Effectiveness of herbicide treatment on pea crops

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Abstract. In the Chuvash Republic, peas are cultivated as a food and feed crop. Great damage to crops caused by weeds. With severe contamination, the reduction in grain yield in farms is 35-50 %. In order to obtain high yields of pea grain, experiments were conducted with the use of herbicides. The article discusses the research conducted in 2018-2020 on the effectiveness of a two-component herbicide Korsar Super normal 1.2 l/ha in phase 4-5 leaves of a cropper and the early phases of development of weeds in crops of pea varieties Spartak in the southern part of the Volga-Vyatka region of Russia. During the fieldwork experience in the Chuvash Research Agricultural Institute – Branch of “Federal Agricultural Research Centre of the North-East named N.V. Rudnitsky” on loamy gray forest soil, the use of herbicide treatment led to a significant reduction in the number of weeds in biological effectiveness 84.2 %. It provided a reliable grain increase of 0.9 t/ha. At the same time, the level of profitability of grain production made averaged 33 % in 2018-2020.

1. Introduction

Leguminous crops are of great economic importance in the agricultural production of Russia. They are an essential source of protein for human nutrition and animal feeding. The most common legume crop in the Republic of Chuvashia is peas, the acreage of which is constantly increasing. The soil and climatic conditions of the republic are favorable for the vegetation and production process of peas. Peas simultaneously solve three tasks: increase grain production, provide production with high-protein feed, enrich the soil with nitrogen at the expense of atmospheric nitrogen and thereby increase its fertility. With proper agricultural techniques, peas produce high and stable yields, and in favorable weather conditions, advanced farms receive pea grains at 35-40 c/ha [1].

A high culture of agriculture is a necessary condition for increasing the yield of any agricultural crop. One of the most important reserves for increasing the productivity of agricultural crops is the clearing of weeds from the fields. Weeds are a permanent component in pea crops. With a high number, they reduce the yield, and make it difficult to perform many types of fieldwork, including harvesting [2].

Having a high genetic yield potential, peas need protection from weeds, which are becoming increasingly difficult to control due to the emergence of resistant species. About 30 % of all growing costs are spent on weed control. By reducing the crop yield, weeds degrade its quality by using nutrients and soil moisture. The use of herbicides on agricultural crops is essentially the only effective means of controlling weeds, preventing crop losses [3]. The peculiarity of pea cultivation is that its crops are subject to clogging both in the early stages of development due to the slow initial growth of the crop, and during the harvest period. Comprehensive protection of crops from weeds, which is an integral part
of the cultivation technology that forms the yield of peas, within the framework of economically and environmentally sound land use. It includes all agrotechnical measures to increase the competitiveness of peas and reduce field pollution, from crop rotation, tillage, selection of varieties, fertilization to mechanical control and application of herbicides. [4].

In the conditions of the Chuvash Republic, the effectiveness of herbicides in the cultivation of peas is currently insufficiently studied. When using herbicides, it is first necessary to find out what types of weeds are present or may appear on the field in the near future. Repeated application of herbicides with the same mechanism of action contributes to the spread of certain resistant weed species. To improve the technology of crop cultivation, new experimental data on the effect of modern herbicides on the phytosanitary condition of crops and the productivity of grain crops are needed [5].

The purpose of our three-year research was to study the effect of the herbicide Korsar Super on the growth, development, and productivity of pea plants of the Spartak seed variety when grown in the conditions of the Chuvash Republic.

2. Materials and methods

The place of the experience layout: the experimental field of the Chuvash Research Institute of Agriculture. The study was conducted by laying production experience on dark gray forest soil. The effect of the herbicide Korsar Super, IBS with a dose of 1.2 l/ha against weeds was studied in comparison with the control variant without this treatment. The experiments were based on seedgrowing crops of Spartak peas. The treatment was carried out in the phase of 4-5 leaves of the crop and in the early stages of weed development. Post-emergence two-component herbicide Korsar Super, VRK (contains bentazone, 400 g/l + imazamox, 25 g/l) has a wide spectrum of action against annual cereal and dicotyledonous weeds, inhibits the development of perennials.

The variety of pea Spartacus (morphological type chameleon) was obtained by crossing the heterophyll line Az-23 with a vegetable (wrinkled seeds) leaf sample of San Cipriano (Italy). The Spartak variety has a high yield potential, which is most fully realized under favorable growing conditions [6].

During the experiment followed the principle of the only differences is the identity predecessor, soil fertility experience, in addition to study the economic potential of the variety. The equality of conditions for both options is met. The terrain and soil fertility were equalized, the placement was based on a single predecessor, the same types and doses of fertilizers, soil treatment and seeds were used. In the experiment, simultaneous sowing of seeds with high sowing qualities, one year of cultivation, was carried out. The agrotechnical background in the production test corresponded to the southern part of the Volga-Vyatka region. Geomorphology of the territory-the area is located in the North-Eastern part of the Volga upland, called the Chuvash plateau. The relief is weakly slope of the South-Eastern exposure. The elevation above sea level is 110 m. the coordinates of the center of the Tsivilsky district can be considered 55°49' s. w. and 47°29' w. d. [7]. The soil of the experimental site is gray forest heavy loamy with a humus content of 4.6, a neutral reaction of the soil solution – 6.1, and an increased content of mobile phosphorus and exchangeable potassium [8].

Methods of observations and records in the experiment: phenological observations, biometric analysis of plant samples, crop accounting and mathematical data processing were carried out according to generally accepted methods [9, 10, 11]. The calculation of economic efficiency is made on the basis of standard technological maps, as well as on the basis of the actual price level for material and technical resources and agricultural products, which has developed over the years of research.

The predecessor is potatoes. The main tillage was carried out in the third decade of September of the previous year with the KOS-3.0 aggregate. In the spring at the end of April, the field was harrowed in order to close the moisture with a trailed wide-reach harrow BPSh-15. The cultivator Spider-6 carried out pre-treatment in early May. Sow peas varieties Spartak reproductions super elite seeder SZ-3.6 a rolling on 4-8 May, the seeding depth of 6-8 cm. The seeding rate is 1.4 million grains per hectare or in weight terms 340-360 kg/ha.
Weather conditions in the years of research differed in the temperature regime and the amount of precipitation during the growing season. According to the conditions of humidification, 2018 was classified as arid (SCC = 0.68), 2019 and 2020 were moderately warm with a lack of moisture at the beginning of the growing season of plants and with high moisture availability during the maturation phase of the crop. The GTC of the growing season was 1.09 and 1.1, respectively. The sum of active temperatures (∑t> 10 °C) in 2018 was 1782 °C, in 2019 – 2303 °C, in 2020 – 2160 °C from [12].

3. Results
The composition of the weed flora was typical for the crops in this region. At the experimental site, we studied the species composition of weeds, the number of which in the control was 48.2-72.6 pcs./m², dominated by Chenopodium album, Galium aparine, Amaranthus retroflexus, Convolvulus arvensis L. Cereal weeds accounted for about 39.4 %, juvenile and perennial dicotyledonous weeds accounted for on average, 60.6 %. By the time of harvesting, the height of the weeds was 50-58 cm (table 1).

Table 1. Infestation of pea crops by type of weed (before harvesting), pcs./m².

| Weed species                  | Control (without herbicides) | Herbicide treatment |
|-------------------------------|------------------------------|---------------------|
|                               | 2018 | 2019 | 2020   | average   | 2018 | 2019 | 2020   | average   |
| Chenopodium album             | 22.3 | 26.2 | 20.1   | 22.9      | 1.0  | 1.5  | 2.1    | 1.5       |
| Galium aparine                | 17.3 | 8.7  | 8.1    | 11.4      | 7.3  | 0    | 4.0    | 3.8       |
| Amaranthus retroflexus        | 2.7  | 8.3  | 5.3    | 5.4       | 0    | 0    | 0      | 0.0       |
| Echinochloa crus-galli        | 1.6  | 6.5  | 8.4    | 5.5       | 1.0  | 0    | 0      | 0.3       |
| Málva pusilla                 | 1.0  | 8.2  | 2.1    | 3.8       | 0.3  | 0    | 0.2    | 0.2       |
| Sonchus arvensis L.           | 1.0  | 6.3  | 4.2    | 3.8       | 0    | 1.8  | 1.0    | 0.9       |
| Convolvulus arvensis L.       | 2.3  | 8.4  | 5.4    | 5.4       | 0.5  | 4.6  | 2.3    | 2.5       |
| Total                         | 48.2 | 72.6 | 53.6   | 58.2      | 10.1 | 7.9  | 9.6    | 9.2       |

According to the results of taking into account the infestation for 2018-2020 of pea crops before harvesting, it was found that herbicide treatment reduced the number of weed components in relation to the control by 4.8-9.1 times, which amounted to an average of 49 pcs./m². It was found that the drug Korsar Super effective against annual cotyledons and cereals, as well as some perennial weeds. Most of the approved drugs, as a rule, do not have a negative effect on peas. The herbicide Korsar Super over the years of research also showed no signs of phytotoxic action. In general, it was found that the studied herbicide has a large selective effect on the protected pea plants. The herbicide did not adversely affect the field germination of pea seeds, the growth and development of plants during the entire growing season and did not cause leaf burns.

In the years of research, the herbicide Korsar Super had a strong toxic effect in the crop protection system during the entire growing season on both dicotyledonous and cereal weeds. The total contamination of pea crops of the Spartak variety before harvesting decreased by 80-84.2 %.

Yield is the final parameter of plant development, reflecting the intensity of growth and productive processes during the growing season [4]. Biometric analysis of a sheaf of peas showed that in terms of
plant height, the number of beans per plant, the number of grains in a bean and the weight of seeds per plant, there were no significant differences between the variants. The increase in yield was due to the number of plants per square meter before harvesting. Reduced competition from weeds during herbicide treatment contributed to the growth and development of cultivated plants, resulting in a high yield of pea grain – 2.73 t/ha (table 2). A significant increase compared to the control was 0.9 t/ha (with an NSR0.5 of 0.6 t/ha). The economic efficiency of the use of the herbicide Corsar Super on pea crops was 51%.

Table 2. Structure of the pea crop.

| Option                          | Number of plants before harvesting, pcs/m² | Weight of 1000 grains, g | Yield, t/ha |
|---------------------------------|--------------------------------------------|--------------------------|-------------|
| Control (without herbicides)    | 123                                        | 249.23                   | 1.81        |
| Herbicide treatment             | 134                                        | 279.37                   | 2.73        |
| Difference                      | 11                                         | 30.14                    | 0.92        |

As a result of calculating the economic efficiency in the pea protection system, it was revealed that with herbicide treatment relative to control in the conditions of 2018-2020, with an increase in yield by 9.2 t/ha, the cost of pea grain decreased by 208 rubles/c, and the profitability increased by 34%.

4. Conclusion
According to the results of research in 2018-2020 on gray-forest soils of the southern part of the Volga Vyatka region of Russia, it is advisable to use the herbicide Korsar Super at a rate of 1.2 l/ha to increase the grain yield of field peas of the Spartak variety to 0.9 t/ha. Carrying out protective measures is recommended in the phase of 4-5 leaves of the crop and the early stages of weed development. Biological efficiency is 84.2%, economic efficiency is 51%, and profitability is 74%.

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