

Age-related changes in lawn phytocenoses of various species

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Abstract. This article presents comparative data on the study of several composite multicomponent and monocomponent lawn cenoses based on the analysis of their density and decorative score. To ensure the best stability, projective coating and decorativeness, it is important when choosing components and composing herbal mixtures to take into account their interspecific dynamics of development, pace of development and longevity. Optimum cenoses are obtained by combining species from the rhizome-bush group, slowly growing, yet more long-lived, such as *Festuca rubra* L., *Poa pratensis* L. The decorativeness of such cenoses is about 7.5 points, density about 20000 pcs / m². With age, in complex cenoses, the density of shoots increases, in monotypic ones it decreases.

1 Introduction

At the first stages of the scientific substantiation during the assortment selection for lawn cenoses, monocultural cenoses were considered the best. Gradually, researchers concluded that the use of herbal mixtures includes an advantage, as it increases the range of genetic diversity and increases the adaptive potential of phytocenosis cultures. In grass mixtures, the projective cover is increased, the number of weeds is reduced and the material costs for their maintenance are reduced. [1,2]. The consumption of grass mixtures is also intended to offset the difference in climatic conditions according to years. The presence of cereal species of various ecological characteristics in the grass stand ought to increase the adaptability of the grass stand to changing moisture conditions and thermal conditions, which vary greatly in accordance with years. The advantage of mixtures in comparison with single-species crops in reducing the probability of the disease occurrence and their harmfulness has also been proved [3]. To determine the percentage ratio of certain groups of lawn grasses in grass mixtures, the dominance of species in certain soil and climatic conditions, the rate of their development and longevity, the rhythm of development during the growing season, and the interspecific dynamics of phytocenosis components in time are significant importance [4]. These features are widely used in modeling grass lawn mixtures. One of the most common

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options is a combination of species that differ in growth rate and life expectancy. Most researchers believe that herb tillering is considered to be one of the essential indicators of the vitality of a particular species growing in cenosis with other species. The maximum tillering occurs at temperatures far lower than the optimal shoot growth temperatures [5] and the optimum temperature for “cold climate” herbs is from 10 to 18 ° C [6,7].

The research aim was to study the connection of different herb species growing in multicomponent lawn cenoses of various compositions and to compare with similar monocultural grass stands based on an assessment of their tillering and decorative qualities.

2 Materials and Methods

2.1 Object of study

When creating artificial lawn phytocenoses, components of grass mixtures with programming of dominants are outlined in advance. We have compiled 4 variants of compound mixtures and 3 monocomponent variants: 1. ‘Chewing’s fescue’ type - *Festuca rubra* ‘Boreal’ 40%, *Lolium perenne* ‘Score’ 30%, *Poa pratensis* ‘Balin’ 20%, *F. rubra* ‘Frida’ 10%; 2. ‘Ryegrass’ type - *L. perenne* ‘Score’ 30%, *L. perenne* ‘Raygaubek’ 30%, *F. rubra* ‘Boreal’ 20%, *P. pratensis* ‘Balin’ 20%; 3. ‘Bluegrass meadow’ type - *P. pratensis* ‘Sobra’ 60%, *F. rubra* ‘Boreal’ 20%, *F. rubra* ‘Frida’ 10%, *L. perenne* ‘Score’ 10%; 4. *F. rubra* ‘Boreal’ 100%; 5. *L. perenne* ‘Score’; 6. *P. pratensis* ‘Balin’ 100%. The component order in the composition of grass mixtures is represented taking into account the percentage of their content in the grass mixture from larger to smaller. As a fast-growing component, we used *L. perenne*. It not only adduces a high projective cover in the first year of sowing, yet it also creates micro conditions for the germination of other herbs. Accounting sites were subjected to regular haircuts (20–22 times per season).

2.2 Methods of study

The density of shoots is one of the main aspects of quality [8]. It has been proven that visual quality levels correlate with shoot density [9]. To determine the number of shoots per unit surface area of the soil, as one of the objective indicators of the decorative and mechanical qualities of the turf coating, a framework of (0.1 x 0.1) m was used [10]. Counting was carried out twice per season - in May (at the time of active tillering) and in September (during the period of autumn tillering activation) in four repetitions. Within the above framework, the total number of shoots was calculated regardless of the type of tillering, separately the number of shoots of each species constituting the grass mixture, the number of green and yellow leaves twice a season for five years According to the proposed method of L.P. Mytsyk, the aspectual greening of the lawn was determined from a distance of 5–7 meters and an angle of 15 degrees once a year of sowing [11], whereas the projective cover was glazed annually twice a season. Sod quality assessment was carried out on a scale from 1 to 9: 1 – bad, 2 – adequate, 9 – ideal, and included color, density, disease susceptibility, uniformity, winter damage, plant vitality [12].

2.3 Statistical methods

Statistical analysis of the observation results, taking into account the average values and the coefficient of variation, was carried out using the Microsoft Excel 2010 application;

LSD (Lowest Significant Difference) was used to determine the significance of differences between the data sets [13].

3 Results

Tests of *L. perenne*. in the conditions of an arid steppe zone in southeast Kazakhstan showed its nice germination energy and germination in the field, rapid development, excellent tillering in the first year of life. The dominant position of *L. perenne* will take 1–3 years, and then gradually begin to be replaced by slowly developing, yet more long-lived species (*F. rubra*, *P. pratensis*). *F. rubra* and *P. pratensis* by type of tillering belong to the rhizome-bush group. They form a system of rosette shoots of bush nature, connected by rhizomes of different lengths [14]. Samples of *F. rubra* differ in the degree of formation of vegetative shoots and the type of shoots, which is taken into account when assessing the decorativeness of biotypes. Significant differences in shoot density between species and between species within species are noted [15]. Rhizome-friable bush cereals, such as *F. rubra*, *P. pratensis*, are most perfect for long-term turf coverings. Over time, these species will act as codominants. That is, their participation will depend on the climatic and soil conditions of the laid experiment place [16]. Subdominant species compile more than 10% of the number of shoots in the grass mixture. Species that compile less than 10% are classified as complementary [4].

‘Chewing’s fescue’ type. The main dominant of the *F. rubra* mixture is represented in this herb mixture by two varieties from *subsp. rubra* and *subsp. commutata*. These two subspecies differ not only in the specifics of tillering, the formation of vegetative and generative shoots, seed productivity, habit, but also in appearance [17]. Promising greening occurs on the 30th day from the moment of mass shoots. Projective coverage – 83%. Table 1 represents the five-year dynamics of grass stand development in compound grass mixtures ‘Chewing’s fescue’ type, ‘Ryegrass’ type and ‘Bluegrass meadow’ type. Changes in the ratio of components occur gradually towards a decrease in the presence of fescue and an increase in the content of Pooidae and Ryegrass. Changes in the ratio of components are wave-like with a positive trend of an increase in the total density of grass by 20% by the fifth year of life. The maximum number of fescue shoots is observed in the fourth year of lawn life. An increase in the percentage of *poa* occurs only in the fifth year. A significant variation in the content of shoots of fescue (5350–18200 per m²) and ryegrass (800–14050 per m²) is observed. The representative of the subspecies *rubra* cultivar ‘Boreal’ is characterized by the presence of both plagiotropic and orthotropic shoots. The subspecies *commutata*, to which the ‘Frida’ variety belongs, does not form plagiotropic shoots and increases the vegetative mass solely due to orthotropic shoots and leaves on them. The combination in the cenosis of plants with a different character allows to create a lawn with the best projective cover and decorative qualities. *P. pratensis* acts as a codominant. As a subdominant – *L. perenne*. Despite the insignificant presence of ryegrass in the first year of sowing, from the second year there has already been an increase in the content of its shoots in the grass with a maximum by the third year.

‘Ryegrass’ type. Some researchers reported that when seeding ryegrass mixed with *P. pratensis* and *Festuca arundinacea* L., even in a small percentage (about 10%), ultimately, *L. perenne* dominated, despite the care measures experiments [3,18,19]. Other sources noted a decrease in the number of ryegrass shoots from the second year of life both in clean crops and in a mixture with other species [20]. According to A.A. Lapteva, *L. perenne* acts as a temporary dominant in the first 1–3 years of grass stand life [4]. In our experience, this rapidly developing species is represented by two varieties ‘Score’ and ‘Raygaubek’. Aspective greening – on day 22, projective coverage – 77%. An increase is observed in the total density of grass by 28% by the fifth year of life due to an increase in the content of *poa* and *festuca*.

The maximum number of ryegrass shoots is observed in the second year of the lawn's life, after which its content gradually decreases.

‘Bluegrass meadow’ type, *P. pratensis* will dominate, two varieties of *F. rubra* act as subdominants here, and *L. perenne* is present as a complementary species to obtain a green background more quickly. Perspective greening – on day 30, projective cover – 80%. Changes in the ratio of components occur gradually towards a decrease in the presence of ryegrass and fescue and a smooth increase in *Poa* content with a trend towards an increase in the total density by 19% by the fifth year of life. The maximum number of *Poa* shoots is observed in the fourth year of the lawn's life, after which its content gradually decreases.

Table 1. Changes in the composition of grass stands during five years of life and the main parameters of the samples

№	Sample parameters, n = 9	Shoots, pcs / m ²				Leaves, pcs / m ²		Points
		<i>Festuca</i>	<i>Lolium</i>	<i>Poa</i>	Total	Green	Yellow	
1	(50) (30) (20)*							
	Avg	9560	7330	1380	18820	45920	1390	7,3
	Max	18200	14050	2600	26800	82550	2750	9
	Min	5350	800	350	14200	32650	500	6
	σ	3930	3460	790	3420	1400	750	0,9
	V,%	41,1	47,2	57,6	18,2	30,5	53,9	12,9
	The ratio of components, %							
	1 year	91,5	5,6	2,8	100	100	6,1**	
	5 year	61,1	24	14,8	100	100	1,8	
2	(20) (60) (20)							
	Avg	2260	8520	3230	14010	32510	1230	6,6
	Max	3900	15250	7100	18250	38700	2550	8
	Min	1200	4700	1100	9450	21050	600	5
	σ	910	3280	2380	2870	5600	670	0,8
	V,%	40,3	38,5	73,5	20,5	17,2	54,2	12,7
	The ratio of components, %							
	1 year	13,2	75,8	11	100	100	9,9	
	5 year	24,8	30	45,2	100	100	2,7	
3	(30) (10) (60)							
	Avg	6060	3330	9120	18530	49790	2660	6,9
	Max	9250	10200	17900	22650	59300	6000	8
	Min	3000	600	1250	13150	32800	1200	5
	σ	1840	3120	5290	2660	7930	1710	0,9
	V,%	30,3	93,5	58,0	14,4	15,9	64,2	12,7
	The ratio of components, %							
	1 year	39,3	18,3	42,3	100	100	14,4	
	5 year	28,4	3,7	67,9	100	100	3,6	
Shoots***		Green leaves			Yellow leaves		Points	
	LSD ₀₅	d	LSD ₀₅	d	LSD ₀₅	d	LSD ₀₅	d

1–2	3150	4810	10110	13420	640	160	0,9	0,7
1–3	3060	290	10790	3870	1190	1270	0,9	0,4
2–3	2770	4520	6510	17290	1170	1430	0,9	0,3

Note: * – the percentage of participation in the mixture, ** – percentage of yellow leaves of the number of green leaves, *** – a comparison of samples by parameters: number of shoots, number of green and yellow leaves, total decorative points, LSD with a confidence level of 95%, d – difference between the average values of samples, with $d \geq LSD$ differences are significant.

Monoculture *F. rubra* ‘Boreal’. Slowly developing grass stand. Aspective greening – on the 35th day, projective cover 76%. Table 2 presents the five-year dynamics of the development of monocultural crops ‘Boreal’, ‘Score’, ‘Balin’. In option 5, the maximum tillering was noted in the second year of the test of 22000 shoots / m². The general trend is a 15% decrease in grass density by the fifth year.

Monoculture *L. perenne* ‘Score’. Fast growing grass stand. Promising greening – on day 26, projective cover – 74%. Changes in the number of ryegrass shoots are wave-like, regardless of the time of year, from 14400 to 28100 shoots / m². The maximum tillering was noted in the first year of the test of 28100 shoots / m². The general trend of the density of grass stands is a decrease of 53% by the fifth year.

Monoculture *P. pratensis* ‘Balin’ Slow-growing grass stand. Aspective greening – on day 35, projective cover 80%.

In this version, the maximum tillering was noted in the fourth year – 14450 shoots / m². The decrease in density of grass by the fifth year by 2%. So, when creating clean lawns from slow-growing grasses *P. pratensis*, *F. rubra*, grass stands develop slowly including a low projective cover in the first year, so during this period they are actively populated by weeds, as a result of which their content becomes more expensive and decorativeness is lost. Comparing the data between multicomponent

Table 2. Changes in the density of monotypic grass stands during five years of life and their comparison with analogous multicomponent

№	Sample parameters, n = 9	Shoots, pcs / m ²			Leaves, pcs / m ²		Points
		<i>Festuca</i>	<i>Lolium</i>	<i>Poa</i>	Green	Yellow	
4	(100) (0) (0)*						
	Avg	18040			44850	2660	6,6
	Max	22000			60750	4450	8
	Min	14700			30100	1400	6
	σ	2330			9120	1010	0,7
	V, %	12,9			20,3	38,1	10,4
	The ratio of components, %						
	1 year				100	8,8**	
	5 year				100	7,1	
5	(0) (100) (0)						
	Avg		17240		37420	1840	6,2
	Max		28100		55000	4600	7
	Min		13200		31100	350	5

	σ		4580		7450	1160	0,8		
	V,%		26,5		19,9	62,8	12,6		
	The ratio of components, %								
	1 year				100	1,5			
	5 year				100	3,7			
6	(0) (0) (100)								
	Avg			11580	29540	1810	6,9		
	Max			14450	39750	3800	8		
	Min			6850	13900	1250	6		
	σ			2520	7850	990	0,7		
	V,%			21,7	26,6	54,6	10,7		
	The ratio of components, %								
	1 year					100	11,6		
	5 year					100	6,1		
	Shoots***		Green leaves		Yellow leaves		Points		
	LSD ₀₅	d	LSD ₀₅	d	LSD ₀₅	d	LSD ₀₅	d	
	1–4	2920	780	10920	1070	770	1270	0,8	0,7
	2–5	3820	3230	6250	4920	850	610	0,8	0,4
	3–6	2590	7030	7310	20250	1250	850	0,8	0,0

Note: * – the percentage of participation in the mixture, ** – the percentage of yellow leaves out of the number of green leaves, *** – a comparison of samples in terms of the number of shoots, the number of green and yellow leaves, total decorative points, LSD with a confidence level of 95%, d – is the difference between the average values of the samples, with $d \geq LSD$ differences are significant and are highlighted in bold.

grass mixtures and monoculture, the difference can be seen in the onset of aspect greening. In ‘chewing’s fescue’ and ‘bluegrass meadow’ types it is five days earlier than in the clean crops, in the ‘ryegrass’ type it is 4 days earlier.

4 Discussion

The tables show that the dynamics of changes in the content of slowly growing components like *F. rubra* and *P. pratensis* occurs very smoothly. So, in ‘chewing’s fescue’ grass stand, dominated by *F. rubra* from the first year of life, the peak of its presence is observed only in the fourth year of life. In the fourth year, the maximum presence of *P. pratensis* in ‘Bluegrass meadow’ type grass stand is also observed. The number of shoots of *Festuca*, *Poa*, *Lolium* varies greatly from spring to autumn, from year to year in all tested grass mixtures. Each artificially created phytocenosis is an example of a complex, movable in time and space, yet quite flexible system. With the joint growth of species from different genera, with various life forms and various rates of development in ontogenesis in the lawn cenosis mode under conditions of competition and symbiosis, decorativeness is affected by planting density, agrotechnical care conditions, and the composition of the grass mixture. The degree of leaf destruction may indicate the state of a particular cenosis. The trend comparison of shoot

formation of composite and monotypic cenoses reveals a stable increase in shoot density by the fifth year of life in ‘chewing’s fescue’ type by 20%, in ‘ryegrass’ type by 27%, and in ‘bluegrass meadow’ type by 21%. While in monotypic grass stands a gradual decrease in density is observed: in ‘bluegrass meadow’ (2%), ‘chewing’s fescue’ ‘Fescue’ (15%) and, to a greater extent, in ‘ryegrass’ (53%). The maximum shoot density, projective cover and a high decorative point in the ‘chewing’s fescue’ and ‘bluegrass meadow’ types (7.3 and 6.9, respectively) occur due to the presence of two subspecies of *F. rubra*. Thus, complex culture phytocenoses, composed of the most compatible components, develop a denser elevated mass compared to pure crops, which is consistent with the findings of other scientists. The latter is undesirable to use for creating extensive lawn coverings due to their instability to adverse climatic conditions, diseases and low decorativeness.

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