The influence of agrotechnology on barley productivity in the Republic of Khakassia

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Abstract.

The article presents the results of an experiment studying the influence of the technology of cultivation of Emelya barley variety on productivity in the conditions of the Republic of Khakassia. The experiment was carried out in 2022 at Chernogorskoe settlement, located in the Ust-Abakansky district of the Republic of Khakassia. The results of the study showed that the maximum productivity of barley variety Emelya was obtained when azofoska was applied at a dose of 60 kg. d. per hectar with the use of plant protection products of 4.05 t/ha. The increase in comparison with the control was 1.12 t/ha.

1 Introduction

Modern agricultural production, under the influence of global climate change, requires the use of new adaptive approaches for more efficient and stable production. Especially not just in the conditions of risky farming areas. Many researchers are engaged in this direction [1,2]. It is as well relevant for the conditions of the Republic of Khakassia.

The introduction of intensive technologies for the cultivation of new varieties of grain crops is an important task in agriculture. The variety, which is the biological foundation in the development of any farming system, has a great influence on the growth of the crop and its stability. A variety can realize its productive potential and technological qualities only in specific soil and climatic conditions. Improper cultivation of varieties can cause a decrease in the yield and quality of the resulting grain, therefore, in order to fully unleash the potential of a variety, it is necessary to develop simultaneously a technology for cultivating a variety for specific regional conditions [3].

The main task of agricultural production in the Republic of Khakassia is the production of quality products and the restoration of soil fertility. These tasks can be solved primarily through the effective use of the soil and climatic conditions of the territory, the use of various

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types of mineral fertilizers and plant protection products. An important factor in the soil and climatic conditions of Khakassia is the protection of the soil from wind and water erosion.

Elements of agricultural technology are of key importance in the cultivation of spring barley. The choice of the optimal sowing dates and seeding rates allows the most complete use of the potential of the variety, agro-climatic resources, reducing the infestation of crops and increasing the yield of spring barley. When going beyond the optimal sowing time, the quantitative and qualitative losses during harvesting will be large, up to the crop leaving under the snow. A delay in sowing by 5 days leads to a decrease in field germination by 10-15%, by 10 days - by 20%. Not only the level of yield, but also its quality depends on the correctly selected sowing time. Excessively early or too late sowing dates lead to a sharp decrease in the technological properties of the grain. Mid-ripening and mid-late varieties of spring crops, in which grain formation occurs at low air temperatures and high humidity, react especially strongly to late sowing dates [4].

One of the conditions that will ensure a more complete use of varietal potential and good development during the growing season is the correct selection of predecessors. The best forerunners of barley are crops that leave the field cleaner from weeds, with sufficient soil nutrients readily available to plants [5].

The use of mineral fertilizers in the cultivation of spring barley significantly increases both the quantity and quality of the resulting grain. Improving nutrition contributes to the mobilization of the physiological resources of the plant and increase yields. To maximize profitability, it is important to calculate the optimal fertilizer dose that will produce a high yield of good quality while increasing or maintaining soil fertility. Properly chosen terms and rates of application of mineral fertilizers serve as an anti-stress factor in the application of chemical plant protection products and remove a negative varietal reaction. In addition, improved nutrition contributes to an increase in overall resistance to diseases and pests [6].

The choice of the optimal predecessor, the sowing of seeds with the recommended seeding rate, the introduction of optimal doses of mineral fertilizers and the use of new plant protection products will make it possible to obtain the maximum yield of spring barley grain of the Emelya variety with high technological qualities in the conditions of the Republic of Khakassia.

The main task of agricultural production is to increase the gross harvest of grain, while improving its quality indicators is important.

The increase in the cost of fuels, lubricants, fertilizers, chemical plant protection products force farmers to look for ways to reduce production costs in the cultivation of crops.

Reducing costs, increasing profitability in the production of spring barley grain is possible while minimizing the use of agrotechnical and chemical resources. The greatest reduction in production costs is facilitated by the rejection of the most energy-intensive method of the main tillage - plowing and the rational use of mineral fertilizers.

The yield and quality of grain depends on many factors. For agricultural production, it is important to establish which factors determine the formation of yields and the quality of the products obtained.

According to the data obtained earlier in a multifactorial experiment [3], the effectiveness of mineral fertilizers in the formation of spring barley yield is 25-80%, the location of crops in the relief is 26-70%, crop rotation is 12-30%, the main tillage is 0-10%. %. In the formation of the quality of barley grain, the role of crop rotation is 60-90%, the location of crops in the relief - 55-76%, mineral fertilizers - 16-35%, the main tillage - 0-3%. At the same time, the application of mineral fertilizers is more effective on the slopes, compared to the watershed plateau. The best quality barley grain is formed on the watershed plateau.

The purpose of the article is to study the influence of the main agrotechnical practices on the productivity of spring barley of the Emelya variety in the conditions of the Republic of Khakassia.

2 Methods and materials

The object of research is the variety of spring barley six-row smooth-skinned Emelya. Mid-season with the duration of the growing season from full germination to economic maturity 74-76 days, characterized by a six-row spike structure with smooth awns. Resistant to lodging, drooping and brittleness of the ear, slightly susceptible to loosen smut. The plant is well leafy, which increases the value of the variety for threshing harvesting for haylage and green fodder.

2.1 Research conditions

The soil of the experimental plot is represented by meadow-chestnut soils of medium loamy mechanical composition. The soil is medium fertile. The weighted average content of humus is 5.0%. According to the degree of acidity, soils with pH = 7.4 prevail. Provision with nitrate nitrogen before sowing for fallow - 7.6 mg/kg of soil, for grain predecessor 4.5 mg/kg, mobile phosphorus was 198-230 mg/kg of soil, exchangeable potassium - 160-180 mg/kg of soil.

The climate of the territory where the experimental field is located is marked by sharp continentality, aridity and negative average annual temperatures, which average - 0.9 0C. The growing season starts at the end of April and lasts 5-6 months. Soil freezing due to the insignificant height of the snow cover (15-20 cm) and snow blowing into logs and hollows occurs to a depth of 2.0 meters or more. Soil thawing ends by the end of May. Slow warming of the soil in the spring delays the development of microbiological processes, therefore, in the first periods of life, plants feel a lack of available nutrients and respond well to fertilization.

The duration of the frost-free period is from 91 to 114 days. The average temperature of the warmest month (July) is -19.4 0C, the absolute maximum is 38 0C and is observed in June-August. The sum of average daily temperatures above +5 0C during the growing season is about 2000 0C.

The average annual rainfall is 300-327 mm. The distribution of precipitation is extremely uneven during the growing season. Most of the precipitation (up to 70-75%) falls in May-September. In winter, about 25% of the annual precipitation falls. The spring period is characterized by relatively low relative air humidity, which, with a lack of moisture in the soil, causes a complex soil-air drought.

Throughout the year, winds of predominantly southwestern and northern directions prevail. The average annual wind speed is 2.6 m/s. Strong spring winds at low relative air humidity largely dry out the upper soil horizons, and also lead to the formation of strong storms and soil erosion [7].

The growing season of 2022 was characterized by a lack of moisture in all months (Table 1). June and August were especially dry months - the amount of precipitation was 35.0 and 42.6 mm lower than the long-term average. The spring of 2022 was warm, the average monthly temperature in May was 3.2 °C higher than the long-term average. In June and September, the average monthly temperature was higher than long-term values by 0.4 and 0.8 0C, respectively. The average monthly temperature in July was 1.7 0C lower than long-term values.

2.2 Scheme and methods of conducting research

The study of the effect of mineral fertilizers and plant protection products on the productivity of spring barley variety Emelya provided for the following scheme (two fertilizer backgrounds):

1. 000 (control without fertilizers);

2. N_{60} (ammonium nitrate);
3. $N_{60}P_{60}K_{60}$ (azofoska).

In the experiment, ammonium nitrate - NH_4NO_3 (34.7% nitrogen) was used at the rate of N_{60} in physical weight - 176 kg/ha. The dose of azophoska (16% nitrogen, phosphorus and potassium each) for $N_{60}P_{60}K_{60}$ in physical weight is 375 kg/ha.

Against these backgrounds, the scheme of plant protection was studied in comparison with the control:

1. Control (no pesticide treatment);
2. Plant protection scheme: Hat-Trick seed treater, SC - 1.3 l/t; herbicides Ballerina Super, SE - 0.5 l/ha and Lastik Extra, EC - 1.0 l/ha; fungicide Baly, KME - 0.8 l/ha; insecticide Borey Neo, SK - 0.2 l/ha [8].

Pre-sowing treatment of seeds was carried out with Hat-Trick, SC 10-14 days before sowing, in the tillering phase (June 10) the crops were treated with a tank mixture of herbicides Ballerina Super at a dose of 0.5 l/t and Lastik Extra at a dose of 1.0 l/t T. In the earing phase (July 20), the crops were treated with the fungicide Baliy, KME at a dose of 0.8 l/ha and the insecticide Borey Neo, SK at a dose of 0.2 l/ha.

Repeatability of experience was 3-fold. The area of the experimental plot is 45 m^2.

Soil cultivation: in autumn - plowing with a layer turnover of 18-20cm; in spring - early spring harrowing as soon as the soil is ready, cultivation to a depth of 5-6 cm. Mineral fertilizers were applied by the SZP-3.6 seeder on May 10. Before fertilization, a primary breakdown of the experiment was made.

For sowing the experiment, the seeds were preliminarily prepared: they were cleaned from weeds, dust (purity up to 100%), presowing treatment of seeds, laboratory germination of seeds was determined, and phytosanitary examination was carried out. In accordance with the scheme, weights were prepared for each plot.

The sowing of the experiment with the SKS 6-10 seeder for fallow and grain predecessors was carried out on May 12, 2022. The seeding rate is 5.0 million w.s./ha.

Phenological observations of the growth and development of plants were carried out on a visual basis in four repetitions. The beginning of the phase was considered the moment when 10% of the plants entered it, the end - 75% of the plants. Field germination was determined by the calculated actual plant density and seeding rate in four repetitions. Accounting for the density of plant standing during the growing season was carried out twice: in the phase of full germination and before harvesting.

The analysis of sowing qualities of seeds was carried out according to GOST 12042-80, laboratory germination was determined according to GOST 12038-84. Carrying out phytosanitary examination of seeds of grain crops in accordance with GOST 12044-93.

Soil samples for agrochemical analysis were taken before fertilization, as well as in the heading and full ripeness phases. The content of humus in the soil was determined in accordance with GOST 26213-84, nitrate nitrogen - by the ionometric method (GOST 26951-86), mobile compounds of phosphorus and potassium - by the Chirikov method in the modification of TsINAO (GOST 26204-91).

Determination of protein in barley grain was carried out according to GOST 10846-91, film content according to GOST 10843-76, fat by the Randall extraction method (GOST 11085-2016), grain nature according to GOST 10840-64.

The weed infestation of crops was taken into account before the application of herbicides and 21 days after their application; for this, a frame of 0.25 m2 was used. The total number of weeds was counted, their species composition was determined. To account for leaf diseases, 10 plants were analyzed at 10 points. Diseases were recorded on the main stem of plants, the level of damage to the main leaf was determined, and the degree of damage to each plant was calculated [9]. The treatment of crops with pesticides was carried out by a sprayer ONM - 400 (width of coverage 12 m).

The experiment was harvested on September 10 with a Sampo-500 combine. The grain was brought to 14% moisture and 100% physical purity. Statistical processing of the obtained data was carried out by the method of analysis of variance using the SNEDECOR applied statistics software package [10].

3 Results and discussion

The use of mineral fertilizers and plant protection products contributed to an increase in the survival rate of Emelya spring barley plants by improving mineral nutrition, as well as reducing the adverse effects of pests on seeds and plants during the growing season (Table 1). In the control variant, survival to harvest was 59.0%. The use of mineral fertilizers made it possible to increase the survival rate by an average of 18.0 - 23.1%. The complex use of mineral fertilizers and plant protection products increased the percentage of survival before harvesting. The maximum survival of barley plants was noted in the variant of the experiment with the use of complex fertilizer (azofoska) at a dose of 60 kg. d.v. and application of the plant protection scheme - 84.1%.

Table 1. Survival of spring barley variety Emelya depending on the use of mineral fertilizers and plant protection products, 2022.

Experiment variant		**Number of plants, pcs./m^2**		**Survival to harvest, %**
		in the germination phase	**to harvest**	
000	Control	214.0	126.3	59.0
	Plant Protection Scheme	289.0	192.0	66.4
N_{60}	Control	318.6	245.4	77.0
	Plant Protection Scheme	354.5	291.0	82.1
$N_{60}P_{60}K_{60}$	Control	320.1	257.0	80.3
	Plant Protection Scheme	378.3	318.2	84.1

Pre-sowing application of mineral fertilizers and the use of plant protection products had a positive effect on the elements of the crop structure of Emelya barley variety (Table 2). On fertilized backgrounds with the use of plant protection products, an increase in the height of plants, the number of plants per ear and the weight of 1000 grains was noted. In the control variant, the height of the stem with the ear was 52.9 cm, the average length of the ear was 4.9 cm, the number of grains per ear was 12.1 cm. The application of mineral fertilizers at a dose of 60 kg a.i./ha significantly increased all the studied elements of the crop. The complex use of mineral fertilizers and plant protection products made it possible to obtain the maximum indicators of the elements of the crop structure. The largest weight of 1000 grains in Emelya barley when placed on the grain predecessor was obtained on the N60P60K60 background with the use of plant protection products - 38.3 g.

Table 2. Elements of the crop structure of Emelya spring barley variety depending on the use of fertilizers and plant protection products, 2022.

Experiment variant		Stem height with ear, cm	Average spike length, cm	Number of grains in an ear, pcs.	Weight of 1000 grains, g
000	Control	52.9	4.9	12.1	33.8
	Plant Protection Scheme	65.0	5.6	14.3	34.5
N_{60}	Control	73.2	6.3	16.8	35.7
	Plant Protection Scheme	74.8	7.2	18.9	36.5
$N_{60}P_{60}K_{60}$	Control	81.0	7.9	23.2	37.5
	Plant Protection Scheme	83.6	8.6	23.8	38.3
	HCP_{05}	**8.70**	**0.18**	**1.45**	**0.69**

Emelya barley variety responded positively to the use of mineral fertilizers by increasing the yield (Table 3). Reliable increases were obtained in the variants of the experiment with the introduction of mineral fertilizers. The maximum increase from the application of mineral fertilizers for bare fallow was obtained when applying azofoska - 0.98 t/ha, for the grain predecessor - 0.97 t/ha. The use of plant protection products on a fertilized background made it possible to obtain a significant yield increase of 1.12 t/ha for bare fallow and 0.96 t/ha for the grain predecessor in comparison with the control.

Table 3. The influence of mineral fertilizers and plant protection products on the productivity of Emelya spring barley variety, 2022.

Fertilizer background	Fertilizers (without chemical plant protection products)		Fertilizer + Crop Protection Scheme	
	Yield, t/ha	Increase, t/ha	Yield, t/ha	Increase, t/ha
Without fertilizers	2.65	Control	2.93	Control
N_{60}	3.38	+ 0.73	3.73	+ 0.80
$N_{60}P_{60}K_{60}$	3.63	+ 0.98	4.05	+ 1.12
HCP_{05}	**0.39**	**-**	**0.47**	**-**

Thus, the maximum productivity of spring barley of the Emelya variety in the soil and climatic conditions of the Republic of Khakassia was obtained when placed on a bare fallow, pre-sowing application of a complex fertilizer (azofoska) at a dose of 60 kg. d. per hectar.

4 Conclusion

The maximum survival rate of barley before harvesting was noted with the use of azofoska ($N_{60}P_{60}K_{60}$ background) and plant protection products - 84.1%.

Pre-sowing application of mineral fertilizers and the use of plant protection products had a positive effect on the elements of the crop structure of barley variety Emelya. Complex mineral fertilizers and plant protection products increased all the studied elements of the crop

structure. The largest weight of 1000 grains in Emelya barley when placed on the grain predecessor was obtained on the $N_{60}P_{60}K_{60}$ background with the use of plant protection products - 38.3 g.

The maximum yield of barley variety Emelya was obtained by applying azofoska at a dose of 60 kg. d. per hectar - 3.63 t/ha. The use of plant protection products on a fertilized background made it possible to obtain a significant yield increase of 4.05 t/ha (an increase of 1.12 t/ha compared to the control).

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