Assessment of the prospects of growing perennial grasses on landfills

Alexey Gorbunov[*] *and Tatyana Abdrashitova*

S. Seifullin Kazakh Agro Technical Research University. Astana, Kazakhstan

Abstract. Nineteen species of agricultural plants, recommended for cultivation in arid conditions of the USA, were tested on the dumps of the Ekibastuz coal mine. The most promising was Atriplex gardneri var. aptera - a North American plant that naturally inhabits the steppe regions of the USA. The group of promising species includes Leymus racemosus, Elymus trachycaulus, and Psathirostachys jnceus. Less promising species for biological reclamation include Calamovilfa longifolia, Bouteloua gracilis, Andropogon gerardii, Leymus arenarius, Pascopyrum smithii sv. Rosana, Pascopyrum smithii sv. Rodan, Elymus lanceolatus, Elytrigia intermedia, Agropyron cristatum, Atriplex canescens, Festuca ovina, and Elimus sibiricus. Lowly promising and unpromising species include Panicum virgatum, Agropyron cristatum x A. desertorum, Schizachyrium scoparium, and Bouteloua curtipendula. These plants are either not frost-resistant or cannot tolerate drought on the dumps.

1 Introduction

To restore disturbed areas and prevent their harmful impact on the natural environment, land reclamation is carried out. This reclamation consists of a complex of mining engineering and biological measures aimed at creating and accelerating the formation of optimal cultural landscapes with productive cover in areas that have experienced anthropogenic impact. The ultimate goal of biological reclamation is to create productive biogeocenoses, primarily for agricultural and forestry purposes, on the surface of waste dumps [1, 2].

Biological reclamation in semi-arid conditions is extremely difficult due to the harsh climate and insufficient moisture of the rocks that make up the waste dumps [3]. In these conditions, it is extremely important to select plants resistant to extreme conditions.

The purpose of this report is to summarize the results of growing herbaceous plants on the waste dumps of the Ekibastuz coal field for agricultural reclamation.

2 Material and Methods

[*] Corresponding author: simyeandr.ksu@mail.ru

Experimental plots were established on the southern slope of the Northern Ekibastuz coal mine spoil landfill. The experimental plot is located on a 12-15% slope, composed of loams and saline clays. After leveling, the plot was disked four times with disk harrows to a depth of 8-12 cm. For sowing perennial grasses, plots of 32 m² (4 x 8 m) were used. In total, 19 species of agricultural plants, recommended for cultivation in arid conditions, were used.

Seeds were obtained from the University of Kentucky (USA). After sowing, germination, survival the following year after sowing, and plant condition under spoil heap conditions were observed annually in the plants.

The evaluation of the viability and prospects of plants grown on the "Northern" landfill was carried out according to the method of A.N. Kupriyanov et al. [4]. It takes into account such important indicators as winter hardiness, resistance to diseases and pests, general plant condition, plant condition during the growing season, and method of reproduction. The assessment was carried out in the third year after sowing.

3 Results and Discussion

The most promising species proved to be *Atriplex gardneri var. aptera*, a North American plant native to the steppes of the United States. This species exhibits growth comparable to plants in their natural habitat and reproduces through self-seeding. Within ten years, this plant had naturalized and spread throughout the entire waste heap [5]. The successful cultivation of this plant on landfills indicates its potential for improving pastures in the steppe and semi-desert regions of Kazakhstan.

Leymus racemosus, Elymus trachycaulus, and *Psathirostachys jnceus* belong to a group of promising species. These species are quite stable on landfills, exhibit high productivity, and are drought-resistant. Some of them, such as *Psathirostachys jnceus*, are widely used for pasture improvement in Kazakhstan [6].

Less promising species for biological reclamation include: *Calamovilfa longifolia, Bouteloua gracilis, Andropogon gerardii, Leymus arenarius, Pascopyrum smithii sv. Rosana, Pascopyrum smithii sv. Rodan, Elymus lanceolatus, Elytrigia intermedia, Agropyron cristatum, Atriplex canescens, Festuca ovina*, and *Elimus sibiricus*. These plants, as a rule, are smaller in size than in natural conditions, do not reproduce by self-seeding or vegetatively. Their use on landfills is possible only in areas with favorable ecological conditions.

Panicum virgatum, Agropyron cristatum x A. desertorum, Schizachyrium scoparium, and *Bouteloua curtipendula* were determined to be poorly suited for the studied conditions. These species exhibited insufficient cold tolerance or were unable to withstand the arid conditions characteristic of the spoil heaps (Table 1).

Table 1. Assessment of the viability and prospects of plant cultivation on landfills

Plant species	*1	2	3	4	5	Point total	Prospect Class	Note
Leymus racemosus (Trin.) Nevski	20	20	15	15	5	85	II	Promising
Elymus trachycaulus (Link) Gould et Schinners)	20	20	15	15	5	85	II	Promising
Panicum virgatum L.	10	20	5	5	5	45	IV	Low
Atriplex gardneri (Moquin-Tandon) D. Dietrich var. *aptera* (A. Nelson) S. L. Welsh & Crompton	20	20	20	20	20	100	I	Highly promising
Calamovilfa longifolia	20	20	15	5	5	65	III	Less

(Hook.) Scribn.								promising
Bouteloua gracilis (Willd. ex Kunth) Lag. ex Griffiths)	20	20	5	15	5	65	III	Less promising
Andropogon gerardii Vitman	20	20	5	5	5	55	III	Less promising
Leymus arenarius Hocht.	20	20	15	5	5	65	III	Less promising
Pascopyrum smithii (Rydb.) Á.Löve sv. Rosana	20	20	15	15	5	75	III	Less promising
Pascopyrum smithii (Rydb.) Á.Löve sv. Rodan	20	20	15	15	5	75	III	Less promising
Elymus lanceolatus Scribn. & J.G.Sm.) Gould	20	20	15	15	5	75	III	Less promising
Elytrigia intermedia (Host) Nevski	20	20	5	15	5	65	III	Less promising
Agropyron cristatum (L.) Beauv.	20	20	5	5	5	55	III	Less promising
Agropyron cristatum x *A. desertorum*	10	20	5	5	5	45	IV	Low
Bouteloua curtipendula (Michx.) Torr	5	20	5	5	5	40	V	Unpromising
Schizachyrium scoparium (Michx.) Nash)	5	20	5	15	5	50	IV	Low
Atriplex canescens (Pursh) Nutt.)	20	20	5	5	5	55	III	Less promising
Atriplex gardneri (Moquin-Tandon) D. Dietrich	20	20	10	15	5	70	II	Promising
Festuca ovina L.	20	20	5	15	5	65	III	Less promising
Elimus sibiricus L.	20	20	5	5	5	55	III	Less promising
Psathirostachys jnceus (Fischer) Nevski	20	20	15	15	5	75	II	Promising

*1 - Winter hardiness, 2 – Disease and pest resistance, 3 – Overall plant health, 4 – Vegetative vigor, 5 – Propagation method

4 Conclusion

Nineteen species of agricultural plants, recommended for cultivation in arid regions of the USA, were tested on the spoil heaps of the Ekibastuz coal mine. After three years, an assessment of plant viability and stability on the landfills was conducted.

Atriplex gardneri var. aptera, a North American plant naturally occurring in the steppe regions of the USA, proved to be the most promising. *Leymus racemosus, Elymus trachycaulus,* and *Psathirostachys junceus* were also classified as promising species. These species demonstrated high resistance to the landfills environment, high productivity, and drought tolerance.

Species considered less promising for biological reclamation included *Calamovilfa longifolia, Bouteloua gracilis, Andropogon gerardii, Leymus arenarius, Pascopyrum smithii sv. Rosana, Pascopyrum smithii sv. Rodan, Elymus lanceolatus, Elytrigia intermedia, Agropyron cristatum, Atriplex canescens, Festuca ovina,* and *Elimus sibiricus*. These plants generally exhibited smaller sizes compared to their natural habitats and did not reproduce through self-seeding or vegetative means.

Panicum virgatum, Agropyron cristatum x A. desertorum, Schizachyrium scoparium, and *Bouteloua curtipendula* were considered low-potential or unsuitable. These plants

either lacked frost resistance or were unable to withstand the drought conditions on the landfills.

References

1. T.S. Chibrik, G.I. Baturin Biological reclamation of industrially disturbed lands (Ural Universit Publishing House, Ekaterinburg, 2003)
2. V.K. Tokhtar, I.D. Martynova Selection of plant species for phytoreclamation of dumps of mining enterprises of the KMA. Mining magazine. **8**, 95–99 (2015)
3. A.G. Gorbunov Greening and reclamation in the semi-desert zone of Kazakhstan (Kemerovo, 2014)
4. A.N. Kupriyanov, L.A. Bogdanovich, V.G. Mikhailov Integral method for assessing the success of introduction of herbaceous plants of natural flora: Morphophysiological and ecological features of the flora of Central Kazakhstan. Karaganda (1986)
5. A.N. Kupriyanov Abstract of the Flora of the Kazakh Uplands (Academic Publishing House "Geo", Novosibirsk, 2020)
6. E.L. Bekmukhamedov, S.M. Seilgazina, Zh.A. Omarkhanova, D.S. Abdykarimova Tarlau - brittle rush (history of culture). Agriculture, forestry and water management. **5** (2013) https://agro.snauka.ru/2013/05/1092