Advanced technology for the removal of trees and shrubs on the berms of irrigation canals using the oppression of stumps with chemicals

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Abstract. The introduction discusses the relevance and significance of the irrigation canal problem related to the growth and removal of shrub and tree vegetation on the berm and in the bed of the irrigation canal. A number of main problems of shrub and tree vegetation growth on the berm and in the canal bed are described. The presented images show the state of irrigation canals of the Engels branch of the Federal state budgetary institution "Saratovregiongaz". The research methodology includes a description of the main methods of studying the problem and its representation in graphical form. The essence of the method for destroying stumps and undergrowth after cutting down tree and shrub vegetation along irrigation canals is described. The results of the study are presented using a theoretical description of the proposed improved technology for removing tree and shrub vegetation on irrigation canals of farms using chemical hemp suppression. The proposed schemes of movement of heavy machinery during cultural and technical work on the removal of tree and shrub vegetation are described. A set of spraying schemes is proposed based on the availability of equipment, the rate of consumption and distance of transportation of arboricide, as well as the form of sprayers. The process of operation of the sprayer on the canals depending on the dead-end part of the berm is presented. In conclusion, a General conclusion is made about the proposed improved technology for removing shrub vegetation using brushcutters and spraying stumps with chemicals, as well as about the practical and theoretical significance of the study.

1. Introduction
Obtaining high and sustainable yields is a top priority for agriculture, but this would not be possible without land reclamation. Water supply structures, called irrigation canals, deliver the required amount of water and meet the necessary standards for watering crops. Each irrigation canal of the irrigation network must be in good condition, respectively, for this purpose, operational and repair measures are carried out to maintain the canal, such as maintenance and cleaning of the canal from tree and shrub vegetation. This is due to the fact that this vegetation, growing uncontrollably on farms and canal slopes, makes it difficult or almost impossible for canal cleaning machines and people to repair damaged lining. Vegetation growing on canal slopes in an earthen canal reduces the capacity of irrigation canals. Accordingly, the research topic is relevant and deserves attentions [1].

The purpose of this article is to improve the technology for removing tree and shrub vegetation on irrigation canal farms using chemical stump suppression.
An important negative consequence is also the leaves and branches falling into the canal, which pollute the water, contributing to its flowering, and increase the amount of sediment and debris in the canal, which in turn negatively affects the operation of pumping stations (figures 1 and 2) [1-3].

![Figure 1. An irrigation canal overgrown with shrubs.](image1)

![Figure 2. Woody vegetation on an irrigation canal.](image2)

Figures 1 and 2 show irrigation canals of the Engels branch of the Federal state budgetary institution "Saratovmeliovodkhoz Management".

The main problem is as follows. After cutting off the tree and shrub vegetation, stumps remain, and it is impractical to uproot them during the operation of the canals, since the uprooting destroys the berm and canal slopes, as well as the lining of the canals in the concrete canal. A year later, the cleared canal is overgrown with young growth from the remaining stumps. Therefore, an urgent task at present is to develop an environmentally safe technology and equipment for processing stumps with arboricides, in order to prevent the growth of overgrowth. Cut shrubs and young growth in traditional technologies of canal operation are burned, which is unacceptable from either an environmental or economic point of view [3-4].

Thus, at the moment it is necessary to develop an effective technology and technical means to suppress the stumps formed after cutting wood and shrub vegetation, and this requires an analysis of existing technologies and designs of sprayers [5].
2. Methods of Research
The study used the method of empirical cognition, which served as a synthesis for the theoretical analysis of literature by the deductive method. The theoretical method included abstracting, summarizing and quoting the general and special scientific works of scientists in this science-intensive field. Mathematical and statistical methods were used to obtain and establish quantitative dependencies between the studied phenomena. The mathematical method involved registering data. The statistical method included determining the average values of the obtained indicators, respectively comparing and obtaining a quantitative or qualitative dependence of the studied process.

3. Results and Discussion
For productive work on the removal of tree and shrub vegetation on engineering and reclamation structures, in particular on irrigation canals, it is necessary to develop an effective technology for the production of works and select a set of machines for it.

The basis for carrying out the work of removing unwanted trees and shrubs is a calendar plan, prepared in accordance with the objective data forecasts and includes basic technological operations removal of trees and shrubs along irrigation canals and related payments needs in cars, arboricide etc [6-7].

The essence of the method for destroying stumps and undergrowth after cutting wood and shrub vegetation along irrigation canals is that the stumps are sprayed with various doses of an arboricide mixture (figure 3), which contributes to their suppression and complete death.

![Figure 3. 1 - brushcutter, 2 - mounted sprayer.](image)

The working fluid sprayers are applied to the treated plants and stumps in a sprayed form, so it is well distributed on the growth surface and on the stumps and shows its toxic properties for a long time.

As a rule, tree and shrub vegetation grows on the canal berm in a lined canal at a distance of 1-4 m from the canal edge (figure 4).

Figure 3 shows the author's diagram of the technological process of cutting shrubs and processing stumps using a mounted sprayer.

The technological process of suppressing stumps and shrubs includes the following operations [8-11]:

- Preparation of the working fluid;
- Transportation to the place of work;
- Filling the sprayer;
- Direct spraying of the stumps on the berms.
Spraying is recommended to be carried out according to four schemes, depending on the availability of equipment, the rate of consumption and distance of transportation of arboricide, the form of sprayers.

The first scheme is the operation of the sprayer without moving to the gas station. This scheme provides for the use of machine complexes in all operations: preparation of the working fluid, its transportation and spraying. Arboricide solution is prepared at mobile or stationary filling stations installed near the water source.

The second scheme is the operation of a spray unit with an entrance to the gas station. When working under the second scheme, unlike the first, tankers are excluded. For refueling, the sprayer drives up to a stationary installation.

According to the third scheme, water is brought to the treated area by tankers; the sprayer drives up to the place of refueling; the arboricide solution is prepared directly in the sprayer container or the mother liquor is prepared in additional containers manually.

According to the fourth scheme, the sprayer drives up to the reservoir for refueling with water; the arboricide solution is prepared in the sprayer tank or the mother liquor is pre-prepared in separate containers. When working under the fourth scheme, unlike the first, tankers are excluded, as well as units and installations for preparing an arboricide solution.

The fourth technological scheme is most suitable for the operation of our sprayer, which is primarily due to the proximity of the water source – the irrigation canal.

By the beginning of the upcoming work, the sprayer should be fully equipped and tested in action. When inspecting sprayers, they check the reliability of fixing the nodes on the machine frame, the technical condition of the hoses, and their connection. Before starting work, it is necessary to clean the site of debris and remnants of woody vegetation. It is necessary to adjust the sprayers and achieve an optimal spray torch (figure 5).

Depending on the stumpiness and the nature of the stump distribution on the canal farms, different schemes of working movements of the sprayer should be used. Figure 6 shows the traffic patterns used on the canals of an open irrigation system.

The process of working according to these schemes with high berm stumpiness is shown in figure 7.

Experience shows that the choice of traffic layout affects the consumption of arboricide, operating time, quality of stump processing and productivity.
Figure 5. Distribution scheme of the spray torch: B-width of spraying; h - height of installation of sprayers; α-spray angle; b-distance between sprayers; C-overlap width; D rasp – diameter of the spray.

4. Conclusion
The theoretical work carried out in this article on the development of technology for cleaning irrigation canals and a sprayer for chemical suppression of stumps and tree and shrub growth has practical and theoretical significance for further development of the topic and direct application of these results on irrigation canals. Thus, we can draw the following conclusions that the developed technology for cleaning irrigation canals from unwanted tree and shrub vegetation is reasonable and can really improve the technological process of cleaning irrigation canals from unwanted vegetation. The essence of the developed technology for the destruction of stumps and undergrowth after cutting wood and shrub vegetation along irrigation canals is that the stumps are sprayed with various doses of an arboricide mixture, which contributes to their suppression and complete death. For more efficient use of machine time, 4 sprayer movement schemes were proposed, depending on the availability of
equipment, the flow rate and distance of transportation of arboricide, as well as the shape of the sprayers themselves.

![Flow diagram of the sprayer depending on the porosity.](image)

**Figure 6.** Flow diagram of the sprayer depending on the porosity.

![Operation of the sprayer on the canals: b1 – distance from the tractor axis to the edge of the canal slope; b2-distance between the axes of movement of the units.](image)

**Figure 7.** Operation of the sprayer on the canals: b1 – distance from the tractor axis to the edge of the canal slope; b2-distance between the axes of movement of the units.

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