CROP PRODUCTION

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RESULTS OF THE STUDY OF GERMINATION OF SEEDS OF *LYCHNIS CHALCEDONICA* L. DEPENDING ON THE CONDITIONS

Research article

Abstract

The article provides information on the results of the study of laboratory and soil germination of seeds of ornamental wild plants of the Republic of Bashkortostan *Lychnis chalcedonica* L. depending on the shelf life, temperature, humidity, different concentrations and time of exposure to the growth stimulator GUMI. It is shown that freshly harvested seeds of *Lychnis chalcedonica* L. begin to germinate on the 12th – 14th day of germination. After storing seeds for 2 years, there is a decrease in laboratory germination by 6%. The optimal temperature for the germination of seeds of *Lychnis chalcedonica* is 20–25 ° C, at lower and higher temperatures there is an increase in the duration of germination, a decrease in laboratory germination and germination energy. The optimal humidity for seed germination is 80–95%. The growth regulator of GUMI has a positive effect on the germination of seeds of *Lychnis chalcedonica* L.

Keywords: *Lychnis chalcedonica* L., latent period, seed germination energy, laboratory seed germination, ground seed germination, growth stimulators.

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РЕЗУЛЬТАТЫ ИЗУЧЕНИЯ ВСХОЖЕСТИ СЕМЯН *LYCHNIS CHALCEDONICA* L. В ЗАВИСИМОСТИ ОТ УСЛОВИЙ

Научная статья

Аннотация

В статье приводится информация об итогах изучения лабораторной и грунтовой всхожести семян декоративного дикорастущего растения Республики Башкортостан *Lychnis chalcedonica* L. в зависимости от срока хранения, температуры, влажности, различных концентраций и времени воздействия стимулятора роста ГУМИ. Показано, что свежесобранные семена *Lychnis chalcedonica* L.начинают прорастать на 12 – 14 сутки проращивания. После хранения семян в течение 2 лет наблюдается снижение лабораторной всхожести на 6 %. Оптимальной температурой для прорастания семян *Lychnis chalcedonica* является 20 – 25°С, при более низкой и высокой температуре наблюдается увеличение продолжительности прорастания, снижение лабораторной всхожести и энергии прорастания. Оптимальная влажность для прорастания семян 80 – 95 %. Регулятор роста ГУМИ оказывает положительное влияние на прорастание семян *Lychnis chalcedonica* L.

Ключевые слова: *Lychnis chalcedonica* L., латентный период, энергия прорастания семян, лабораторная всхожесть семян, грунтовая всхожесть семян, стимуляторы роста.

1. Introduction

The problems of flora and vegetation protection in the era of scientific and technological progress are becoming more acute every year in all countries of the world. Currently, the areas with the natural habitat of species in this nature have greatly decreased on the globe, as a result of this, not only some species of rare plants have disappeared, but also entire plant communities. The preservation of the species diversity of the flora is important for the preservation of the phytogen pool. One of the effective methods of protecting the flora is the introduction of plants into botanical gardens, where their private biology is studied.

A large number of species of wild flora of vascular plants of the Republic of Bashkortostan is declining due to anthropogenic impact and other reasons. The decrease in the number of plants in natural habitats is especially true for ornamental wild plants, due to the fact that this group of plants is reduced not only by anthropogenic destruction of landscapes, but is also destroyed when the population collects bouquets. One of these plants is *Lychnis chalcedonica* L. from the family *Caryophyllaceae*.

Lychnis chalcedonica L. – Eurasian meadow species. In Bashkortostan it occurs sporadically and always in small numbers. It is destroyed during grazing, haymaking and when collecting bouquets. It is protected in the Bashkir State Reserve and on the territory of some natural monuments (Kukhtur tract). It is necessary to control natural populations [1].

The purpose of our work is to study the germination of seeds of *Lychnis chalcedonica* L. depending on the conditions.

Morphological descriptions are given in the works of L.S. Novikova [2], B.N. Golovkin, L.A., Kitaeva, E.P. Nemchenko [3] E.V. Kucherov, A.A. Muldashev, A.H. Galeeva [1]. *Lychnis chalcedonica* L. – kistekornevischny perennial with a few stiff–haired erect, leafy stems 60 – 80 cm tall. The leaves are opposite, oval or ovate–lanceolate, sharp, heart–shaped at the base, up to 8 cm long. Flowers up to 1 cm in diameter, in a dense multi–flowered corymbose inflorescence with two leaves at the base. The pedicels are shortened, as well as the calyx are rigidly hairy. The calyx is hairy, tubular or oblong–club–shaped 15–18 mm long and 3–4 mm wide, with sharp triangular teeth. The corolla is separate, the petals are bright red, their bend is half or more incised into two broadly ovate lobes, at the base with two long or awl–shaped appendages. The fruit is a single–nest egg–shaped capsule. The seeds are small 1.5–2 mm in diameter, gray– or dark brown, the weight of 1000 pieces is 0.625 g. Germination lasts 3–4 years. Flowering period: June–July.

Lychnis chalcedonica contains saponins – substances that, when shaken with water, give an abundant foam. Most saponins are in parenchymal cells of underground organs.

Lychnis chalcedonica L. it is found in the European part of the former USSR: Upper Dnieper, Middle Dnieper, Vozhsko–Don, Zavolzhsky, Black Sea, Lower Don floristic areas; in Western Siberia: Ob, Irtysh, Upper Tobolsk, Altai floristic areas; in Eastern Siberia: Angara–Sayan floristic district; in the Middle of Asia: the Aral–Caspian, Balkhash, Tien Shan floristic districts. Outside the former USSR, it was recorded in Mongolia [4]. It is rare [3].

Lychnis chalcedonica L. is an ornamental plant. Tall varieties are used for group plantings and rabatok, low – for curbs. It can be used for cutting. Flowers remain in the water for a short time (up to 15 days, if the slices are updated after 2–3 days) [5]. According to a number of authors [6], *Lychnis chalcedonica* L. shows a high level of inhibition in the treatment of superficial mycoses caused by *Trychophyton rubrum, Aspergillus niger, Candida albigans, Microsporum canis,* and also has a capillary–protective effect due to the presence of flavonoids [7]..

2. Materials and methods of research

Experimental work was carried out during 2020–2021 in laboratory and stationary conditions of the Birsky branch of Bashkir State University. Experiments on the germination of seeds of *Lychnis chalcedonica* L. plant reproductions of the arboretum of the Birsky branch of Bashkir State University were carried out on the example of seeds.

The determination of germination (laboratory and soil), the mass of 1000 and the size of seeds was carried out according to the method of M.T. Firsova [8], [9], S.S. Lischuk [10]. The types of seed germination were determined by the standard method of seed germination [11], [12].

The germination energy (germination rate) was determined by the standard method [13].

We studied the germination of seeds of *Lychnis chalcedonica* L. depending on temperature and humidity. An experiment to study the effect of temperature on seed germination was conducted in the dark, the seeds were placed between two layers of filter paper in Petri dishes. Four repetitions were investigated. We have put 6 variants of the experiment at different temperatures: 0–5 °C; 5–10 °C; 10–15 °C; 15–20 °C; 20–25 °C; 25–30 °C. An experiment to study the effect of humidity on seed germination was carried out on soil in Petri dishes at a temperature of 18–20 ° C. Three repetitions were investigated. We have supplied 19 variants of the experiment from 5% to 95% humidity.

Experience in studying the effect of the GUMI stimulant on the germination of seeds of *Lychnis chalcedonica* L. depending on the temperature, it was carried out in light in Petri dishes in temperature ranges: 0–5°C; 5–10°C; 10–15°C; 15–20°C; 20–25°C; 25–30°C and concentrations of GUMI solution $1\cdot10^{-3}$; $2\cdot10^{-3}$; $3\cdot10^{-3}$; $4\cdot10^{-3}$; $5\cdot10^{-3}$ g/l. Three repetitions of 100 pieces were studied . seeds. We have delivered 30 experience options.

An experiment to study the effect of the GUMI stimulant on the germination of *Lychnis chalcedonica* seeds, depending on temperature, was carried out in light in Petri dishes in temperature ranges: 0–5°C; 5–10°C; 10–15°C; 15–20°C; 20–25°C; 25–30°C and concentrations of GUMI solution $1\cdot10^{-3}$; $2\cdot10^{-3}$; $3\cdot10^{-3}$; $4\cdot10^{-3}$; $5\cdot10^{-3}$ g/l. Three repetitions of 100 pieces were studied . seeds. We have delivered 30 experience options. Three repetitions of 100 pieces were studied on the example of seeds of reproduction of arboretum plants.

3. Characteristics and preparative forms of GUMI

Soil organic matter consists of living organisms, living roots and soil humus in a broad sense. In the soil, along with living organic matter, there are always remnants of dead organisms. Free or non–humified organic substances are a light fraction with a high content of carbon, nitrogen, subject to light degradation. Humic substances, non–specific compounds and intermediate decomposition products are distinguished in the composition of humus. Humic substances are divided into a number of groups: humic acids, fulvic acids and humin. Humin is a strong organo–mineral component of the soil, which includes insoluble clay–humus complexes, as well as salts and chelates. In turn, humic acids include two groups: brown humic acids and gray (black) humic acids.

Brown and gray humic acids can be separated from each other by electrophoresis. Gray humic acids are represented by more polycondensed compounds. Brown humic acids are characterized by a high content of aliphatic compounds and nitrogen and mineralize faster. Strictly speaking, humic acids with a high physiological effect on plants mainly belong to this group of humic acids, which are the most active components of the GUMI preparation.

The natural regulator of the growth and development of GUMI plants, produced by the NVP "Bashink" in accordance with the technical conditions [14] – is a powdery substance from brown to black. The liquid preparation of GUMI is aqueous solutions of sodium salts of humic acids obtained by exhaustive neutralization using the navigation–ultrasound method from young brown coals of the Kumertau deposit containing up to 60% of humus compounds. The active substance of the drug is both humic acids and macro– and microelements that are part of the ash residue. The composition of the GUMI preparation includes sodium humate (up to 90%), basic nutrition elements (N, P, K) and trace elements (Ca, Co, Mp, B, Mo, Mg). The preparation can contain mechanical impurities (no more than 2%), as well as heavy metal salts in an amount not exceeding permissible levels.

4. The research results

The seeds of *Lychnis chalcedonica* L. have a rounded shape with a length of 1.31 ± 0.03 mm, a width of 1.32 ± 0.01 mm. The weight of 1000 seeds is 0.37 g. The surface of the seeds is matte, roughly dotted, dark gray.

When germinating freshly harvested seeds, we found that the seeds have a slow germination, begin to germinate on the 12th – 14th day, and belong to the type of seeds with slow uniform germination throughout the germination period.

Based on our observations, the seeds of *Lychnis chalcedonica* L. when stored in dry form (in paper bags) at a temperature of 18 ° C, a high percentage of germination is preserved (germination at the natural length of the day, at a temperature of 20–22 °C). After storage for 7 months of seeds collected in natural conditions, laboratory germination was 77.3%, after storage for 19 months, germination decreases by 6% and is 71.2%. The duration of germination is 20–24 days. Seeds begin to germinate on the 3rd – 4th day of the experiment. Thus, when storing seeds for 19 months, there is a slight decrease in laboratory germination.

Good results can be obtained with ground sowing of seeds in autumn. At autumn sowing in the year of seed collection, germination was 58.2%, at spring sowing, germination was lower – 42.5%. When sown after a year of storage in autumn sowing – 20.3%, in spring – 7.1%. Seeds have good germination when sown in a greenhouse (March 25): when sowing in the year of harvest, the germination rate was 65.4%, after a year the germination rate decreases by 13% and is 52.1%. When sowing in the greenhouse, the first shoots appeared after 5–7 days. The picking was carried out at the end of the state of the seedlings. They have dived into paper cups, then in mid–May they planted them in cups in the open ground. The survival rate of plants is 100%.

Thus, freshly harvested seeds of *Lychnis chalcedonica* L. they begin to germinate on the 12th – 14th day of germination. After storing the seeds for 2 years, there is a decrease in laboratory germination by 6%. It is better to produce autumn sowing, because the seeds have the greatest germination.

We have studied the germination of seeds of *Lychnis chalcedonica* L. depending on temperature and humidity.

In an experiment to study the effect of temperature on germination, seeds at a temperature of 0 – 5 ° C did not germinate. The data for the remaining five variants of the experiment are shown in Figure 1.

Seeds begin to germinate at a temperature of 5–10 °C (option 1) on the 14th – 15th day, the duration of germination is 23–24 days, laboratory germination (32%), germination energy is 26.35 days. With an increase in temperature for every 5°C seedlings appear earlier (option 2 — on the 9th – 10th day, option 3 – on the 8th – 9th day, option 4 – on the 5th – 6th day), and in option 5, seedlings appear later — on the 8th – 9th day. The minimum duration of germination (15–16 days) is noted at a temperature of 20–25 °C, with an increase in temperature, the duration increases to 23–24 days.

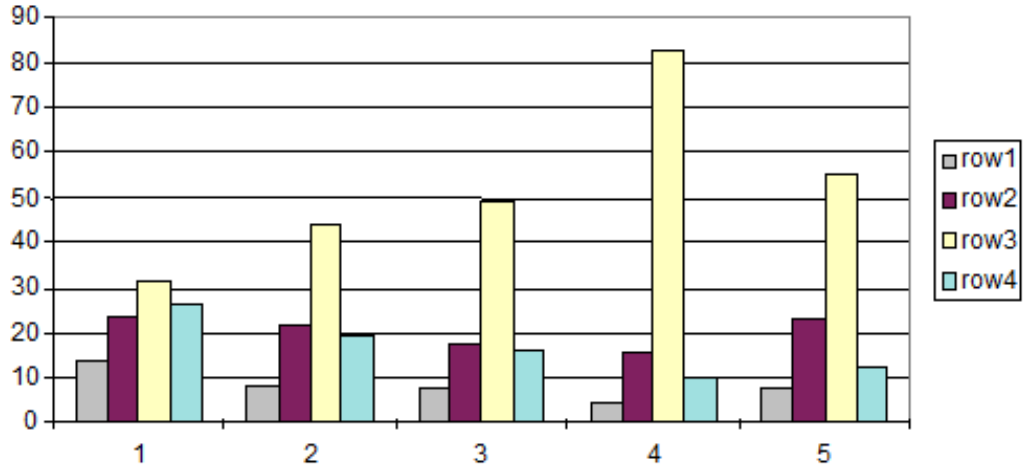

Fig. 1 – The effect of temperature on the germination of seeds of *Lychnis chalcedonica*:
row 1 — the number of days before germination; *row 2* – the duration of germination; *row 3* – laboratory germination (%);
row 4 – germination energy; *on the axis of the abscissa* – variants of experience

Laboratory germination has an average value in the second (44%), third (49%) and fifth variants (55%) and reaches the maximum value (82%) in the 4th variant (20–25 °S). The germination energy increases with increasing temperature and reaches a maximum value at 20–25 °C (10.16 days), and then at 25–30 °C again decreases to 12.42 days. Thus, the optimal temperature for the germination of seeds of *Lychnis chalcedonica* is 20–25 °C, at lower and higher temperatures there is an increase in the duration of germination, a decrease in laboratory germination and germination energy.

In an experiment to study the effect of humidity on germination, seeds begin to germinate at a humidity of 35%. Data on seed germination for 13 variants of the experiment (from 35% to 95% humidity) are shown in Figure 2.

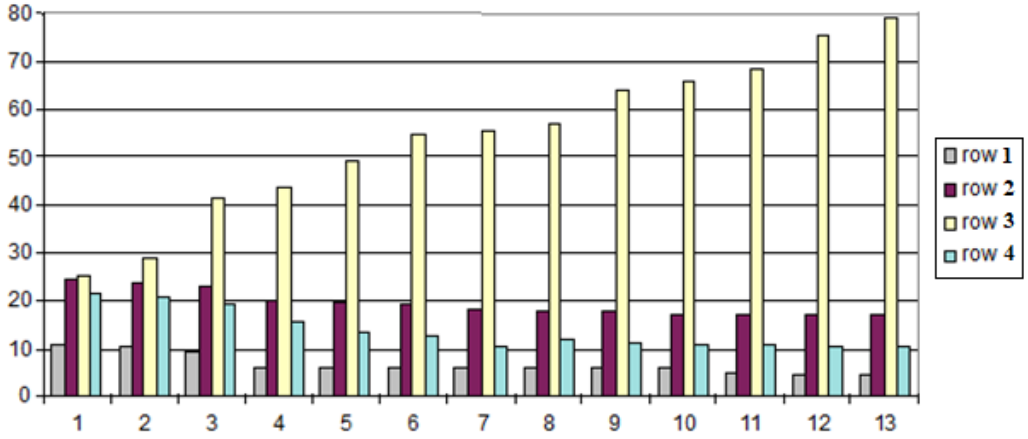

Fig. 2 – The effect of humidity on the germination of seeds of *Lychnis chalcedonica*:
row 1 — the number of days before germination*; row 2* – the duration of germination*; row 3* – laboratory germination (%)*;*
row 4 – germination energy*; on the axis of the abscissa* – variants of experience

With an increase in humidity, the number of days before the start of germination decreases, the duration of germination and the energy of germination and germination increases. The first seedlings appear at a humidity of 35–45% on the 10th – 13th day, at 50–85% – on the 6th – 8th day, at 90–95% on the 5th – 6th day. The appearance of mass seedlings was not observed at a humidity of 35–45%, because seedlings appear one by one, less often two during the entire germination period, at 50–75% humidity, mass seedlings appear on the 9th – 10th day of germination, at 80–95% – on the 7th – 8th day. The duration of germination decreases from 24.33 days (35%) to 17 days (95%). Germination increases with increasing humidity: at 35–40% humidity has the lowest value – 25.33 – 29.33%, at 45–55% humidity – 40–50%, at 60–75% humidity – 50–64%, at 80 – 85 % — 66 – 68 %, at 90–95% humidity reaches a maximum value of 75–79%. The germination energy increases with increasing humidity from 21.82 days (35%) to 10.14 days (95%). Thus, at a humidity of 80–95%, seeds germinate in less time (17–18 days) and have high germination (66–79%), the average germination of seeds is noted at a humidity of 50–75%, but for a longer period of time (18–20 days).

We have set 30 variants of the experiment to study the effect of the stimulator GUMI on the germination of seeds of Lychnis chalcedonica. Three repetitions of 100 seeds were studied. The experiment was carried out in the light in Petri dishes in temperature ranges: 0–5°C; 5–10°C; 10–15°C; 15–20°C; 20–25°C; 25–30°C and concentrations of growth matter: $1\cdot10^{-3}$; $2\cdot10^{-3}$; $3\cdot10^{-3}$; $4\cdot10^{-3}$; $5\cdot10^{-3}$g/l. Data on this experience are reflected in table 1.

The smallest number of days before germination is 2.3, observed at a temperature of 15–20 °C and a GUMI concentration of $1\cdot10^{-3}$ g/ l. The maximum number of days is 30, at a temperature of 5–10 °C and a stimulant concentration of $2\cdot10^{-3}$ g/l.

The highest germination energy (9 days) is observed at a temperature of 20–25 °C and a concentration of GUMI $2\cdot10^{-3}$ and $5\cdot10^{-3}$ g /l, a temperature of 15–20 ° C and a concentration of $4\cdot10^{-3}$ g /l. The minimum germination energy is noted (30 days) at a temperature of 25–30 °C and a concentration of GUMI $1\cdot10^{-3}$, $2\cdot10^{-3}$, $5\cdot10^{-3}$ g/l; 15–20ºC and $2\cdot10^{-3}$ g/l and 5–10ºC and $2\cdot10^{-3}$, $3\cdot10^{-3}$, $5\cdot10^{-3}$ g/l.

Table 1 – The effect of the GUMI growth regulator on seed germination *Lychnis chalcedonica* L.

Temperature , °C	Concentration GUMI, g/l	The number of days before germination, day	Germination energy, day	Germination, %
25–30	$1\cdot10^{-3}$	4,67	30	52
	$2\cdot10^{-3}$	4,3	30	41,3
	$3\cdot10^{-3}$	2,67	19	64
	$4\cdot10^{-3}$	5	11	36
	$5\cdot10^{-3}$	2,67	30	61,3
20–25	$1\cdot10^{-3}$	4,3	24	27,36
	$2\cdot10^{-3}$	4	9	16
	$3\cdot10^{-3}$	5	11	21,3
	$4\cdot10^{-3}$	5	11	12
	$5\cdot10^{-3}$	6,3	9	9,3
15–20	$1\cdot10^{-3}$	2,3	15	40
	$2\cdot10^{-3}$	5	30	54,7
	$3\cdot10^{-3}$	4,3	19	38,7
	$4\cdot10^{-3}$	4,3	9	32
	$5\cdot10^{-3}$	3,3	11	29,3
10–15	$1\cdot10^{-3}$	–	–	0
	$2\cdot10^{-3}$	25	25	1,3
	$3\cdot10^{-3}$	–	–	0
	$4\cdot10^{-3}$	–	–	0
	$5\cdot10^{-3}$	–	–	0
5–10	$1\cdot10^{-3}$	–	–	0
	$2\cdot10^{-3}$	30	30	2,7
	$3\cdot10^{-3}$	19	30	2,7
	$4\cdot10^{-3}$	15	15	2,7
	$5\cdot10^{-3}$	24,5	30	4
0–5	$1\cdot10^{-3}$	–	–	0
	$2\cdot10^{-3}$	–	–	0
	$3\cdot10^{-3}$	–	–	0
	$4\cdot10^{-3}$	–	–	0
	$5\cdot10^{-3}$	–	–	0

The best germination is observed at 25–30 ° C and GUMI concentrations of $3\cdot10^{-3}$ and $5\cdot10^{-3}$ g/l (64% and 61.3%, respectively). The lowest germination rate is 1.3% (temperature 10–15ºC, GUMI concentration $2\cdot10^{-3}$ g/l).

At a temperature of 0–5ºC; 5–10ºC (stimulant concentration $1\cdot10^{-3}$ g/l); 10–15ºC (concentration $1\cdot10^{-3}$, $3\cdot10^{-3}$–$5\cdot10^{-3}$ g/ l) seeds do not germinate.

Thus, the optimal conditions for the germination of seeds of *Lychnis chalcedonica* L. in the presence of a GUMI growth regulator, the temperature is 25–30 °C and the concentration of GUMI is $3\cdot10^{-3}$ and $5\cdot10^{-3}$ g/ml.

5. Conclusions

1. Freshly harvested seeds of *Lychnis chalcedonica* L. they begin to germinate on the 12th – 14th day of germination. After storing seeds for 2 years, there is a decrease in laboratory germination by 6%. It is better to produce ground sowing in autumn, because the seeds have the greatest germination.

2. The optimal temperature for germination of seeds of *Lychnis chalcedonica* L. 20–25 °C, at lower and higher temperatures, an increase in germination duration, a decrease in laboratory germination and germination energy is observed.

3. Optimal humidity for seed germination is 80 – 95%. Under these conditions, the seeds germinate in less time (17–18 days) and have a high germination rate (66–79%). The germination of seeds is noted at a humidity of 50–75%, but for a longer period of time (18–20 days).

4. Optimal conditions for germination of seeds of *Lychnis chalcedonica* L. in the presence of a GUMI growth regulator, the temperature is 25–30 °C and the concentration of GUMI is $3 \cdot 10^{-3}$ and $5 \cdot 10^{-3}$ g/ml.

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

References

1. Кучеров Е.В. Охрана редких видов растений на Южном Урале. / Е.В. Кучеров, А.А. Мулдашев, А.Х Галеева – М.: Наука, 1987. – 208с.

2. Новикова Л.С. Интродукция декоративных дикорастущих многолетников из флоры Башкирии / Л.С. Новикова // Ресурсы и интродукция растений в Башкирии. – Уфа, 1983. – С. 54–62.

3. Головкин Б.Н. Декоративные растения СССР. / Б.Н. Головкин, Л.А. Китаева, Э.П. Немченко. – М.: Мысль, 1986. – 320 с.

4. Флора СССР / Ботан. ин–т им. В.Л. Комарова АН СССР. – М.; Л.: Изд–во АН СССР, 1935. Т. 4. 760 с.; Т. 6. 1936. 954 с.; Т. 15. 1949.744 с.

5. Аксенов Е.С. Декоративные растения. Энциклопедия природы России. / Е.С. Аксенов, Н.А. Аксенова. – М., 1997. – Т. 2: Травянистые растения. – 608 с.

6. Поликсенова В.Д. Антимикробное действие растительных экстрактов / В.Д. Поликсенова, М.А. Стадниченко, М.А. Федорович и др. // Иммунология, аллергология, инфектология: Международный научно–практический рецензируемый журнал. – № 2. – 2009. – С. 151.

7. Поветьева Т. Н. Капилляропротекторное действие флавоноидов лихниса халцедонского / Т. Н. Поветьева, Л. Н. Зибарева, Ю. В. Нестерова и др. // Медицина и фармакология: от вопросов к решениям: сборник научных трудов по итогам международной научно–практической конференции, Томск, 25 октября 2016 года. / Автономная некоммерческая организация Институт инновационных технологий – Томск, 2016. – С. 62–65.

8. Фирсова М.К. Методы исследования и оценки качества семян. / М.К. Фирсова. – М.: Сельхозгиз, 1955. – 376 с.

9. Фирсова М.К. Семенной контроль. / М.К. Фирсова. – М.: Колос, 1969. – 295 с.

10. Лищук С.С. Методика определения массы семян / С.С. Лищук // Ботан. журн. – 1991. – Т. 76, № 11. – С. 1623–1624.

11. Беспалова З.Г. Семенное возобновление растений / З.Г. Беспалова, И.В. Борисова, Т.А. Попова и др.// Пустынные степи и северные пустыни МНР. – Л., 1980. – Ч. 1. – С. 154–175.

12. Борисова И.В. Типы прорастания семян степных и пустынных растений / И.В. Борисова // Ботан. журн. – 1996. – Т. 81, № 12. – С. 9–22.

13. Реймерс Ф.Э. Физиология семян культурных растений Сибири (зерновые злаки). / Ф.Э. Реймерс, И.Э. Илли. – Новосибирск: Наука, 1974. – 144 с.

14. ТУ 2387–003–20672718–93. [Электронный ресурс] / URL: http://www.1bm.ru/techdocs/kgs/tu/490/info/82988/ (дата обращения: 07.03.2022)

References in English

1. Kucherov E.V. Ohrana redkih vidov rastenij na Juzhnom Urale [Protection of rare plant species in the Southern Urals] / E.V. Kucherov, A.A. Muldashev, A.H Galeeva – M.: Nauka, 1987. – 208p. [in Russian]

2. Novikova L.S. Introdukcija dekorativnyh dikorastushhih mnogoletnikov iz flory Bashkirii [Introduction of ornamental wild perennials from the flora of Bashkiria] / L.S. Novikova // Resursy i introdukcija rastenij v Bashkirii [Resources and plant introduction in Bashkiria]. – Ufa, 1983. – P. 54–62. [in Russian]

3. Golovkin B.N. Dekorativnye rastenija SSSR [Ornamental plants of the USSR]. / B.N. Golovkin, L.A. Kitaeva, Je.P. Nemchenko. – M.: Mysl', 1986. – 320 p. [in Russian]

4. Flora SSSR [Flora of the USSR] / Botan. in–t im. V.L. Komarova AN SSSR [Botan. V.L. Komarov Institute of the USSR Academy of Sciences]. – M.; L.: Publishing House AN SSSR, 1935. V. 4. 760 p.; V. 6. 1936. 954 p.; V. 15. 1949.744 p. [in Russian]

5. Aksenov E.S. Dekorativnye rastenija. Jenciklopedija prirody Rossii [Ornamental plants. Encyclopedia of Nature of Russia]. / E.S. Aksenov, N.A. Aksenova. – M., 1997. – V. 2: Travjanistye rastenija [Herbaceous plants]. – 608 p. [in Russian]

6. Poliksenova V.D. Antimikrobnoe dejstvie rastitel'nyh jekstraktov [Antimicrobial effect of plant extracts] / V.D. Poliksenova, M.A. Stadnichenko, M.A. Fedorovich et al. // Immunologija, allergologija, infektologija: Mezhdunarodnyj nauchno–prakticheskij recenziruemyj zhurnal [Immunology, allergology, infectology: International scientific and practical peer–reviewed journal]. – № 2. – 2009. – p. 151. [in Russian]

7. Povet'eva T. N. Kapilljaroprotektornoe dejstvie flavonoidov lihnisa halcedonskogo [Capillaroprotective effect of lychnis chalcedon flavonoids] / T. N. Povet'eva, L. N. Zibareva, Ju. V. Nesterova et al. // Medicina i farmakologija: ot voprosov k reshenijam: sbornik nauchnyh trudov po itogam mezhdunarodnoj nauchno–prakticheskoj konferencii, Tomsk, 25 oktjabrja 2016 goda. [Medicine and pharmacology: from questions to solutions: a collection of scientific papers on the results of the international scientific and practical conference, Tomsk, October 25, 2016.] / Avtonomnaja nekommercheskaja organizacija

Institut innovacionnyh tehnologij [Autonomous non–profit organization Institute of Innovative Technologies] – Tomsk, 2016. – P. 62–65. [in Russian]

8. Firsova M.K. Metody issledovanija i ocenki kachestva semjan [Methods of research and evaluation of seed quality] / M.K. Firsova. – M.: Sel'hozgiz, 1955. – 376 p. [in Russian]

9. Firsova M.K. Semennoj kontrol' [Seed control] / M.K. Firsova. – M.: Kolos, 1969. – 295 p. [in Russian]

10. Lishhuk S.S. Metodika opredelenija massy semjan [Methodology for determining the mass of seeds] / S.S. Lishhuk // Botan. zhurn. [Botan. journal.] – 1991. – V. 76, № 11. – P. 1623–1624. [in Russian]

11. Bespalova Z.G. Semennoe vozobnovlenie rastenij [Seed renewal of plants] / Z.G. Bespalova, I.V. Borisova, T.A. Popova i dr.// Pustynnye stepi i severnye pustyni MNR. [Desert steppes and northern deserts MNR]. – L., 1980. – P. 1. – P. 154–175. [in Russian]

12. Borisova I.V. Tipy prorastanija semjan stepnyh i pustynnyh rastenij [Types of germination of seeds of steppe and desert plants] / I.V. Borisova // Botan. zhurn. [Botan. journal.] – 1996. – V. 81, № 12. – P. 9–22. [in Russian]

13. Rejmers F.Je. Fiziologija semjan kul'turnyh rastenij Sibiri (zernovye zlaki) [Physiology of seeds of cultivated plants of Siberia (grain cereals)] / F.Je. Rejmers, I.Je. Illi. – Novosibirsk: Nauka, 1974. – 144 p. [in Russian]

14. TU 2387–003–20672718–93. [Electronic resource] / URL: http://www.1bm.ru/techdocs/kgs/tu/490/info/82988/ (accessed: 07.03.2022)