Optimization of terms and rate of Puma Plus, EC application on spring wheat crops

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Abstract. The data of three-year studies on determination of the optimal terms and rates for the herbicide Puma Plus use, EC on spring wheat crops are presented. The experiments were carried out on meadow-chernozem medium-low-humus medium-loamy soil in the southern forest-steppe of the Omsk region. In the variant without herbicide use, the proportion of weeds in the agrophytocenosis varied over the years from 12.9 to 19.0%, which corresponded to the average degree of infestation. Spraying of wheat crops began with the formation of 2-3 leaves in the culture and continued every 5 days. 20 days after the first period of herbicide application, 2-3 nodes were noted on wheat stalks (a variant with the last treatment period). Three herbicide rates were used – 1.3, 1.4 and 1.5 l/ha. At all treatment periods and herbicide rates, a weak level of contamination was achieved. The share of weeds was in the range of 0.1-5.8 %. Increases in the yield of wheat grain are significant for all terms and rates, which indicates the possibility of using the Puma Plus herbicide, EC from the formation of 2-3 leaves and up to the formation of 2-3 nodes on wheat stalks.

1. Introduction
Back in 1980 G.S. Gruzdev noted that it is necessary to search for preparations destroying the complex of weeds and ensuring the reduction of weediness when they are used in a certain system [1]. When spring wheat crops are weeded with dicotyledonous and meadow grass weed species, it becomes necessary to use herbicides against different groups of weeds and preferably in one pass of the sprayer [2]. In production conditions, different variants of weed species set in crops are possible. Among the meadow grass species, Avena fatua L. [3] often prevails, and in recent years Panicum miliaceum ruderale (Kitag.) Tzvel. [4]. Among the dicotyledonous species, the perennial soboliferous – Sonchus arvensis L., Cirsium setosum Bess., Convolvulus arvensis L., Euphorbia waldsteinii Czer. [5], are particularly dangerous.

Researchers suggest different combinations of herbicides in grain crops. For example, in wheat crops, a mixture of agroxon + iaren Pro + Puma Super 100 [6] or Elant + Puma Super 100 [7] is proposed for use. The need for a combination of dicotyctides and graminicides was noted not only on wheat, but also on hulless barley [8,9]. At the same time, it should also not be forgotten that the adaptive capabilities of weeds are great, so it is necessary to periodically change the system of measures to protect crops from weeds [10].

The aim of this work was to determine the possibility of using the herbicide Puma Plus, EC, acting against both meadow grass and dicotyledonous weed plants, in spring soft wheat crops.

Tasks:
- to determine the possible period of use of the herbicide Puma Plus, EC
- to set the optimal rate of preparation consumption.

2. Materials and methods
The experiments were conducted in 2016-2018 at the training and experimental field of the Omsk SAU, located in the southern forest-steppe of the Omsk region. The soil of the experimental site is meadow-chernozem medium-thick low-humus medium-loamy. Crops of wheat of the OmGAU 90 variety with a seeding rate of 4.5 million germinating grains per hectare were in the second crop after pure steam without the use of herbicides on the first crop. In the spring, when the physical ripeness of the soil was reached, in order to close the moisture, BZSS-1.0 was harrowed in two tracks to a depth of 3-4 cm. Pre-sowing cultivation was carried out on the day of KPS-4 sowing to the depth of seeds sowing. Sowing with a disc seeder (La Rocca) for 5-6 cm with post-sowing rolling (3 KKSH-6A).

Accounting of seed yield was carried out in the phase of full ripeness of the crop by a SAMPO combine (CCP FSBEI HE Omsk SAU "Selection and seed production of field crops").

The study of the effect of the herbicide Puma Plus, EC on the weediness and yield of spring wheat was carried out in a two-factor field experiment.

Factor A - crop treatment period:
- 2-3 leaves of wheat
- + 5 days
- + 10 days
- + 15 days
- + 20 days (2-3 nodes on wheat stalks)

Factor B – preparation consumption rate:
- 1.3 l/ha
- 1.4 l/ha
- 1.5 l/ha

The flow rate of the working fluid is 200 l/ha. Repetition in the experiment is three times, the area of the plot is 20 m² (2X10).

3. Results and discussion
In wheat crops, a type of weediness was formed with a predominance of juvenile late-spring species. Among the dicotyledonous Amaranthus retroflexus L., and Panicum miliaceum ruderale (Kitag.) Tzvel. and Echinochloa crus-galli L. of the meadow grass. Isolated specimens of Chenopodium album L., Erodium cicutarium L., and Convolvulus arvensis L. were recorded.

The share of the weed component in the agrophytocenosis averaged 16.0%, with fluctuations over the years from 12.9 to 19.0% (Table 1), which corresponded to the average degree of weediness [11].

With all the terms and rates of the Puma Plus herbicide use, EC the level of weediness in all years of observation was weak. The share of weeds ranged from 0.1 to 5.8%. At the same time, it can be noted that this indicator tends to decrease with an increase in the rate of herbicide application. The minimum values were observed during treatment 10 and 15 days after the first term, which corresponded to the tillage phase and the beginning of wheat leaf-tube formation.

When comparing the rates of the herbicide use, on average for all periods, the values of the share of weeds in the agrophytocenosis are close – from 1.4% at the preparation use rate 1.3 l/ha, to 0.8% at the consumption rate of 1.5 l/ha.

| Treatment period | Rate, l/ha | Years | average |
|------------------|------------|-------|---------|
| Control          | 0          | 12.9  | 19.0    | 16.0    |
| 2-3 leaves of wheat | 1.3       | 5.8   | 1.6     | 0.7     | 2.7     |
|                  | 1.4       | 4.0   | 1.0     | 0.7     | 1.9     |

Table 1. The share of weeds in the agrophytocenosis of wheat, depending on the treatment period and consumption rate of Puma Plus, EC, %
The yield of wheat grain in the control variant varied over the years from 1.24 to 2.80 t/ha (Table 2). Changes in the value of the yield index are primarily associated with weather conditions during the years of experiments. The use of the herbicide Puma Plus, EC provided significant increases in all treatment periods for all tested rates.

**Table 2.** Wheat grain yield depending on the treatment period and the rate of Puma Plus, EC, t/ha.

| Treatment period (A) | Rate, l/ha (B) | 2016 | 2017 | 2018 | average |
|---------------------|---------------|------|------|------|---------|
| Control             | 0             | 1.31 | 2.80 | 1.24 | 1.78    |
|                     | 1.3           | 1.90 | 3.87 | 1.67 | 2.48    |
| 2-3 leaves of wheat | 1.4           | 2.27 | 4.04 | 1.80 | 2.70    |
|                     | 1.5           | 1.72 | 3.94 | 1.75 | 2.47    |
| average             |               | 1.96 | 3.95 | 1.74 | 2.55    |
| + 5 days            | 1.3           | 1.93 | 3.87 | 1.72 | 2.51    |
|                     | 1.4           | 2.09 | 3.95 | 1.82 | 2.62    |
|                     | 1.5           | 1.85 | 3.83 | 1.70 | 2.46    |
| average             |               | 1.96 | 3.88 | 1.75 | 2.53    |
| +10 days            | 1.4           | 2.23 | 4.15 | 1.75 | 2.71    |
|                     | 1.5           | 2.12 | 3.88 | 1.66 | 2.55    |
| average             |               | 2.08 | 3.90 | 1.68 | 2.55    |
| + 15 days           | 1.4           | 2.01 | 3.99 | 1.67 | 2.56    |
|                     | 1.5           | 1.99 | 3.88 | 1.64 | 2.50    |
| average             |               | 1.94 | 3.85 | 1.62 | 2.47    |
| +20 days            | 1.4           | 2.14 | 3.58 | 1.50 | 2.41    |
|                     | 1.5           | 2.11 | 3.45 | 1.52 | 2.36    |
| average             |               | 1.94 | 3.57 | 1.48 | 2.33    |
| LSD₀.₀ five differences | 0.28 | 0.08 | 0.19 |
| factor A            | 0.16          | 0.12 | 0.11 |
| factor B            | 0.12          | 0.04 | 0.08 |

The presence of the antidote mefenpyr-diethyl in the composition of the preparation apparently contributed to the protection of wheat plants and ensured their good development with a wide range of processing periods. In practice, this is an important point, since weather conditions in the southern...
forest-steppe, and in other areas of Western Siberia, often do not allow herbicide treatment in the optimal phase of crop development – tillage. From the applied herbicide rates, on average for all treatment periods, the highest grain yield was obtained from the use of 1.4 l/ha – 2.60 t/ha. Both a decrease and an increase in the Puma Plus, EC rates led to a decrease in grain harvest to 2.39 and 2.47 t/ha, respectively. Ultimately, the possibility of using Puma Plus, EC is determined by economic feasibility. The high level of costs for the use of the herbicide turned out to be beneficial when using the preparation with a rate of 1.4 l/ha (Table 3).

**Table 3.** The economic efficiency of the Puma Plus, EC application.

| Indicator                        | Control (without herbicide) | 1.3  | 2.60 | 2.47 |
|----------------------------------|-----------------------------|------|------|------|
| Grain yield, t/ha                | 1.78                        | 2.39 | 2.60 | 2.47 |
| Material and monetary costs, rub/ha | 6425.9                      | 8958.8 | 9179.0 | 9709.9 |
| Grain cost, rub/t                | 3610.0                      | 3748.5 | 3530.4 | 3931.1 |
| Cost of production, rub/ha       | 14240                       | 19120 | 20800 | 19760 |
| Net income, rub/ha               | 7814.1                      | 10161.2 | 11621.0 | 10050.1 |
| Level of profitability, %        | 121.6                       | 113.4 | 126.6 | 103.5 |

The cost of 1 ton of wheat grain in this case was lower than in the control by 79.6 rubles, net income increased by 3806.9 rubles/ha, and the level of profitability by 5%. Both the decrease and the increase in the rate of Puma Plus, EC application reduced the level of profitability by 8.2-18.1 %, although the net income from 1 ha was higher than the control option.

4. Conclusions

The use of the Puma Plus, EC herbicide on spring wheat crops is possible in the period from the formation of 2-3 leaves and to the formation of 2-3 nodes on the stem of the crop with an optimal rate of preparation consumption 1.4 l/ha. At the same time, the weediness of crops decreases to a weak level, and the crop yield increases.

References

[1] Gruzdev G S 1980 *Chemical protection of plants* (M: Kolos)
[2] Ledovsky E N 2013 *Efficiency of application of herbicide and fungicide treatment systems in four-field grain-steam crop rotation in the southern forest-steppe of Western Siberia* (Omsk)
[3] Rendov N A 2008 *Reproduction of soil fertility and biologization of agriculture in the forest-steppe zone of Western Siberia* (Omsk: PPC "Sfera")
[4] Krasavin V D 2002 *Weed millet and its relationship with seed millet* (Orenburg: Research Institute of Rural Economy)
[5] Plant protection system in resource-saving technologies 2011 (Kurtamysh: SUI "Kurtamysh Printing House")
[6] Doronin V G and Ledovsky E N 2012 *Improving the efficiency of soil protection of resource-saving farming systems* (Omsk) pp 131-134
[7] Nemchenko V V, Filippov A S and Tsypyshev A I 2012 *Improving the efficiency of soil protection of resource-saving farming systems* (Omsk) pp 114-119
[8] Gladkich A, Rendov N, Nekrasova E and Mozyleva S 2019 *The Fifth Technological Order: Prospects for the Development and Modernization of the Russian Agro-Industrial Sector* 393
[9] Rendov N, Gladkikh A and Nekrasova E 2019 The influence of the cultivation technology elements on the economic performance of the bare barley grain production IOP Conference Series: Earth and Environmental Science 395

[10] Dudkin I V 2012 Improving the efficiency of soil protection of resource-saving farming systems (Omsk) pp 128-130

[11] Milashchenko N Z and Neklyudov A F 1981 Bulletin of Agricultural science 1 pp 8-16