The influence of the cultivation technology elements on the economic performance of the bare barley grain production

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Abstract. At the educational and experimental field of the Omsk State Agrarian University, the evaluation of the influence of elements of the cultivation technology of bare barley of the Omsk golozernyy variety 2 (chemical background, sowing time, and seeding rate) on the indicators of the economic efficiency of grain production was carried out. On the background without the use of chemicals, as well as when using herbicides on the background of applying nitrogen fertilizer, the cost of grain per hectare is higher when sowing the crop in the third decade of May. The use of only herbicides (without fertilizer) provided a greater cost of grain at an earlier sowing. Among the studied seeding rates, the maximum cost indicators were observed when sowing 4.5 million viable seeds per hectare. The chemical background also influenced this indicator. The cost of grain per 1 hectare increased by 3,227 rubles with the use of a tank mixture of herbicides, as well as by 4,551 rubles with their complex use with fertilizers (in comparison with the chemical background). At the same time, the strengthening of the chemical background led to an increase in costs per 1 hectare by 1,559 and 3,543 rubles, respectively. An increase in the seeding rate was also accompanied by an increase in costs. The use of herbicides did not lead to a significant change in the cost of grain, but the additional use of nitrogen fertilizer led to its growth. The level of profitability in the version with the use of a tank mixture of herbicides coincided with the option without the use of chemicals (113.1%). The application of nitrogen fertilizer reduced profitability to 81.5% despite the fact that their use was justified by an increase in grain yield. Thus, when considering specific options for the cultivation of bare barley, sowing on May 14-18 with a rate of 4.5 million viable seeds per hectare while using the Puma Super 7.5 herbicides tank mixture, EMV (0.9 l/ha) and Turbo Pruner, MD (75 ml/ha) should be allocated.

1. Introduction
Grain is of strategic importance and is the basis of the country’s food security. Barley can be distinguished among the main grain crops of Russia. In a number of regions, particularly in the Southern Urals [1], Northern Trans-Urals [2], and Novosibirsk region [3], the spread of bare barley is hampered by the possibility of reducing its productivity compared with foamed barley, first of all. With the creation of new varieties of bare forms, the differences in yield are smoothed out [4-6]. At the same time, it is generally accepted that bare barley is superior to filmy barley in terms of the protein, starch, fat, and β-glucanate content [7].

At present, the efficiency of agricultural production largely depends on the choice of its production technology [8]. Thus, at the current level of prices for grain, fertilizers, and pesticides, there is a need...
to develop a technology for the cultivation of crops, including bare barley, which would ensure high economic efficiency of production.

2. Materials and Methods

In 2011-2014, in the teaching and experimental field of the T&E farm of the Omsk State Agrarian University named after P. A. Stolypin, an assessment of the elements of the cultivation of bare barley varieties of the Omsk Golozornyy 2 was carried out. The teaching and experimental field is located on the soil (meadow-chernozem, medium-power, low-humus, medium loamy) in the southern forest-steppe of Western Siberia.

The crops were located in a crop rotation with the scheme: clean steam – wheat – wheat – barley. The three-factor experience included:

Three chemical backgrounds:
1) Without chemicals (0);
2) Herbicides Puma Super 7.5, EMV - 0.9 l/ha and Turbo Pruner, MD – 75 ml / ha (G);
3) Herbicides + fertilizers at the rate of N60 (G + U).

Three sowing times:
1) May 14–18;
2) May 25–28;
3) 4–6 June.

Three seeding rates:
1) 3.5 million germinating grains per hectare;
2) 4.5 million germinating grains per hectare;
3) 5.5 million germinating seeds per hectare.

The flow rate of the working fluid in the processing of crops with herbicides is 200 l/ha.

3. Results

The formed yield level of bare barley in the variants of the experiment allowed to get the results on the following indicators of economic efficiency: cost of grain (Table 1), costs (Table 2), cost of barley grain (Table 3), conditional net income (Table 4), and the profitability of production (Table 5).

Table 1. Cost of grain of bare barley (2011-2014), rub./ha.

| Chemical background | Sowing date | Seeding rate | An average chemical background |
|---------------------|-------------|--------------|-------------------------------|
|                     |             | I | II | III | 3.5 | 4.5 | 5.5 |
| O                   | 12540       | 13020 | 11520 | 11780 | 12660 | 12640 | 12360 |
| G                   | 16440       | 15160 | 15160 | 14780 | 16120 | 15860 | 15587 |
| G+U                 | 16960       | 17300 | 16360 | 16140 | 17220 | 17260 | 16873 |
| The average         | 15313       | 15160 | 14317 | 14233 | 15333 | 15253 | 14940 |

Table 2. Costs in the cultivation of bare barley (2011-2014), rub./ha.

| Chemical background | Sowing date | Seeding rate | An average chemical background |
|---------------------|-------------|--------------|-------------------------------|
|                     |             | I | II | III | 3.5 | 4.5 | 5.5 |
| O                   | 5664        | 5842 | 5756 | 5436 | 5671 | 6155 | 5754 |
| G                   | 7392        | 7289 | 7289 | 6933 | 7344 | 7664 | 7313 |
| G+U                 | 9302        | 9321 | 9268 | 8921 | 9317 | 9653 | 9297 |
| The average         | 7443        | 7484 | 7438 | 7097 | 7444 | 7824 | 7455 |
Table 3. The cost of grain of bare barley (2011-2014), rub./t.

| Chemical background | Sowing date | Seeding rate | An average chemical background |
|---------------------|-------------|--------------|-------------------------------|
|                     | I           | II           | III            | 3.5 | 4.5 | 5.5 |                     |
| O                   | 2783        | 2691         | 2998           | 2775 | 2764 | 2932 | 2882              |
| G                   | 2689        | 2884         | 2886           | 2816 | 2738 | 2905 | 2820              |
| G+U                 | 3294        | 3233         | 3400           | 3317 | 3247 | 3362 | 3309              |
| The average         | 2922        | 2936         | 3095           | 2969 | 2916 | 3066 | 2984              |

Table 4. Conditional net income in the cultivation of bare barley (2011-2014), rub./ha.

| Chemical background | Sowing date | Seeding rate | An average chemical background |
|---------------------|-------------|--------------|-------------------------------|
|                     | I           | II           | III            | 3.5 | 4.5 | 5.5 |                     |
| O                   | 6725        | 7178         | 5763           | 6343 | 6839 | 6485 | 6556              |
| G                   | 9078        | 7870         | 7871           | 7847 | 8776 | 8196 | 8273              |
| G+U                 | 7658        | 7979         | 7092           | 7219 | 7903 | 7607 | 7576              |
| The average         | 7820        | 7676         | 6909           | 7136 | 7839 | 7429 | 7468              |

Table 5. Profitability level in the cultivation of bare barley (2011-2014), %.

| Chemical background | Sowing date | Seeding rate | An average chemical background |
|---------------------|-------------|--------------|-------------------------------|
|                     | I           | II           | III            | 3.5 | 4.5 | 5.5 |                     |
| O                   | 115.6       | 123.2        | 100.4          | 116.6 | 117.4 | 105.3 | 113.1              |
| G                   | 123.3       | 108.0        | 108.2          | 113.1 | 119.4 | 106.9 | 113.1              |
| G+U                 | 82.3        | 85.6         | 76.7           | 80.9  | 84.8  | 78.8  | 81.5               |
| The average         | 107.1       | 105.6        | 95.1           | 103.5 | 107.2 | 97.0  | 102.6              |

4. Discussion

Indicators of the grain costs varied depending on the factors studied in the experiment. So, without the use of chemicals and for all seeding rates on average, the cost of grain in the first term was 12,540 rub./ha (Table 1). When sowing a decade later, the cost of grain increased to 13,020 rubles/ha. A similar trend was observed when using herbicides against the introduction of nitrogen fertilizer. The use of only herbicides was more effective in early sowing (16,440 rub./ha). Among the studied seeding rates for all chemical backgrounds, the maximum indicators of grain cost were observed when using 4.5 million viable seeds per hectare (15,333 rub./ha). Depending on the chemical background, differences in the cost of the obtained grain were also observed. So, when using a tank mixture of herbicides, the cost of grain from 1 hectare increased by 3,227 rubles, and when used in combination with fertilizer – by 4,513 rubles without the use of chemicals).

However, strengthening the chemical background led to an increase in costs per 1 hectare, i.e. by 1,559 and 3,543 rubles, respectively (Table 2). An increase in the seeding rate was also accompanied by an increase in costs. Assessing the cost of cultivating bare barley, one should pay attention to their structure. Without the use of chemicals, the share of technological costs was 72.0%, the share of the remaining costs (seeds) was 28.0%. When using herbicides, they consume 15.6% of all costs. Naturally, the share of expenses for seeds (22.1%) and the share of technological costs (62.3%) decreased. Additional costs for the purchase and application of fertilizers amounted to 18.4%, which reduced the share of technological costs to 52.0%, as well as to 17.4% for seeds and 12.2% for herbicides.

The ratio of the cost of grain and costs allows you to judge the cost of production of grain (Table 3). If the use of herbicides did not lead to a significant change in this indicator, the additional use of nitrogen fertilizer led to an increase in the cost of grain, in all cases, including in relation to the
background without the use of chemicals. On average, the chemical background in the variants with the joint use of herbicides and fertilizers, the cost of 1 ton of grain amounted to 3309 rubles, which is higher than the background without the use of chemicals and the background with herbicidal treatment by 427 and 489 rubles, respectively. However, due to the higher cost of the obtained grain, the net income exceeded the control results not only against the background of herbicides (by 1,717 rub./ha), but also when they were combined with fertilizers (by 1,020 rub./ha) (Table 4).

In terms of profitability, the use of a tank mixture of herbicides led to the same level as the option without using chemicals – 113.1% (Table 5). The application of nitrogen fertilizer reduced profitability to 81.5% despite the fact that their use was justified by an increase in grain yield. At the same time, taking into account all chemical backgrounds, sowing at a rate of 4.5 million viable seeds per hectare was more profitable. Among the studied sowing dates, the results of sowing in the second decade of May stood out on this indicator. The profitability in that case was 1.5% higher than the sowing in the third decade of May, as well as 12.0% higher than the profitability of the June sowing period.

5. Conclusion
When considering specific options for cultivating bare barley, sowing on May 14–18 with a rate of 4.5 million germinating grains per hectare against the background of the use of the Puma Super 7.5 herbicide tank mixture, EMV (0.9 l/ha) and Turbo Pruner, MD (75 ml/ha) should be highlighted. Here, the maximum indicators of the profitability level (131.0%) and conditional net income (9,700 rub./ha) were obtained, with a minimum cost of 1 ton of grain being at the level of 2,596 rubles.

References
[1] Gryaznov A A, and Lojkova A V 2010 Bare barley in the Southern Urals (CHGAA)
[2] Yakubyschina L I, Vydrin V V, and Fajzullina G N 2014 Stability of spring barley yield in various areas of the Tyumen region Vestnik GAU of Northern Zauryeye 4(27) pp 30-32
[3] Gomasko S K, Kapinos A I, Stadnik A T, and Stepanenko O Ya 2015 Efficiency of spring barley varieties in the conditions of the forest-steppe of the Novosibirsk Priobye Vestnik NGAU 2(35) pp 25-31
[4] Aniskov N I, and Krolevets S S 2008 Study of naced barley cultivars of the VIR World collection under conditions of the Siberian Irtysh river region Russian Agricultural Science 34 pp 293-295
[5] Bogoviz A, Sandu I, Ryzhenkova N 2018 Scientific basis of innovative development of the agro-industrial complex: The mechanism of public-private partnership in venture capital investment MATEC Web of Conferences 212 07006
[6] Bajkalova L P, and Serebrennikov Yu I 2018 Bare barley and oat in Siberia (KrasGAU)
[7] Newman R K 2009 Barley for food and health – science technology and products (USA)
[8] Bogoviz A V, Bugai Y A, and Minenko A V 2019 Economic analysis of effectiveness of the existing tools of state support for entrepreneurship in the AIC in the digital economy Lecture Notes in Networks and Systems 57 pp 789-794