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СКРИНИНГ КОЛЛЕКЦИОННЫХ ОБРАЗЦОВ КОСТРЕЦА БЕЗОСТОГО В ТАЕЖНОЙ ЗОНЕ ЗАПАДНОЙ СИБИРИ

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Представлены результаты изучения коллекционных образцов костреца безостого Федерального исследовательского центра Всероссийский институт генетических ресурсов растений им. Н.И. Вавилова (ВИР) для выявления доноров селекционно-ценных признаков. Исследования 2015–2018 гг. проведены в Томской области. Почвы опытных участков дерново-подзолистые, супесчаные по гранулометрическому составу, с содержанием гумуса в пахотном горизонте не более 2%. Учетная площадь делянки 0,5 м^2. Повторность двукратная. Закладка опытов, фенологические наблюдения, учет урожая и обработка данных проведены согласно методическим рекомендациям Всероссийского научно-исследовательского института кормов им. В.Р. Вильямса, ВИР и методике Государственного сортоиспытания. Годы исследования характеризовались неравномерным распределением тепла и влаги в течение вегетационного периода. Это позволило выявить наиболее адаптивные образцы для использования в селекции костреца безостого сенокосно-пастбищного направления в условиях таежной зоны. Выделен ценный исходный материал по высокорослости – сорта Хабаровский, Титан, Возвышенский, СибНИИСХоз 88, дикорастущие образцы Якутии (К-14215), Вологодской (К-14224), Омской (К-14228), Свердловской (К-14209) областей, местный образец Томской области (К-14226). Выявлены образцы, устойчивые к поражению грибными болезнями, – сорта Моршанский, Хабаровский, Эркээни, дикорастущие образцы Иркутской (К-14221, К-14227), Вологодской (К-14212, К-14224), Омской (К-14228) областей, местный образец Томской области (К-14226). Высокоурожайными по кормовой массе признаны дикорастущие формы Вологодской области (К-14212, К-14222) и местная популяция Томской области (К-14214); высокооблиственными – сорта Приморский 46, СибНИИСХоз 88, дикорастущие формы Коми (К-14208), Иркутской (К-14227), Вологодской (К-14212, К-14224) областей, местные образцы Томской области (К-14214, К-14226); с высокой семенной продуктивностью – сорта Дуэт, Приморский 46, Эркээни, дикорастущие формы Вологодской области (К-14212, К-14224), местный образец Томской области (К-14226). По комплексу основных хозяйственно важных признаков для посева в питомнике поликросса отобраны дикорастущие образцы Вологодской области (К-14212, К-14224), местные образцы Томской области (К-14214, К-14226).

Ключевые слова: кострец безостый, коллекционный питомник, урожайность, хозяйственно важные признаки, устойчивость

SCREENING OF AWNLESS BROMEGRASS COLLECTION SAMPLES IN THE TAIGA ZONE OF WESTERN SIBERIA

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The paper presents the results of the study of collection samples of awnless bromegrass from the Federal Research Center N.I. Vavilov All-Russian Institute of Plant Genetic Resources (VIR) to identify donors of valuable breeding traits. The study was carried in 2015-2018 in Tomsk region. The soils of the experimental plots were sod-podzolic, sandy loam by granulometric composition, with a humus content in the arable layer of no more than 2%. The recorded area of the plot was 0.5 m^2. The trials were repeated two times. Procedures for trial establishment, phenological observations, harvest recording and data processing were performed in accordance with the methodological

recommendations of the All-Russian Williams Fodder Research Institute, VIR and the State Variety Testing Methodology. The years of the study were characterized by uneven distribution of heat and moisture during the growing season. This made it possible to identify the most adaptive samples for selective breeding of awnless bromegrass which can be used as a hay and pasture plant in the taiga zone. The following valuable source materials were selected for tall varieties: Khabarovsky, Titan, Vozvyshensky, SibNIISkhoz 88; samples of wild plants Yakutia (K-14215), Vologda (K-14224), Omsk (K-14228), Sverdlovsk (K-14209) regions, a local sample of Tomsk region (K-14226). The following samples resistant to fungal diseases were identified: Morshansky, Khabarovsky and Erkeeni varieties; samples of wild forms of Irkutsk (K-14221, K-14227), Vologda (K-14212, K-14224), Omsk (K-14228) regions, a local sample of Tomsk region (K-14226). The following high-yielding varieties in terms of fodder mass were recognized: wild forms of Vologda region (K-14212, K-14222) and a local population of Tomsk region (K-14214); highly leafy varieties: Primorsky 46, SibNIISKHoz 88, wild forms of Komi (K-14208), Irkutsk (K-14227), Vologda (K-14212, K-14224) regions, local samples of Tomsk region (K-14214, K-14226); varieties with high seed yield: Duet, Primorsky 46, Erkeeni, wild forms of Vologda region (K-14212, K-14224), a local sample of Tomsk region (K-14226). Based on the set of the main economically valuable traits for sowing in a polycross nursery, samples of wild plants from Vologda region (K-14212, K-14224), and local samples of Tomsk region (K-14214, K-14226) were selected.

Keywords: awnless bromegrass, collection nursery, yield, economically valuable traits, resistance

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INTRODUCTION

Awnless bromegrass (Bromopsis inermis Leys.) is a perennial tall loosely-bunched rootstock grass. It is eaten by all species of animals and is used in the form of green mass, haylage, dehydrated fodder and is suitable for grazing; it is rated higher than that of many cereal grasses in terms of fodder merits (nutritional value, digestibility, and palatability) [1–3].

High yield of awnless bromegrass, its endurance in relation to lack of moisture and low temperatures, undemanding soil, ability to grow well after mowing and grazing, immunity against fungal diseases make it one of the most valuable fodder grains [4, 5].

Natural and climatic conditions of Siberia limit the species composition of cultivated forage crops and their productivity, and affect the quality of forage. The creation of varieties of fodder crops with high productivity and tolerance to the extreme conditions of Siberia is an urgent task of breeding perennial grasses [6–8].

Currently, the primary problem for all zones of cultivation of awnless bromegrass is the creation of productive varieties for fodder and seeds that have yield stability in space and time, resistant to unfavorable environmental factors, diseases, pests, combining high yield of green mass with good feed advantages [9-11].

The purpose of the research is to study and identify samples of awnless bromegrass with high productivity and resistance to diseases for use in the breeding process.

MATERIAL AND METHODS

Breeding studies were carried out in 2015–2018 in the fields of the Narym Department of Breeding and Seed Production of the Siberian Research Institute of Agriculture and Peat - a branch of the Siberian Federal Scientific Center

of Agrobiotechnology of the Russian Academy of Sciences (a branch of the SFSCA RAS) in Kolpashevo, Tomsk Region. The study area is characterized by extreme soil and climatic conditions[1,2] [12].

The research used collection samples of awnless bromegrass obtained from the Federal Research Center N.I. Vavilov All-Russian Institute of Plant Genetic Resources (VIR). In the 2015 collection nursery 24 samples of domestic origin were studied for a complex of economically important traits and properties: breeding varieties (12), local varieties (2), wild forms from Western and Eastern Siberia, and the European part of Russia (10).

The technology of setting up the main breeding and seed-growing nurseries is generally accepted in the cultivation of perennial grasses in Western Siberia [13]. The area of the plots is 0.5 m^2 in duplicate with a row spacing of 50 cm. Crop care consisted of three or four weeding with simultaneous loosening of the row spacings. The study of the source material in the collection nurseries was carried out according to the methodological instructions of the All-Russian Williams Fodder Research Institute (FWRC FPA)[3]. The obtained data was processed according to B.A. Dospekhov[4] using the Snedecor[5] application package.

Phenological observations were carried out at all stages of the study which characterize the following features of development: growth rates, recovery ability, early maturity, and other signs. In the year of sowing the date of the emergence of the seedlings and the date of full germination, the date of the tillering start and full tillering, the state of the herbage before leaving for winter and the date of termination of the growing season were noted. In the second year of life and subsequent years tests of the grass stand the following data was noted: the beginning of the growing season; dates of the onset of development phases (beginning of earing, full earing, beginning of flowering, mass flowering, mass ripening of seeds); harvest dates (for hay - two mows or for seeds); the condition of the grass stand before leaving for the winter; the date of termination of the growing season. The general assessment took into account leafiness, bushiness, evenness, stand density and other indicators. Eye assessments were performed on a five-point scale (see footnote 3).

The density of the grass stand was noted in the first year of the study at full germination and before going into winter, in the second and subsequent years - during regrowth in spring, along mows and before going into winter. Winter hardiness was determined by counting overwintered and dead plants according to the method for determining the density of the herbage (see footnote 3). It was combined with the determination of the nature of damage, the causes of plant death. The measurement of plant height was carried out when used for green mass in the phase of mass earing, when counting for seeds - at the beginning of the seed ripening. Lodging resistance was determined at the beginning of flowering and seed ripening.

Record of performance of the herbage was carried out using double-cut mowing: the first - in the phase of complete ear formation, the second - as the mowing maturity was reached (the length of stand was above 50 cm). The foliage of the perennial grasses is an indicator of the quality of the green mass and hay and one of the important indicators of the nutritional value of the variety, since the leaves contain 2-3 times more crude protein than the stems [5]. To determine the foliage samples taken at the time of the yield registration to determine the hay yield were used.

Seed productivity of the selection material was determined by sowing samples in a pure form according to the optimal agricultural technology. The grass stand was mowed from the entire counting area with a sickle. Threshed

[1]Agroclimatic resources of the Tomsk region. L.: Gidrometeoizdat, 1975.147 p.
[2]Agroclimatic reference book on the Tomsk region. L.: Gidrometizdat, 1960.116 p.
[3]Guidelines for the selection of perennial cereal grasses. Moscow: VIK, 2012.51 p.
[4]Dospekhov B.A. Field experiment technique. Moscow: Kolos, 1985.351 p.
[5]Sorokin O.D. Applied statistics on the computer. Novosibirsk, 2007.225 p.

seeds were brought to the standard for purity and germination.

When studying resistance to leaf infections, the counts were carried out during the period of maximum development of the disease according to the methodological instructions of the VIR (see footnote 6). To determine the degree of plant damage in the field, 20 leaves were collected from each plot, which were then compared with the tables of the Peterson Scale and other [14].

Determination of the content of protein and fiber in the dry mass was carried out in the Laboratory and Analytical Center of the Siberian Federal Scientific Center of Agrobiotechnology of the Russian Academy of Sciences - a branch of the SFNCA RAS in accordance with GOST 13496.4–93 and GOST R 52839–2007.

RESULTS AND DISCUSSION

Extreme weather conditions during the period of research made it possible to evaluate the breeding material for adaptability to stress factors of the environment. The samples tolerated well moderately cold winters 2015/16 - 2017/2018 with a high snow cover.

In the year of sowing of the collection nursery (2015), August and September were somewhat cooler (–0.5–2.6 ° C) and drier (–28.4; –24.8 mm) of mean annual values.

In 2016, the regrowth of awnless bromegrass was noted on April 18 (average air temperature 4.8 ° C, precipitation in the form of rain at the end of the third decade, deviation from the average long-term indicators minus 29 mm). The average monthly air temperature in May in 2016 was 7.8 ° C. Due to favorable weather conditions, the bromegrass samples grew well. The regrowth occurred in the spring of 2017 on April 20. The average air temperature during this period was 8.8 ° C, no precipitation was observed. The average monthly air temperature in May 2017 was recorded at 8.3 ° C, precipitation in a form of rain and snow was in the first decade, the beginning of the second and third decades (exceeding the norm by 39 mm). Dry and hot weather in the 1st decade of June 2017 (the air temperature reached 25 ° C in the absence of precipitation) accelerated the development of plants. Drought adversely affected the development of plants; in cereals, premature yellowing of the leaves of the lower layer was observed. After rains in the 2nd and 3rd decades of June, the condition of the plants improved slightly, but damage from drought significantly affected the seed yield.

Due to cold protracted spring of 2018, regrowth began in spring on May 8, 18 days later than in 2017.The average air temperature during this period was 12.0 ° C. In May, the average monthly air temperature was 3.7 ° C, precipitation in a form of rain and snow in the first decade, the beginning of the second and third decades (deviation from the norm plus 26 mm). Despite the unfavorable weather conditions in the spring period of 2018, perennial grasses grew well. Dry and hot weather in the 1st decade of June 2018 (air temperature reached 25 ° C) accelerated the development of grasses. Warm and dry weather in July - August promoted accelerated seed ripening.

Plant density of most of the studied issues for 2015–2018. was 4–5 points. Low density (1–2 points) was noted in SGP-7 from the Krasnoyarsk Territory and a wild specimen of the Irkutsk Region (K-14221). These estimates coincide with the state of the herbage of the samples before going into winter.

In terms of development rates, the studied varieties and wild populations of awnless bromegrass belong to mid-season species. In 2016, full heading was noted on June 14, mass flowering on June 29, and seed ripening on July 25. In 2017, full earing was recorded on June 19, mass flowering on June 28, and mass seed ripening on August 4. In 2018, full earing was noted on June 27, mass flowering - on July 6, mass ripening of seeds - on August 16. The flowering duration varied from 4 to 7 days. The termination of the growing season in 2016 fell on October 12, in 2017 - on October 22, in 2018 - on October 29. The duration of the growing season in 2016 was 99 days, in 2017 - 106, in 2018 - 101 days.

Winter hardiness of perennial grasses is determined by living conditions and agrotechnical methods of cultivation [15]. Due to the high

snow cover in 2015/16 - 2017/18, bromegrass samples overwintered well, winter hardiness was 100%. Plants left in the winter in a developed state, mowing and harvesting of crop residues was carried out a month before the onset of constant frosts, so no fallout on the crops was observed.

On average for 2016–2018 the height of plants varied in the phase of mass earing from 108 to 125 cm, during the flowering period - from 131 to 150 cm. According to the experiments, the cultivars Khabarovskiy, Titan, Vozvyshenskiy, SibNIISHoz 88, wild specimens of Yakutia (K-14215), Vologda (K-14224), Omsk (K-14228), Sverdlovsk (K-14209) regions, a local sample of the Tomsk region (K-14226) (see Table 1) belong to tall grass. At the same time, the bromegrass samples were characterized by high lodging resistance (4–5 points).

Fodder grasses are affected by a large number of fungal diseases. Leaf diseases are the most widespread; they have a noticeable effect on the quality and quantity of forage [12, 16]. In the conditions of the Tomsk region, awnless bromegrass is most often affected by helminthosporium (Helminthtosporium bromi Died.) and septoria (Septoria sp.). According to the research data, during seed ripening, leaves are affected by helminthosporiosis on average for 2016–2018. amounted to 19.2–59.3%, septoria - 0.5–11.3% (for the standard, respectively, 40.9 and 4.5%) (see Table 2). Varieties Morshanskiy, Khabarovskiy, Erkeeni, wild specimens of Irkutsk (K-14221, K-14227), Vologda (K-14212, K-14224), Omsk (K-14228) regions, local specimen of Tomsk region (K-14226) showed high resistance to these diseases. The infection with helminthosporiosis was 19.2–36.7%, with septoria - 0.5–1.8%.

In the case of haymaking use the productivity of the awnless bromegrass was recorded in the case of two-mowing use. The first cut - in the full ear formation phase on June 14 (2016), June 20 (2017), July 2 (2018). The second cut - June 26 (2016), August 2 (2017), August 17 (2018). On average for 2016–2018 the yield of the green mass of the studied samples was 19.7–43.3 t / ha, air-dry 6.1–13.5 t / ha. According to these characteristics, the wild-growing forms of the Vologda Oblast (K-14212, K-14222) and the local population of the Tomsk Oblast (K-14214) were distinguished. The excess over the standard variety Langepas was 10.3–11.0% in terms of the green mass yield, 5.8–12.5% of dry matter.

The leafiness of the studied numbers on average for three years changed in the first cut from 53.2% (wild specimen, Omsk region) to 66.3% (wild specimen, Komi). Varieties Primorsky 46, SibNIISKhoz 88, wild forms of Komi (K-

Табл. 1. Высота растений образцов костреца безостого в коллекционном питомнике посева 2015 г., см

Table 1. Plant height samples of awnless bromegrass in the collection nursery sown in 2015, cm

Variety, origin	2016	2017	2018	Average	± to the standard
Langepas, standard, Tyumen region	123	132	158	138	0
Titan, Omsk region	140	139	172	150	+12
Vozvyshensky, Kemerovo region	136	135	175	149	+11
SibNIISkhoz 88, Omsk region	129	153	159	147	+9
Khabarovsky, Khabarovsk region	131	144	162	146	+8
K-14215, wild form, Yakutia	129	135	170	145	+7
K-14224, wild form, Vologda region	124	151	161	145	+7
K-14226, local form, Tomsk region	123	140	168	144	+6
K-14228, wild form, Omsk region	130	129	174	144	+6
K-14209, wild form, Sverdlovsk region	128	136	166	143	+5
LSD_{05}	8,0	7,0	7,2		

Табл. 2. Оценка поражения болезнями коллекционных образцов костреца безостого посева 2015 г. (средние данные за 2016–2018 гг.), %

Table 2. Assessment of disease damage to collection samples of awnless bromegrass sown in 2015 (average data for 2016-2018), %

Variety, origin	Helminthosporiosis	Rust	Mildew	Septoria blight
Langepas, standard, Tyumen region	40,9	0	0	4,5
K-14221, wild form, Irkutsk region	19,2	0	0	4,8
Khabarovsky, Khabarovsk region	27,7	0	0	6,8
K-14212, wild form, Vologda region	32,6	1,0	0	11,3
Vozvyshensky, Kemerovo region	35,9	0	0	4,5
Morshansky 707, Tula region	36,7	0	0	0,5
SibNIISkhoz 88, Omsk region	36,9	0	0	5,3
K-14228, wild form, Omsk region	51,2	0	0	0,7
Erkeeni, Yakutia	59,3	0	0	1,0
K-14224, wild form, Vologda region	49,9	0	0	1,0
K-14227, wild form, Irkutsk region	45,8	0	0	1,0
Duet, Arkhangelsk region	45,3	0	0	1,6
K-14226, local form, Tomsk region	48,1	0	0	1,8
Pomor, Arkhangelsk region	49,2	0	0	2,4
K-14222, wild form, Vologda region	45,4	0	0	2,4
K-14216, wild form, Yakutia	53,3	0	0	2,8
K-14215, wild form, Yakutia	52,8	0	0	2,9
K-14209, wild form, Sverdlovsk region	41,2	7,0	0	3,0
Antei, Irkutsk region	45,0	0	0	4,0

14208), Irkutsk (K-14227), Vologda (K-14212, K-14224) regions, local samples of the Tomsk region (K-14214, K-14226).

The nutritional value of a culture can be judged by its protein and fiber content. The average protein content in the studied samples was 9.6%, fiber - 32.9%. According to these indicators, the Duet variety from the Arkhangelsk region (11.0% protein, 30.95% fiber) surpassed the standard Langepas variety (10.8% protein, 33.49% fiber). Wild samples from the Vologda Oblast K-14212 (30.4%) and K-14222 (30.69%) were also characterized by a low fiber content.

Under the research conditions, collection samples of awnless bromegrass for seeds were harvested in 2016 on July 26, 2017 - on August 4, and in 2018 - on August 16. On average, over three years, the seed productivity of the studied numbers was 0.16-0.59 t / ha. In terms of seed yield, the standard varieties Duet, Primorskiy 46, Erkeeni, wild forms of the Vologda region (K-14212, K-14224), and a local sample of the Tomsk region (K-14226) (see Table 3) significantly exceeded the standard.

According to the complex of the main economically important characters for sowing in the polycross nursery, wild-growing samples of the Vologda region (K-14212, K-14224), local samples of the Tomsk region (K-14214, K-14226) were selected.

Табл. 3. Характеристика лучших образцов костреца безостого в коллекционном питомнике посева 2015 г. при двуукосном использовании (средние данные за 2016–2018 гг.)

Table 3. Characteristics of the best samples of awnless bromegrass sown in the collection nursery in 2015 with double cutting (average data for 2016–2018)

Variety, origin	Yield									Foliage, cm
	green mass			dry matter			seeds			
	t/ha	% to the standard	± to the standard	t/ha	% to the standard	± to the standard	t/ha	% to the standard	± to the standard	
Langepas, standard, Tyumen region	39,0	100,0	0	12,0	100,0	0	0,41	100,0	0	61,1
K-14212, wild form, Vologda region	43,3	111,0	+4,3	13,5	112,5	+1,5	0,50	122,0	+0,09	61,4
K-14214, local form, Tomsk region	43,0	110,3	+4,0	12,7	105,8	+0,7	0,29	70,7	-0,12	65,5
K-14222, wild form, Vologda region	39,0	100,0	0	10,9	90,8	–1,1	0,32	78,0	–0,09	58,2
K-14224, wild form, Vologda region	39,0	100,0	0	11,2	93,3	–0,8	0,59	143,9	+0,18	62,2
Duet, Arkhangelsk region	38,0	97,4	–1,0	12,0	100,0	0	0,57	139,0	+0,16	58,5
Primorsky 46, Primorsky Krai	27,3	70,0	–11,7	7,8	65,0	–4,2	0,46	112,2	+0,05	63,2
Erkeeni, Yakutia	33,7	86,4	–5,3	10,0	83,3	–2,0	0,43	104,9	+0,02	58,7
K-14226, local form, Tomsk region	37,3	95,6	–1,7	11,3	94,2	–0,7	0,42	102,4	+0,01	63,0
LSD_{05}			3,8			0,5			0,07	

CONCLUSION

For selection of awnless hay-pasture bromegrass in the taiga zone of the Tomsk region, the following samples were selected:

– tall - varieties Khabarovsk, Titan, Vozvyshensky, SibNIISHoz 88, wild samples of Yakutia (K-14215), Vologda (K-14224), Omsk (K-14228), Sverdlovsk (K-14209) regions, local sample of Tomsk region (K- 14226);

– resistant to fungal diseases - varieties Morshanskiy, Khabarovskiy, Erkeeni, wild specimens of Irkutsk (K-14221, K-14227), Vologda (K-14212, K-14224), Omsk (K-14228) regions, local sample of Tomsk region (K-14226);

– characterized by a high yield of herbage, dry matter - wild forms of the Vologda region (K-14212, K-14222) and the local population of the Tomsk region (K-14214);

– highly leafy - varieties Primorskiy 46, SibNIISHoz 88, wild forms of Komi (K-14208), Irkutsk (K-14227), Vologda (K-14212, K-14224) regions, local samples of Tomsk region (K-14214, K-14226);

– with high seed productivity - varieties Duet, Primorsky 46, Erkeeni, wild forms of the Vologda region (K-14212, 14224), a local sample of the Tomsk region (K-14226).

According to the complex of the main economically important characters for sowing in the polycross nursery, wild-growing samples of the Vologda region (K-14212, K-14224), local samples of the Tomsk region (K-14214, K-14226) were selected.

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