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USING INTRODUCED SAMPLES OF ONION CROPS FOR BREEDING IN THE CONDITIONS OF THE SOUTH OF WESTERN SIBERIA

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The biological diversity of our planet largely depends on human impact on the environment. Globally, there is a large variety of perennial plant species worldwide. One of the methods of genetic preservation of wild species is introducing them into the culture. In the conditions of Altai Krai, scientists have found approximately 28 species of wild-growing onion crops. Wild-growing onion species have important agronomic characteristics. The current research aims to examine, evaluate, and select clones, and create a variety of perennial onion crops. The research objects are samples of three types of perennial onions: Welsh onion, Altai onion, and Chinese chive. The trial establishment, observations, and selections were conducted using instructive methodological regulations. According to the Welsh onion culture, 27 samples were studied. Early growing forms and samples with a long regrowth–bolting period were selected, which determines the duration of economic use in the culture. The least volatile variables were identified. There were 18 samples of Altai onion in the research. A sample of this type with the maximum duration of the regrowth–bolting period was identified. Further research on the selection of clones allowed the identification of promising forms. The selection of clonal material on Chinese chives was carried out using 21 samples. Phenological and morphological evaluation of the samples was performed in this culture, and interesting breeding forms were identified. As a research result, one sample of each type was transferred to the state crop variety testing. According to the results, three new varieties of perennial types of onion crops were zoned: Welsh onion Premiera, Altai onion Viktor, and Chinese chive Zelyeny dol.

Keywords: *perennial onions; Welsh onion; Altai onion; Chinese chive; growing season; bolting; green leaf; blossoming; regrowth; variety*

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ИСПОЛЬЗОВАНИЕ ИНТРОДУЦИРОВАННЫХ ОБРАЗЦОВ ЛУКА ДЛЯ СЕЛЕКЦИИ В УСЛОВИЯХ ЮГА ЗАПАДНОЙ СИБИРИ

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Биологическое разнообразие нашей планеты во многом зависит от воздействия человека на окружающую среду. Во всем мире существует большое разнообразие видов многолетних растений. Одним из методов генетического сохранения диких видов является введение их в культуру. В условиях Алтайского края учеными обнаружено около 28 видов дикорастущих видов лука. Дикорастущие виды лука имеют важные агротехнические характеристики. Данное исследование направлено на изучение, оценку и отбор клонов, а также на создание различных многолетних луковых культур. Объектами исследования являются образцы трех видов многолетнего лука: лука-батуна, лука алтайского и лука китайского. Постановка опыта, наблюдение и отборы проводились по инструктивно-методическим положениям. Изучено 27 образцов лука-батуна. Отобраны раннеспелые формы и образцы с длительным периодом отрастания и стрелкования, что определяет продолжительность хозяйственного использования в культуре. Определены наименее волатильные переменные. В исследованиях использовалось 18 образцов лука алтайского. Определена выборка этого вида с максимальной продолжительностью периода отрастания и стрелкования. Дальнейшие исследования по селекции клонов позволили выявить перспективные формы. Отбор клонального материала по луку китайскому проводился с использованием 21 образца. В этой культуре проведена фенологическая и морфологическая оценка образцов, выявлены интересные селекционные формы. В результате исследований по одному образцу каждого вида было передано на государственное сортоиспытание. Более того, районировано три новых сорта многолетних видов луковых культур: лук-батун «Премьера», лук алтайский «Виктор» и лук китайский «Зеленый дол».

Ключевые слова: *многолетний лук; лук-батун; лук алтайский; лук китайский; вегетационный период; стрелкование; зеленый лист; цветение; отрастание; сорт*

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Introduction

The increasing human impact on the environment has a global nature; hence, there is a significant and urgent problem – the protection of the biological diversity of our planet, including the territory of Russia. The biosphere of the planet is a large species diversity in the vegetable world. The intensification of the industrial impact leads to the disappearance of many plant species, thereby violating ecosystem integrity. The disappearance of any kind, even an insignificant population or species of plants, is a great irreparable loss of biological diversity [5; 11; 13].

One of the areas of work on biodiversity conservation is the introduction of local flora into plant culture. Performing such important work will help preserve the gene resources of plants through their cultivation. The second possibility of species conservation, which complements the protection of species in native habitats and is used by the scientific community, is the introduction – transfer of species to the collections of botanical gardens and scientific institutions [7; 10; 16].

Introduction and further research of valuable or endangered plant species in various ecological and geographical zones allow preserving these species, selecting valuable sorts, and expanding the range of cultivated plants, which will increase the supply of vitamin and nutritional products to the population of the country.

One of the most common plant groups in the world is onion crops, which belong to wild perennial forms: Welsh onion (*A.fistulosum*.L), chives (*A.schoenoprasum*.L), tree onion (*A.proliferum*.L) etc., and cultivated species that have long been cultivated and used by humans: bulb onion (*A.cepa*.L), shallot (*A.ascolonicum*.L), winter garlic (*A.sativum*.L) [7; 14].

Many Russian scientists have established the primary centers of origin for many types of onion crops. Most of these centers are located in highland or foothill areas closer to the seacoast. N. I. Vavilov writes on the origin of onion crops in his work, "<…> The first largest independent center of world agriculture and the origin of cultivated plants is a mountain part of central and western China with the surrounding low-lying territories <…>" [4, с. 12]. On page 14 of this work, onion crops are also noted [4, с. 14]. Breeding areas of various types of onion crops have been found in Altai Krai despite the adverse climatic conditions characterized by sudden temperature changes in summer and winter, which are very important for perennial wintering onions. The paper of Altai scientists presents data that about 50 species of wild onion crops grow in Siberia, 28 of which are found in Altai Krai [17, с. 117].

The cultivation of perennial species in the work environment allows for several leaf cuts during the growing season, which is economically profitable

production despite the costs of restoring the plantation and maintaining a high agricultural background [5].

For breeding on the domestication of wild perennial onions, it is important to isolate samples from local and introduced wild forms with good winter hardiness, which is one of the main characteristics, and a long period of delivery of green leaves with a high content of vitamins and antioxidants in them [12; 15; 19].

Many species of onions are quite comfortable in the conditions of the Altai Krai due to their ability obtained over a long evolutionary period - to go dormant during a period unfavorable for vegetation [2, c. 6, 263, 275; 5, c. 239, 260; 12, c. 225].

Cultivated and wild species of onions should be considered as members of a single botanical family whose representatives are intensively used in the national economy. To preserve biodiversity and areas of growth of perennial onion crops, it is necessary to introduce species into the culture, creating and then cultivating varieties of these crops.

Materials and methods

The research aims to study and evaluate some types of perennial onion crops according to agronomic characteristics and identify the types most adapted to Siberian conditions for their further use in breeding in the south of Western Siberia.

The research tasks are as follows:

- To identify the most winter- and frost-resistant samples of perennial onions in the conditions of Altai Krai;
- To evaluate samples of Welsh onion and Altai onion and identify the forms of early regrowing and late-bolting with the longest *regrowth–bolting* period;
- To evaluate samples of Chinese chives based on indications of the timing and length of the development phases and sample a powerful and intensively developing leaf rosette;
- To specify the advanced materials for all types of onions and transfer the selected samples to the state crop variety testing.

The research work on the evaluation of samples of three types of perennial onions – Welsh onion (27 samples), Altai onion (18 samples), and Chinese chive (21 samples) – was performed in the Ob region of Altai Krai from 2008 to 2020.

The soil of the place where the examined samples were established has a thick humus-accumulated horizon of 30–40 cm, which is important for perennial crops, and represents the type of ordinary, medium-loamy chernozems.

The weather conditions differed by year in terms of the accumulated precipitation and variations in temperature recordings, which made it possible to

fully evaluate the samples and identify the most promising ones according to the goal and tasks set.

The research was conducted according to the methodical guidelines: *Methodology for Field Experience* [8], *Methodology for State Variety Testing of Agricultural Crops* [3], and *Methodical Guidelines for the Selection of Onion Crops* [9]. The test plot area was 3 m^2 in the fourth repetition.

Results

The aim of perennial onions cultivation is to obtain a green mass of leaves. The period of growth of a good quality assimilation mass with delicate fragrant leaves continues for onions until the bolting begins. During this period begins the outflow of nutrients from the leaves to form the reproductive organs, flowers, and then – seeds. The leaves coarsen and begin to dry out; the turgor decreases. When growing perennial onions, much attention is paid to the indicator of the "regrowth-bolting" duration. This period determines the production value of the crop.

In 2012–2014 and 2016, the plants had an even and intensive growth. The first sprouts and then a vigorous increase in the green mass of leaves were observed in samples of Welsh onion No.13, No.21, No.22, and No.23. The intensive development of these samples in the spring-summer period indicates their resistance to unfavorable conditions of the winter period (sudden temperature changes, thaw, frost, etc.), which characterizes them as winter- and frost-resistant.

In the collection of Welsh onion samples, the average duration of the *regrowth–bolting* period over the years of the examining fluctuated at the level of 48–50 days. The variation in this characteristic between samples of different precocity was 16–22 days (Fig. 1, Table 1).

A B

Fig. 1. Collectible Welsh onion samples in the bolting-blooming phase: A – general view of the plot, B – close-up picture

Table 1.

Duration of the interphase *regrowth–bolting* period of Welsh onion (collection)

Sample	Year					Characteristic oscillation min-max	Characteristic variability V, %
	2012	2013	2014	2015	2016		
13	34	42	42	40	37	34–42	8.88
14	37	39	39	39	38	37–39	2.33
15	45	49	50	48	47	45–50	4.02
21	33	40	41	42	37	33–42	9.45
22	49	56	57	51	50	49–57	6.93
23	36	41	42	40	41	36–42	5.86
24	37	46	44	45	40	37–45	8.92
25	49	57	58	54	52	49–58	6.8
32	35	43	42	43	38	35–43	8.86
43	36	44	44	41	40	36–44	8.09
44	48	56	59	59	53	48–59	8.43
52	33	41	44	43	38	33–44	11.2

The characteristics obtained as a result of observations allowed dividing the examined samples into three groups according to precocity: early ripening, mid ripening, and late ripening. For early ripening samples, the duration of the interphase *regrowth–bolting* period varies within 40–45 days, and the date of bolting occurs from May 12 to June 1, depending on the conditions of the year.

The second group consisted of mid-ripening samples with the duration of the *regrowth–bolting* period within 44–50 days and the beginning of bolting from May 20 to June 5. This group includes Samples 15, 103, and 109. About 22.2 % of all examined Welsh onion samples (Samples 22, 25, 44, 104, 107, and 111) are late-ripening, with the *regrowth–bolting* period of 48–61 days and the period of bolting from May 26 to June 14.

Early regrowth was observed in Altai onion samples (Samples 10, 11, 113, 147, 148, 155, 179, and 180). The longest *regrowth–bolting* period was more than 44 days in the collection nursery. It was observed in eight samples – Samples 11, 60, 61, 89, 113, 114, 150, and 151. From these samples, promising clones were selected with such characteristics as winter- and frost-resistant with a long productive period - No. 11, 113.

In 2011, the clone of Sample 11 – No. 61/98 – was distinguished by agronomic characteristics and was transferred to the breeding nursery for further research (Fig. 2).

On average, during the years of testing, the early regrowth of plants on the Chinese chive culture was noted in the second decade of April. This group in-

cludes Samples 9 and 62 (April 10), 26 (April 12), and 7 and 8 (April 13). Regrowth in Samples 27, 33, 37, and 59 was noted ten days later (Table 2).

Fig. 2. Plant of Clone 61/98 of Sample 11 in the bolting phase.

Table 2.

Dates of the beginning of phenological phases, promising samples of the A. odorum perennial onion

Sample	Regrowth	Bolting	Boot opening	Beginning of blossoming	End of blossoming	Seed stationary phase		
						milk	wax	full
6	04/18	07/10	08/01	08/03	-	-	-	-
7	04/13	07/06	08/03	08/05	-	-	-	-
8	04/13	07/06	07/25	07/28	-	-	-	-
9	04/10	07/16	08/03	08/05	-	-	-	-
26	04/12	06/23	07/26	07/30	08/20	08/25	08/30	09/15
27	04/26	07/08	07/27	08/15	-	-	-	-
3	04/26	07/08	08/01	08/05	-	-	-	-
37	04/28	07/12	08/03	08/06	-	-	-	-
59	04/26	06/06	07/21	08/01	07/17	08/07	08/12	09/01
62	04/10	06/06	06/19	06/30	07/15	07/25	07/30	08/25

In the research, the Chinese chive samples developed intensively, forming a good leaf mass (Table 3). The number of formed branches varied from 1.8 piec-

es (Sample 7) to 3.4 pieces (Sample 9). The maximum number of leaves on the plant was noted on Sample 37 (8.2 pieces), though the leaves themselves were not large enough (leaf length of 29.0 cm and leaf width of 0.7 cm).

Table 3.

Morphobiometric characteristics of promising samples of the *A. odorum* perennial onion

Sample	Branch number, pcs.	Leaf number, pcs.	Leaf measurement		Plant height, cm	Flower spike height, cm	Inflores-cences diameter, cm
			Length, cm	Width, cm			
6	2.8	3.6	26.4	0.6	36.2	57.4	5.2
7	1.8	5.0	30.7	0.5	34.4	87.6	6.0
8	2.0	4.6	29.9	0.4	38.4	77.6	5.5
9	3.4	4.6	34.8	0.7	37.6	70.6	6.4
26	3.2	5.4	26.2	0.5	34.4	48.2	4.8
27	2.0	4.6	30.0	0.5	38.0	64.0	5.5
33	3.2	6.2	42.4	2.7	42.6	44.0	6.4
37	2.6	8.2	29.0	0.7	41.8	45.8	5.1
59	3.2	6.0	29.8	0.9	38.6	61.8	4.2
62	3.2	5.0	31.0	0.8	37.0	49.6	4.2

Chinese chives begin to bloom from the second year of their life, forming low arrows up to 50–55 cm, with spherical inflorescences. The flower spike height in the research samples reached 87.6 cm (Sample 7); a flower spike was large, with a diameter of up to 6.0 cm. On average, the height of the flower spike in the samples ranged from 45 to 70 cm.

The phenomenon of layerage blossoming and seed formation was most pronounced in Samples 7, 8, 9, 27, 33, and 37.

Discussion

Perennial onion crops represent a great variety of species. Many Siberian scientists have studied and are currently studying them. E. I. Grinberg is one of the main Siberian scientists on perennial types of onion crops [14]. In Russia, perennial onion species are in demand for use in the food industry and as ornamental plants [6; 18]. Scientists have used introduced forms to obtain new breeding material [1].

The research results have shown differences in cultures and samples by an important feature of the Siberian region – early regrowth. Based on this indicator, Welsh onion samples (Samples 13, 14, 21, 23, 24, 32, 43, 52, 73, 99, 100,

101, 102, 105, 106, 108, 110, and 112) have been selected (Table 1). Out of the 18 Altai onion samples, eight showed themselves as well wintering and early regrowing. Sample 11 of this group has the longest *regrowth–bolting* period, which is important for the production of the crop. In the culture of Chinese chive, five out of 21 samples were identified according to the intensity of early regrowth (Table 2). Regrowth was noted at the end of the first and the beginning of the second decade of April. According to the number of leaves formed on a plant and their dynamic parameters, Sample 33 (6.2 pieces; 42.4 cm and 0.7 cm, relatively) and Sample 59 (6.0 pieces; 29.8 cm and 0.9 cm, relatively) have been identified (Table 3).

Conclusion

The obtained results allowed selecting samples on the studied crops according to the most important indicator for perennial onion crops – winter and frost resistance. In the Welsh onion species, it is samples No.13, No.21, No.22, No.23, in the Altai onion species - No.11, No.113, in the Chinese onion species - No.9, No.62, No.26.

Samples No.14 and No.44 of Welsh onion were selected by the characteristics indicated in the research tasks. Clones were selected from each sample. Selection work is currently underway on the cloned material of Sample 14 – cloning with subsequent individual selection. Sample 44, with the maximum *regrowth–bolting* period in the experiment, was transferred to the state crop variety testing after passing a long environmental test in 2016. The successful passing of the test allowed this sample to be zoned as the *Premier* variety in all regions of Russia in 2017.

Promising Samples 107 and 111 selected as early regrowth with a long *regrowth–bolting* period were included in the further selection process [18].

Cloning of samples and intensive individual selection on Altai onion allowed identifying Clone 61/98, which showed uniformity and stability in terms of agronomic characteristics. In 2017, this sample was transferred to the state crop variety testing and successfully passed it. In the same year, it was zoned and entered into the State Register of Selection Achievements Authorized for Use for Production Purposes as a *Victor* variety.

In 2011, Sample 59 of the culture of Chinese chive was distinguished, as it stood out for a number of agronomic characteristics. The sample successfully passed the state crop variety testing. In 2020, it was zoned as a new Chinese chive variety *Zelyeny Dol* and entered into the State Register of Selection Achievements Authorized for Use for Production Purposes (Fig. 3).

Fig. 3. A plant of the new Chinese chive variety *Zelyeny Dol*.

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