypes (species and cultivars) were highly significant (0.05 probability level, Table 4).

Sourceofvariance	**SS**	**df**	**ms**	**F**	**F_{05}**	**p^{in}%**	**LSD_{05}**
Total	14498,359	59				100	
Species	9096,883	3	3032,294	16,17	3,59	65	8,452
Cultivar	2062,471	11	187,497	2,53	2,04	10	16,367
Residual	3339,006	45	74,200			25	

Table 4 – Effects of genotypes on turf density: Summary of ANOVA results

However, the effect of species genotype was higher.

All experimental seeds started their germination within 4-8 days. Perennial ryegrass and creeping bentgrass seeds demonstrated rapid germination (during 3-5 days), while KBG and red fescue seeds were slow to germinate (8-11 days).

The highest germination percentage was determined in creeping bentgrass seeds (the mean value is 95,6 %). Also superior rating demonstrated by perennial ryegrass (95,2 %). There were no significant differences in germination data between these two species. Red fescue (58,2%) and Kentucky bluegrass (71,5%) showed low results.

Of the 15 experimental cultivars, 6 had high (>90%) germination rate (Penn A-1, Pennlinks, Seaside II, Top Gun, Goalkeeper, Sakini), 6 had medium (60% to 90%) results (Penncross, Impact, Award, NU Glade, Tatjana, SR 5210) and 3 demonstrated low (<60%) values (Everest, Audubon, Boreal).

†p (%) were converted into $\varphi=\arcsin\sqrt{p}$

CONCLUSIONS

The cool season cultivars evaluated in 2011-2012 demonstrated acceptable turf quality in both growing seasons. In 2012, the quality ratings from NTEP trial among experimental varieties ranged between 7 and 9. Goalkeeper was the top-ranked variety for turf quality, while Award showed the lowest score.

The results obtained from this experiment indicated the main effects of both species and cultivar genotypes on summer density. In 2012, creeping bentgrass demonstrated density ratings truly superior to other grasses. Its cultivar, Penn A-1, showed the highest density (13050 tillers per sq. m) that was statistically different from other varieties except Penncross and Pennlinks II. Kentucky bluegrass cultivars demonstrated the lowest average data in number of shoots per sq. m in both experimental years.

Our research showed that ground cover was indeed influenced by species genotype. According to the length of establishment period, perennial ryegrass demonstrated the best result, while KBG had the lowest percentage of cover.

Our laboratory evaluation of germination indicated that Seaside II had the highest germinating rate of all experimental cultivars and Audubon showed the lowest value.

It is recommended to continue experimental research of turf quality features provided by different cool season cultivars.

References

1. Лазарев Н.Н., Гусев М.А. Комплексная оценка видов и сортов газонных трав в условиях Московской области // Известия ТСХА. 2011. №3. с 89-94
2. Лакин Г.Ф. Биометрия: Учеб.пособие. М., 1990. – 352 с
3. Agresti, A. An introduction to categorical data analysis. New York: Wilely, 1996. – 744 p.
4. Beard, J.B. Turfgrass: Science and culture. Prentice-Hall, Inc. Englewood Cliffs, N.J, 1973. – 658 p.
5. Bertin C., Senesac A. F., Rossi F. S. Evaluation of selected fine-leaf fescue cultivars for their turfgrass quality and weed suppressive ability in field settings // Horttechnology. 2009 №19 (3)

6. Gould, F.W. The grasses of Texas. Texas A&M Univ. Press. College Station, TX, 1975. – 379 p.
7. Turgeon, A.J. Turfgrass management. Prentice Hall, Upper Saddle River, N.J, 2002. – 406 p.

References

1. Lazarev N.N., Gusev M.A. Kompleksnaja ocenka vidov i sortov gazonnyh trav v uslovijah Moskovskoj oblasti // Izvestija TSHA. 2011. №3. s 89-94
2. Lakin G.F. Biometrija: Ucheb.posobie. M., 1990. – 352 c
3. Agresti, A. An introduction to categorical data analysis. New York: Wilely, 1996. – 744 p.
4. Beard, J.B. Turfgrass: Science and culture. Prentice-Hall, Inc. Englewood Cliffs, N.J, 1973. – 658 p.
5. Bertin C., Senesac A. F., Rossi F. S. Evaluation of selected fine-leaf fescue cultivars for their turfgrass quality and weed suppressive ability in field settings // Horttechnology. 2009 №19 (3)
6. Gould, F.W. The grasses of Texas. Texas A&M Univ. Press. College Station, TX, 1975. – 379 p.
7. Turgeon, A.J. Turfgrass management. Prentice Hall, Upper Saddle River, N.J, 2002. – 406 p.