STEPPE VEGETATION COVER OF FALLOW LAND OF URAL PIEDMONT

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Abstract

The paper presents the study of vegetation cover state of the lands withdrawn from agricultural use (fallow land). The results of a systematic analysis of agrophytocenosis of Ural steppes are presented. The floristic composition of segetal grass community in the agrophytocenosis of the experimental field was analysed. Studied plots included the following treatments: 1. Control (cultivation of fallow land without any addition); 2. Sowing wheatgrass without fertilization; 3. Sowing wheatgrass with 50 tonnes manure addition; 4. Sowing wheatgrass with addition of mineral fertilizer ($N_{30}P_{40}$); 5. Sowing wheatgrass with addition of 50 tonnes of manure and mineral fertilizer ($N_{30}P_{40}$). The results were compared with virgin fallow land characteristics. There were observed certain changes in the species composition of vegetation cover already after the first and second year of cultivation of fallow land. The changes correlated with the applied amendments. Comparison between the studied years showed that observed small differences were due to the differences in weather conditions between the years. The plots with manure and fertilizer application, both separately and in combinations, showed significantly higher density of herbage compared to the control.

***Keywords**:* fallow land, agrophytocenosis, geobotanical state, soil, floristic composition.

INTRODUCTION

The United Nation reported that in the Republic of Kazakhstan the area of degraded unproductive lands, that need in improvement comprises 179.9 million hectares. The solution of these problem can be effectively solved by the accelerated transformation of these lands in the state close to the natural (hayfields and pastures), which can be carried out by various methods depending on local climatic conditions.

In West Kazakhstan region, large areas are excluded from agricultural use and are regarded as fallow lands. Withdrawal soil from agricultural use, despite the shortage of land resources, become a global trend, what resulted in a fundamental change in the regularities of the formation and functioning of soils, which in turn resulted in the evolution and the significant change in the ecological functions of the soil. Understanding of these changes is overdue, and the study of the corresponding processes has undeniable fundamental and practical importance for ecology and sustainable environment. In dry-regions this issue remains little known.

The main objective of the research was studying the geobotanical state and composition of fallow land in dry-steppe areas of Ural piedmont.

MATERIALS AND METHODS

Studies of geobotanical state of the fallow land was conducted by a shuttle method on the area of research. Collection of materials, observation of the structure and dynamics of vegetation and flora analysis carried out by the standard method. Collection of materials, observation of the structure and dynamics of vegetation cover and flora analysis carried out according to the standard procedures (Lavrenko and Korchagin, 1964; Shennikov 1964; Guidelines on geobotanical and cultural-technical survey of natural forage land. 1978; All-union manual for the geobotanical studies of natural forage lands and preparation of large-scale geobotanical maps, 1984). Collection and processing of herbarium material were carried out by the Skvortsov method (Skvortsov, 1977).

For classification of the species the determinants of higher plants and weeds were used (Majewski, 1964). Species were named as described in the bulletin of Cherepanova (1995) and Abdullin (1999). Total projective cover of the agrophytocenosis, the percentage of the area covered by the above-ground biomass were determined by the method of Ramensky and the scale of abundance by Drude (with amendments of Uranova and Yaroshenko) (Ramensky et al., 1956; Yaroshenko, 1969; Bykov, 1978).

The similarity of the floristic diversity of the experimental plots between the years (2013 and 2014) was estimated using Jaccard coefficient:

$$K = \frac{c \cdot 100}{a + в - c}, \quad (1)$$

where c is a number of total species in the comparing community A and community B; a and $в$ are number of species in each of the community (Dulepov et al., 2004).

To compare the species composition of the phytocenoses and to record changes over observation time an index of Serensona (Ks) or species similarity index is also widely used:

$$K_s = \frac{2c}{a + в} \cdot 100, \quad (2)$$

where *c* is a number of total species in the comparing community A and community B; *a* and *в* are number of species in each of the community (Sörensen, 1948).

The studied area located in the dry steppe zone with dark chestnut soils and typical for this zone xerophytic vegetation formed mainly by turf grasses, wormwood and steppe mixed grasses.

RESULTS AND DISCUSSIONS

Plantings of wheatgrass on the experimental plots is classified as an agrophytocenosis because they occupy an intermediate position between agrocenosis and virgin phytocenosis. Prior to cultivation this territory was an old fallow land with rhizomatous and turf grasses (wild rye, fescue, feather grass) with a significant portion of mixed grasses. Therefore, in a short period of the experiment (2012-2014) it was not possible to obtain pure planting of wheatgrass. Due to its biological characteristics, the wheatgrass grow slowly in the early years of its life. After fertilization and planting of wheatgrass under barley cover, a mixed-grass - wheatgrass, forb-sagebrush-wheatgrass, wheatgrass -mixed grass and sagebrush communities began to form. These new associations are characterized by presence in their composition of *Poa* family, steppe grass species. Total projective cover of the experiment was 30-60%. Plant distribution uniform. (Table 1).

Table 1. Density wheatgrass-mixed communities in the experimental plots, %

Treatment	Replications				Total projective cover, %
	1	2	3	4	
Fallow land (control)	40	30	45	35	37,5
Wheatgrass (no fertilization)	45	55	55	45	50
Wheatgrass + 50 t. manure	60	70	65	35	57.5
Wheatgrass + $N_{30}P_{40}$	55	45	75	55	57.5
Wheatgrass + $N_{30}P_{40}$+ 50 t. manure	65	60	65	65	63.75

The density of herbage between the plot with wheatgrass was not significantly different from the control plot. However, the plots with manure and fertilizer application, both separately and in combinations, showed significantly higher density of herbage compared to the control (Table 1).

The height of the herbage among the treatments ranged from 30 to 50 cm. The maximum height of the herbage was recorded in the treatment with manure 50 tonnes + $N_{30}P_{40}$ (38,5 ± 5,9 cm), the minimum height the herbage was in the control treatment (28,6 ± 4,55 cm). An average herbage height of experimental plots was 28,6 ± 4,55 cm (Table. 2).

Fertilization, planting perennial grasses and other agrotechnical practices resulted in an intensive growth of plants: in the treatments with fertilization individual perennial plants have reached a height of 60-62 cm.

Table 2. Height of the herbage in the experimental plots (2014 year)

Treatment	Average height, cm	CV, %
Fallow land (control)	28.6 ± 4.55	44.8
Wheatgrass	33.25 ± 4.55	32.7
Wheatgrass + 50 t. manure	37.88 ± 5.4	14.1
Wheatgrass + $N_{30}P_{40}$	36.125 ± 6.6	24.1
Wheatgrass + $N_{30}P_{40}$+ 50 t. manure	38.5 ± 5.9	23.9

The minimum height of the grass (14 cm) was recorded in the fallow areas (control). For the comparison of the variability of grass height the coefficient of variance (CV) was calculated for the plants sampled in the period of mass flowering. The lowest coefficient of variance was observed in the treatment with application of manure (CV – 14.1 %), which implies the homogeneity of the herbage. The highest coefficient of variance was observed on the control treatment and on the planting of wheatgrass without fertilization, 44,8% и 32,7% respectively.

The floristic survey included recording of all species of vascular plants found in the experimental plots. The plots were characterized by dominance of mixed-grass communities. Cereals compose 10-19%, leguminous are missing or found as an impurity (Table 3).

Systematic structure of the agrophytocenosis in studied area in 2013 was represented by 16 families, 53 genera and 60 species. The systematic diversity indicators were: the coefficient of species richness of the family was 3.75; the coefficient of species richness of the genera was 1.14 and the coefficient of generic saturation of family was 3.32.

Predominant species were: *Asteraceae* (L) (15 species), *Poaceae* (L) (6 species) and *Brassicaceae* (L) (5 species). Other families were monotypical consisting of 1 to species. The richness of species of the families characterizes the aridic features of flora.

Analysis of the floristic composition showed that in the first year of cultivation there was observed increase in plant species, what is influenced by the improvement of water and air and nutrition regimes. In addition, increase of the plant species may also depend on the presence of seeds of weeds in soil.

In 2014 the number of species identified in agrophytocenoses of the experimental plots was 47, which belonged to 14 families and 44 genera.

In 2014, the systematic diversity indicators were: the coefficient of species richness of the family was 3.36; the coefficient of species richness of the genera was 1.07; the coefficient of generic saturation of family was 3.15. The largest families represented in the phytocenoses of the fallow land were *Asteraceae* (11 species), *Poaceae* (9 species) and Brassicaceae (8 species). The rest of the family were presented by 1-2 species. The greatest number of species were presented by *Asteraseae* family.

Table 3. Systematic analysis of agrophytocenosis of the experimental plots by studied years

No.	Family (L.)	2013			2014		
		Number of genera	Number of species	% from total species	Number of gen	Number of species	% from total species
1	*Poaceae*	6	7	11,7	9	9	19,2
2	*Polygonaceae*	2	2	3,3	1	1	2,1
3	*Chenopodiaceae*	3	4	6,6	2	2	4,3
4	*Amaranthaceae*	1	1	1,7	1	1	2,1
5	*Caryophyllaceae*	3	3	5	2	3	6,4
6	*Brassicaceae*	5	5	8,3	8	8	17,1
7	*Fabaceae*	5	7	11,7	3	3	6,4
8	*Euphorbiaceae*	1	1	1,7	-	-	-
9	*Apiaceae*	4	4	6,6	1	1	2,1
10	*Limoniaceae*	1	1	1,7	-	-	-
11	*Convolvulaceae*	1	1	1,7	1	1	2,1
12	*Boraginaceae*	1	1	1,7	2	2	4,3
13	*Scrophulariaceae*	3	3	5	3	3	6,4
14	*Lamiaceae*	1	1	1,7	1	1	2,1
15	*Rubiaceae*	1	1	1,6	1	1	2
16	*Asteraceae*	15	18	30	9	11	23,4
	Total	53	60	100	44	47	100

Comparative analysis of the botanical composition of the herbage of tested plot over the years of research has shown the tendency of decrease of the number of species of plants from the *Asteraceae* family for 6.6% and plants from the *Brassica* family for 8.8%.

Bringing of fallow areas into cultivation helps to improve the ecological status of wheatgrass crop, reducing infestation indicators. Therefore, it is necessary to continue monitoring studies of the state of perennial grass agrophytocenosis.

The Jaccard coefficient (K_J= 50.7) indicates that the species differ between the observed years.

The Serensona index calculated for species diversity by studies years was 67.3%, which indicates the changes in the composition of flora between compared plots.

There were widely presented the local flora: *Artemisia* (L.), *Festuca valesiaca* (L.), *Galatella tatarica* (L.), *Achillea millefolium* (L.). Legumes are presented by *Medicago sativa* (L.) (50%), *Melilotus* (L.) and *Astragalus* (L.), but their occurrence is low (up to 40%). The highest occurrence was recorded for *Agropyron cristatum* (L.) (plantings of 2013 and its species found on fallow areas), *Leymus ramosus* (L.) (100%), *Verbascum orientale* (L.) (75%), *Artemisia lercha* (75%) and young weeds, etc. (Table 2).

Most of the described species are found diffusedly, in a small number. In the locations, free of wheatgrass, the weeds, especially annual weeds, causing mosaic pattern of the agrophytocenosis were widely presented. A high class of persistence in the studied plots were recorded as follow:

- On the fallow plot (control): *Leymus ramosus* (L.) (100%), *Artemisia campestris* (L.) (100%), *Festuca valesiaca* (100%), *Achillea millefolium* (75%), *Linaria vulgaris* (50%).
- On the plots without fertilization: *Leymus ramosus* (L.) (100%), *Artemisia campestris* (L.) (100%), *Falcaria vulgaris* (Bernh.) (50%), *Convolvulus arvensis* (75%), *Thlaspi arvense* (L.) (50%).
- on the plots with mineral fertilization: *Leymus ramosus* (L.) (100%), *Artemisia campestris* (L.) (75%), *Verbascum orientale* (L.) (75%), *Artemisia campestris* (L.) (50%), *Medicago falcata* (L.) (50%).
- On the plots with manure: *Leymus ramosus* (L.) (100%), *Artemisia campestris* (L.) (75%), *Taraxacum officinale* (L.) (50%), *Medicago falcate* (L.) (50%), *Descurainia sophia* (L.) (50%).
- On the plots with application of both mineral fertilizer and manure: *Leymus ramosus* (L.) (100%), *Artemisia campestris* (L.) (75%), *Amaranthus retroflexus* (L.) (75%), *Achillea* (L.) (50%), *Medicago falcata* (L.) (50%)

On the fallow areas, there are widely presented: *Festucavalesiaca* (sp-cop$_1$), *Leymusramosus* (sp-cop$_2$), *Artemisialerchiana* (sp-cop$_1$), *Galatellalinosyris* (sp-cop$_2$), *Achilleamillefolium* (sp-cop$_1$);

On the plots without fertilization: *Leymusramosus* (sp-cop$_1$), *Artemisialerchiana* (sp-cop$_1$), *Tanacetumachillefolium* (sp-cop$_1$), Falcariavulgaris (sp);

On the plots with mineral fertilization: *Leymusramosus* (sp-cop$_1$), *Artemisialerchiana* (sp-cop$_1$), *Melilotusofficinalis* (sp-cop$_1$), *Linariavulgaris* (sp-cop$_1$);

On the plots with manure: *Leymusramosus* (sp-cop$_1$), *Artemisialerchiana* (sp-cop$_1$), *DescurainiaSophia* (sp), *Verbascumphoeniceum* (sp).

On the plots with manure and mineral fertilization: *Leymusramosus* (sp-cop$_1$), *Artemisialerchiana* (sp), *Galatellalinosyris* (sp-cop$_1$), *Achilleamillefolium* (sp-cop$_1$).

A comparison of the species composition of the flora on the test sites by Serenson index and the number of common species presented in Table 4.

Table 4. Matrix of the Serensona index and the number of common species of grass-cereal phytocenosis

Treatment	Fallow land (control)	Wheatgrass	Wheatgrass + 50 t. manure	Wheatgrass + $N_{30}P_{40}$	Wheatgrass + $N_{30}P_{40}$+ 50 t. manure
Fallow land (control)	1	73.3	68.0	70.8	63.2
Wheatgrass	22	1	69.2	68.7	67.8
Wheatgrass + 50 t. manure	17	18	1	19	73.5
Wheatgrass + $N_{30}P_{40}$	23	23	66.7	1	75.0
Wheatgrass + $N_{30}P_{40}$+ 50 t. manure	18	20	18	24	1

Note: in the upper right part of the matrix - the similarity coefficient; in the bottom left - the number of common species.

The index of species similarity of the test plots is high and similar (66,7-75,0).

The most similar in species composition were plant communities of fallow and the control plot (73.3), probably due to the fact that only agricultural practices do not alter the botanical composition of grass deposits for a given period. The plant communities in the plots with manure and manure with mineral fertilizer showed a tendency for increased number of annual weeds (coefficient of similarity is 73,5).

Table 5. Productivity and economic-botanical characteristics of green mass of mixed-cereal fallow land, kg/ha

Treatment	Yield of fodder grasses, g/m^2	Including fodder characteristics			
		Valuable as fodder, kg/ha	Low-valuable as fodder, kg/ha	Valuable as fodder, %	Low-valuable as fodder, %
Fallow land (control)	0.890	49.7	39.3	5.59	4.41
Wheatgrass	1.021	62.7	39.4	6.14	3.86
Wheatgrass + 50 t. manure	1.058	66.0	39.8	6.24	3.76
Wheatgrass + $N_{30}P_{40}$	1.094	64.8	44.6	5.93	4.07
Wheatgrass + $N_{30}P_{40}$+ 50 t. manure	1.219	78.9	43.0	6.47	3.53

An important indicator of the ecological state of land is a quality of fodder crops. The harvest of green mass was subdivided into valuable and low-valuable as a fodder crop (GOST 4808-87). Cereal and leguminous grasses are classified as valuable, while other grass families (grasses and sedges) classified as low-valuable fodder grasses.

The most valuable fodder grasses were formed on the treatment wheatgrass with application of manure and mineral fertilizer (wheat grass + $N_{30}P_{40}$ + 50 t manure) (Table 5). In general, in the treatments of the experiment, an increase in the proportion of forage grasses, mainly due to the cereal group was observed. The proportion of legumes varies within 3-5%.

The vegetation cover of virgin lands was represented by cereal-white wormwood and mixed-cereal-white wormwood associations. During the study year, the botanical composition of virgin lands was not significantly changed in comparison with 2013 year.

The flora of the virgin areas in 2014 was represented by 58 species belonging to 52 genera and 18 families. The analysis showed that the most similar in species composition of the flora for 2013 and 2014 years was in the virgin areas with Jaccard coefficient of 67% and Serenson index of 80.4%, which implies absence of significant changes in the flora composition of the compared periods in virgin land. Observed changes in floristic composition between the studied years, apparently occurred due to the yearly fluctuations of weather conditions.

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