The influence of the variety adaptive potential on the formation of the Siberian selection spring wheat crop in the extreme conditions of Mongolia

N S Kozulina, L V Fomina and Zh N Shmeleva
Krasnoyarsk State Agrarian University 660049, Russia, Krasnoyarsk, pr. Mira 90

Abstract. The diversity of climatic and extreme weather conditions in Mongolia requires the presence of a wide range of varieties in the production that differ in their biological and economic characteristics. The Siberian selectionists created grain crops varieties that are drought-resistant, well adapted to the sharply continental climate, with good baking qualities, capable of forming a crop in extreme conditions. According to the contract between Krasnoyarsk state agrarian university (Russia) and “ShinjeAmzhilt” company (Mongolia), the research on the adaptive capacity and elements of cultivation technology of the Siberian selection wheat was conducted on the land of “ShinjeAmzhilt” company in order to develop recommendations aimed at increasing the productivity of agrocenosis. The objects of the research were the varieties of Siberian selection wheat: Novosibirskaya-15, Novosibirskaya-31, Kantegirskaya-89 and varieties Selenge and Tobolskaya, cultivated in “ShinjeAmzhilt” company. Records and observations of wheat plants were carried out during the vegetation season using generally accepted techniques and existing state standards. Statistical processing of the obtained data was carried out by the method of dispersion and correlation analysis. The obtained results allow to conclude that despite the lack of moisture during the vegetation season, the greatest biological yield was formed by the Siberian variety of selection Novosibirskaya-31, and this data emphasize the adaptive potential of the variety and the ability to resist adverse factors.

1. Introduction
At the present stage, Mongolian agriculture keeps a leading position, it has a livestock and agricultural direction, it employs about half of the country’s population and its products make up the majority of the country’s exports. The main grain crop is spring wheat, which is able to form grain of high technological and sowing qualities. Due to products from wheat, the population of Mongolia, as well as other regions of the world, meets up to 40 % of human needs in food, from 40 to 50 % – in protein and carbohydrates.

Despite the positive trend in recent years in the agricultural sector of Mongolia, it is necessary to solve a number of problems related to the agriculture vulnerability and dependence on natural factors for further successful agricultural development.

In increasing the productivity of crop production, the leading role belongs to the variety. The diversity of climatic and weather conditions requires the presence of a wide range of varieties in the
production that differ in their biological and economic characteristics. Of great importance in the production of high-quality grain is the variety and technology of its cultivation [1].

The Siberian selectionists created grain crops varieties, well adapted to the sharply continental climate, drought-resistant, with good baking qualities [2]. In this regard, it is important to assess the varieties of the Siberian selection wheat in the extreme climatic conditions of Mongolia [3, 4].

Scientific work was carried out within the framework of the contract between Krasnoyarsk state agrarian university (Russia) and “ShinjeAmzhilt” company (Mongolia). The purpose of the research is to study the adaptive capacity and elements of the cultivation technology of Siberian selection wheat on the land of “ShinjeAmzhilt” company to develop recommendations aimed at increasing the productivity of agrocenosis.

2. Materials and methods

Field studies were conducted at the experimental plot of “ShinjeAmzhilt” company (Mongolia) that is located in the Bulgan aimak, Teshig village. The climate of the territory is characterized by sharp continental nature, aridity, sharp daily temperature fluctuations which are reflected in the vegetation and soil cover. Soils of the surveyed territory are represented by the chestnut type.

The objects of research are the varieties of the Siberian selection wheat: Novosibirskaya-15, Novosibirskaya-31, Kantegirskaya-89 and varieties Selenge and Tobolskaya, cultivated in “ShinjeAmzhilt” company.

The studied varieties were sown in the three-fold repetition. The area of each plot was 540 m². The seeds were treated with the Tibetan preparation before sowing. Simultaneously with sowing, mineral fertilizers (NPK) were applied at the rate of 100 kg per 1 ha. Before sowing, the site was cultivated.

Sowing of the Siberian selection wheat varieties was carried out at the end of May, with the SamSunflower seeder to a depth of 5 cm, the seeding rate is 160 kg/ha. Records and observations of wheat plants were carried out during the growing season using generally accepted techniques and existing state standards.

The calculation of the plant density and standing was carried out in the tillering phase and before harvesting.

Soil moisture was determined before sowing, in the tillering phase and before harvesting, in layers through 10 cm [5]. At the same time, soil samples were taken for chemical analysis for the content of nutrients in the horizon of 0-30 cm. Chemical analysis of samples was carried out in the Department laboratory of Krasnoyarsk SAU. Nitrate nitrogen was determined by GrandvalLage [6], mobile phosphorus by Machigin [7], exchange potassium – by photo-colorimetric method.

The soil density in the layer of 0-40 cm (layer by layer through 10 cm) was determined by the cutting ring method, the species composition of weeds and the account of the crops contamination was determined by the method of Dospekhov[5].

The biological yield was calculated taking into account the elements of the crop structure. The structure of the wheat crop was determined by the generally accepted method.

Statistical processing of the obtained data was carried out by the method of dispersion and correlation analysis [5, 8].

3. Research results

The research was conducted at the experimental field “ShinjeAmzhilt” that is located in the Bulgan aimak. The Bulgan aimak is situated in the steppe and forest-steppe zone of Central Mongolia. In the North of Bulgan mountains rise, covered with forests of larch, pine, cedar. The southern regions are flat terrain. In the wide intermountain basins there are steppes, characterized by low vegetation cover and they do not have a continuous cover. There are a lot of small-leaved Caragana bushes and wormwood. The climate of the territory is characterized by sharp continental nature, aridity, sharp daily temperature fluctuations which are reflected in the vegetation and soil cover. The territory of the Bulgan aimak is crossed by two large river arteries – the Orkhon and Selenga rivers, which makes it possible to successfully conduct agricultural activities and agricultural crops cultivation. The well-
known “basin effect” [9, 10], manifested in the climate dryness increase in the vast intermountain basins in comparison with the mountain slopes and adjacent plains leads to the chestnut soils formation. Chestnut soils have the widest distribution within the plains of Mongolia.

The morphological description of profiles was carried out, the classification belonging was defined. Selection of soil samples was conducted on genetic horizons. During the growing season, mode observations of the soil condition were carried out. Before sowing spring wheat, the fields were surveyed for agrophysical condition in 5-fold repetition to a depth of 0-20 cm. The availability of soil nutrients was estimated in mixed samples at a depth of 0-20 and 20-40 cm. During the crop vegetation season, the soil condition was assessed by varieties in mixed samples to a depth of 0-20 cm. The basic chemical parameters of soil characteristics were obtained using conventional methods [7]: the reaction of soil solution was determined by potentiometric method; the sum of exchange bases – by Cappen-Gilkovitz; humus by Tyurin; nitrate nitrogen (State Standard 26951-86); exchange ammonium (State Standard 26489-85); mobile phosphorus (State Standard 26204-91); exchange potassium (State Standard 26204-91). In the samples, the addition density and humidity were determined by the thermal weight method [11].

Soils of the surveyed territory are represented by the chestnut type. Chestnut soils develop in the sub-boreal (semiarid) climate, which is characterized by warm dry summers and cold winters with little snow cover. They are formed in the zone of dry steppes under the canopy of low-growth sparse complex grassy cover in the composition of which sagebrush plays a significant role. The degree of coverage is 50-70%; it decreases as the climate of the zone becomes drier. The main features of the soil formation process in this zone are slow rates of humus formation and weak leaching of the profile from carbonates and easily soluble salts. Subtypes of chestnut soils, from dark chestnut to light chestnut, consistently reflect the increasing aridity of the bioclimatic regime. They differ in the content of humus in the surface layer: dark chestnut – 3-6%, chestnut – 2-3%, light chestnut – 1.5-2% [12]. In soils of light granulometric composition (light loam, sandy loam) humus content is different: dark chestnut – 2.5-3%, chestnut – 1.5-2.5%, light chestnut – 1.0-1.5%.

It was established by the research that by the beginning of spring wheat sowing and harvesting the soil had satisfactory moisture reserves (21-26 mm). The acutely arid conditions of the summer months did not contribute to the replenishment of moisture reserves during the period of active growth and the crop development. In the period of July, moisture reserves are estimated as poor. It was found that under the variety of spring wheat Kantegirskaya-89 productive moisture is formed by 2-3 mm less compared to varieties of Novosibirskaya selection.

The obtained results allow to conclude that the land use arable chestnut soils in “ShinjeAmzhilt” agricultural enterprise, having a light granulometric composition, are characterized by a shortage of productive moisture. During the period of the wheat intensive growth, the reserves of productive moisture did not exceed 11 mm, which affected the consumption of mineral forms of nitrogen by plants. The low level of potential fertility of chestnut soils on the experimental field is determined by a very low provision of the arable layer with mobile phosphorus and potassium metabolism during the crop growing season.

The vegetation cover of Mongolia has its own peculiarities and specific features of the herbaceous vegetation species composition, structure and productivity due to its geographical location in the center of the Asian continent. In the steppes of Mongolia, under extremely unfavorable conditions of existence, the plant vegetation can begin at very different times depending on the precipitation mode – both in early April and in the first half of June, but still there is a general tendency to increase the number of vegetating species from spring to summer, which is associated with the mode of precipitation (summer maximum). The Mongolian steppes are characterized by more or less abundant development of a number of young species, mainly summer-autumn annuals.

The experimental field of “ShinjeAmzhilt” company refers to multi-grass tansy (Filifolium sibiricum) steppes. Their edificators are meadow-steppe and northern steppe meso-xerophyte species. There is quite a large diversity in plant communities dominated by these species. The representatives of individual species include: Arctogeron gramineum, Aster, Leontopodium ochroleucum, Potentilla
astragalifolia, Allium mongolicum, Agropyron cristatum, Pulsatilla pratensis, Artemisia frigida, Agropyron cristatum, Cleistogenes squarrosa, nalictrum squarrosum.

During the vegetation season, there was a long drought, which led to the fact that not all plants were preserved for harvesting. The maximum number of plants in the period from tillering to harvesting remained in the variety Kantegirskaya-89 – 85.9%. In general, assessing the safety of plants for harvesting as a parameter characterizing the adaptive abilities of varieties to the conditions of the dry steppe, we note that the Siberian selection varieties were slightly inferior to the varieties grown on the farm.

The highest biological grain yield was formed by the Siberian variety Novosibirskaya-31 and amounted to 23,89 c / ha (figure 1). Variety Novosibirskaya-31 surpassed the rest of the studied varieties due to higher productive bushiness, a greater number of spikelets in the ear and higher grain size.

It should be noted that the conditions for the formation of the grain harvest were extreme: lack of moisture, high air and soil temperatures. In particular, in early July, the soil temperature in the layer 0-10 cm exceeded 30°C and even at a depth of 30-40 cm was about 20°C, which puts forward special requirements for varieties not only for drought resistance, but also for heat resistance. In this regard, the adaptive ability of the Siberian selection spring wheat varieties is vividly manifested in difficult extreme weather conditions.

![Crop capacity of spring wheat varieties, c/ha.](image)

Figure 1. Crop capacity of spring wheat varieties, c/ha.

Keeping all the above-mentioned in mind, one should note that it is necessary to have several varieties that differ in their biological and economic characteristics for production in extreme weather conditions of Mongolia. The area where the fields of “ShinjeAmzhilt” company are located is characterized by frequent repetition of drought, so drought tolerance is the most important feature for varieties grown on the farm.

In crop technologies, it is recommended to have varieties of different ripeness groups. On the experimental field of “ShinjeAmzhilt” company there is a chance of early frost, so some varieties must be from the group of early ripening. In addition, from the point of view of the harvesting organization, a limited number of combine harvesters in “ShinjeAmzhilt” company, early-ripening varieties should occupy 20-30 % of the total volume of other varieties. The presence of early-ripening varieties allows to start harvesting earlier and to carry it out in favorable weather. This allows to use a smaller number of combine harvesters on the existing cultivated area. At the same time, early-ripening varieties can be
removed in the phase of full ripeness, which eliminates the drying of grain and the corresponding costs for their part-time work. In this regard, it is advisable to cultivate the early-ripening variety Novosibirskaya-15, which despite its reduced yield (14.57 centner / ha) quickly formed the grain in full ripeness of all the studied varieties, while only wax ripeness of the grain was observed in other varieties.

4. Conclusions
As a result of the conducted research it is established:

Dark chestnut soils were identified in the structure of the soil cover of “ShinjeAmzhilt” company land use. The given chemical and agrophysical characteristics of chestnut soils of “ShinjeAmzhilt” company fields testify their low potential fertility. Soils are characterized by low humus content and reserves in the 0-20 cm layer, average absorption capacity, unsatisfactory moisture reserves and compaction. There is low and average humus of the arable layer (2.6-4.1%). Soils are characterized by a shortage of productive moisture and do not exceed 11 mm. Variety Novosibirskaya-15 has kept its ripening in the conditions of Mongolia. At the same time, this variety marked full ripeness of the grain during harvest among other varieties, while the other varieties showed only wax ripeness of the grain.

During the period of field experiments on the experimental plots there was a severe drought, but even in the conditions of moisture shortage, the Siberian variety Novosibirskaya-31, formed a higher biological yield (23.86 C / ha), compared with the varieties Selenge and Tobolskaya cultivated in the farm, which emphasizes its ability to withstand adverse factors.

To increase the productivity of wheat agrocenosis in “ShinjeAmzhilt” company production it is advisable to use stable high-yielding varieties of Siberian selection, adapted to different environmental conditions. The presence of similar extreme conditions and the proximity of certain Siberian regions and Mongolia determine the necessity to expand further research aimed at the introduction of Siberian wheat varieties in the production of Mongolia.

References
[1] Arzumanyan M S, Shmeleva Zh N 2019 Grain potential of the Krasnoyarsk territory. Azimuth of Scientific Research: Economics and Management, 8 (2) 50-3
[2] Surin N A 2011 Adaptive potential of varieties of grain crops of Siberian selection and ways of its improvement (wheat, barley, oats) (Novosibirsk) p 708
[3] Kozulina N S, Fomina LV 2018 The research results of Siberian selection wheat varieties in Mongolia // Sci and educ: experience, problems, prospects of development: materials of the international sci.-pract. conf. Part II (Krasnoyarsk state agrarian university, Krasnoyarsk) pp 169-72
[4] Litvinova V S, Antonova N V and Bopp V L 2018 Research work of FSBEI OF HE «Krasnoyarsk state agrarian university» in Mongolia Sci and educ: experience, problems, prospects of development: materials of the international sci.-pract. conf. Part II (Krasnoyarsk state agrarian university, Krasnoyarsk) pp 294-7
[5] Dospekhov B A 1987 Workshop on agriculture (Agropromizdat) p 383
[6] Turchin E F 1965 Methods for determination of nitrogen compounds in soil  pp 64-82
[7] Arinushkina E V 1970 Guidelines for chemical analysis of soils (MSU Publishing house) p 487
[8] Tomilov V P 1987 On statistical processing of field experiments data. Agriculture pp. 48-51
[9] Vedrov N G 1984 Selection and seed production of spring wheat in extreme conditions (Krasnoyarsk) p 240
[10] Dorzhgotov D 1992 Mongolian soils (genesis, systematics, geography, resources, use) (Krasnoyarsk) p 54
[11] Alexandrova L N and Naidenova O A 1986 Laboratory and practical classes in soil science (Moscow: Kolos) p 350
[12] Kurbatskaya S S 2001 Organic matter and humus state of Tuva soils: Natural conditions, history and culture of Western Mongolia and adjacent territories (Tomsk) pp16-7