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Study of a mobile electric installation for the destruction of permanent rhizous weeds

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Study of a mobile electric installation for the destruction of permanent rhizous weeds

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Abstract. This article presents the results of theoretical and experimental studies on the destruction of perennial rhizomatous weeds using the electric method. The biological features, vegetation, growth and development of weeds humai and pygmy beetle as an object of processing have been studied. The layout of the equipment for the installation for electropulse processing, the procedure for implementing the work process and the results of sexual research are described.

1. Introduction

Cultivation of agricultural crops in the zone of irrigated agriculture is one of the most important conditions for increasing productivity with a decrease in labor intensity is the development of measures for the destruction of weeds and methods for their elimination. The problem is also important because weeds are the focus of most diseases.

To date, a significant part of the cultivated area is littered with weeds, mainly with perennial rhizomes.

Weeds, unlike cultivated plants, develop early than cultivated plants, absorb more moisture and micronutrients. In addition, weeds serve as a hotbed for the development of agricultural pests and diseases, which contributes to their reproduction and spread at all stages of the growing season.

In addition to the above, rhizomatous weeds make it difficult to carry out field work on sown areas, which requires additional costs for weeding, manual and mechanical tillage.

In general, over 20 million per person is spent annually for weeding by hand in Uzbekistan: days [1], or an average of 20-30% of the labor costs of manufactured products [2].

With an average infestation of fields with weeds, 8-10% is lost annually, and with a strong infestation, more than 50% of the grown raw cotton [3].

For this reason, the clearing of acreage from weeds is an important measure.

Particular damage to crop yields is caused by weeds such as humai, pig finger, which are perennial and rhizomatous. Their peculiarity is that they multiply with rhizomes, stems and seeds very intensively.

Agrotechnical, mechanical, chemical, biological and other methods are used to destroy perennial rhizomatous weeds. However, for a number of reasons they do not provide the necessary efficiency, and sometimes sometimes contribute to the reproduction of weeds or harm the environment and living organisms. In this regard, it became necessary to use a more progressive electric method for the destruction of perennial rhizomatous weeds.

The electric method has high efficiency, low energy, time, capital investment, and especially does not pollute the environment, as well as without harmful effects.

In order to achieve the effective destruction of rhizomatous weeds, we have studied the most characteristic features of the growth, development, reproduction and vegetation of perennial weeds, humai and pygmy dorsum, which cause great damage to the yield of sown areas.

Humai (Sorghum halepense (L.) Pers.) or Aleppo sorghum is a perennial grass weed.
The humai stem is straight, up to 1–2 m high, up to 1 cm thick. The leaves are linear-lanceolate, long, 1–2 cm wide, glabrous, serrated at the edges. The first leaf of seedlings is 20–25 mm long and 3–4 mm wide, dark green, glabrous, only finely rough along the edge. Inflorescence panicle up to 40 cm long, sprawling, many spikelets. Spikelets are bisexual, sessile, egg-like, pubescent, with an awn up to 14 mm long.
The root system in the form of a rhizome penetrates the soil to a depth of 80 cm. There are three types of rhizomes: primary, located vertically in the soil, secondary horizontal and tertiary, or spare. Arises in March-May, blooms in July-August, bears fruit in August-October. The maximum fecundity is 8,000 grains. The depth of germination is up to 10–12 cm, segments of rhizomes take root at a depth of up to 30 cm. The viability of seeds in the soil is up to five years. The minimum germination temperature is +10...+12 °C, the optimum temperature is +30...+35 °C. Rhizomes freeze at a temperature of -15 ° C.
Pig fingered - (Cynadon dactylon L.), among rhizomatous weeds in cotton fields, is often and almost everywhere found.
Propagated by seeds and vegetatively. Horizontal and vertical rhizomes extending from their nodes to the surface lie in several tiers, but their bulk is concentrated in the arable layer. Pig finger heavily clogs crops, especially rhizomes. The root system of the pigworm is a mass of nourishing roots that penetrate deep into the soil and penetrate the arable layer in all directions with underground rhizomes with numerous nodes.
Stems branched from the base, ascending or recumbent, shortened, generative-weakly leafy 40-50 cm long, vegetative-well leafy 10-25 cm long. Leaves linear-lanceolate, hard 5-6 cm long, sometimes soft up to 10-15 cm long, glabrous or hairy, light green and bluish. The uvula is ciliated, short. From flowering - a palmate panicle of 3 - 8 spike-shaped twigs. The fruit is an elongated grayish-greenish caryopsis. The mass of 1000 grains is about 1 gram.
The perennial weeds humai and pig finger are distinguished by the fact that they bear fruit many times during their life. They reproduce not only by seeds, but also vegetatively with the help of root offspring, rhizomes and tubers. In rhizomatous weeds, the root system goes deep into the soil, the buds developing on the roots are capable of producing shoots. In these plants, shoots are formed at the places where the root is cut with a rogue or other tools, giving rise to new plants. Often, in the place of cuts of one weed, four to eight shoots are formed.
Especially difficult to eradicate a plant in cotton fields is humai and pig fingered. The bulk of the shoots of these plants reproduce at a depth of 10 - 25 cm. They reproduce by seeds and rhizomes. Rhizomes are underground stems covered with scales (underdeveloped leaves). There are numerous buds on the rhizomes. A small piece of rhizome with a kidney is able to form a new plant. The breeding potential of these weeds is enormous.
Fragile white rhizomes of humai and pygmy finger sometimes come to the surface, crawl in the form of green stems, and then again go into the ground. A dense network of rhizomes creates a continuous cover of sod, it is often used for attachment to irrigation furrows, which contributes to an even more extensive spread of malicious weeds. The rhizomes are highly resistant. Even after drying, falling into moist soil, they are able to take root and form new plants that grow from rhizome buds.

2. Methods
The destruction of rhizomatous weeds of humai and pygmy beetle is difficult for the following reasons:
the root system is deepened by 20 - 25 cm, thanks to which the weed receives nutrition and water even during prolonged drought;
shoots of the plant grow rapidly, form new lateral shoots with a root length of up to 10 m;
the first growth begins to form in March;
the main accumulation of weeds is observed on well-irrigated soils, farmer's fields;
flowering begins in July, fruiting - in mid-October, the most intensive growth - in the first year of appearance
it is difficult to fight this pest, especially the next year after its appearance, when young shoots appear;

• in the absence of actions on the part of farmers, humai and pigs will cover the ground with a dense "carpet", closing the rest of the plantings.

Analysis of theoretical and experimental studies on the application of electrical action on living organisms and plant tissues [4-15], as well as discharges of electric current pulses for processing CMC based on the technology proposed by us, made it possible to formulate the requirements for the design of a mobile setup and electrodes, forming sown areas, which are as follows:

- the design of the mobile unit and the processing electrodes must have high mechanical strength and reliable isolation from leakage of electrical energy to the body of the mobile unit;
- during the period of operation, the electrode system of the installation and the high voltage source must ensure: reliable contact, uniformity of processing and continuous supply of high-voltage electrical impulses of the required parameter.

3. Results and Discussion

To implement the proposed technology for the destruction of KMC, taking into account the above requirements and on the basis of the obtained copyright certificates, on the basis of the existing KTH-2V potato digger (Figure 1), we have manufactured a pilot plant (Figure 2)

Figure 1. General view of the KTN-2V mobile device

In the mobile electrical installation, the frame of the conveyor 7 and the flat cutter of the potato digger were used without structural and technical changes. An articulated movable electrode 4 is additionally mounted to the frame of the potato digger, which is suspended from the insulator and is located at a short distance above the conveyor. At the same time, the adjustment of the distance between the movable electrode 3 and the bar conveyor 7 is provided. For crushing soil lumps and weed tubers, taking into account their better separability, a lump crusher 5 is provided, made in the form of a welded metal drum assembled from rod bars. Behind the clod crusher, a dielectric drum 6 is installed, made in the form of a squirrel wheel, consisting of rod electrodes (Fig. 2), fixed around the entire perimeter of the cylindrical drum.

The lump crusher 5 and the dielectric drum 6 are connected to the drive mechanism by means of a chain transmission. To supply current pulses to the electrodes 6, a spark gap is provided - an intermediate spark gap, which is mounted on an insulator and mounted on the frame of a mobile device.

The electrical installation is hung behind the MTZ-80 tractor coupled with a source of high-voltage impulses. The operation of the electrical installation is carried out as follows: after the arrival of the tractor with the electrical installation into the cultivated field, the installation is lowered to the working position by means of a hydraulic pump, then the PTO of the tractor drives the synchronous generator 2, the drive mechanism, and with it the articulated bar conveyor - sieve, lump crusher and a dielectric drum with rod (electrodes).

After that, the tractor is set in motion, at the same time the source of electrical impulse discharges is turned on. Soil-cutting plowshares cut the soil 25 cm thick. The cut soil, and with it the rhizomes of weeds, enter the bar conveyor - a sieve, where the rhizomes are separated from the soil and subjected to 2-stage exposure to high-voltage pulsed discharge currents.

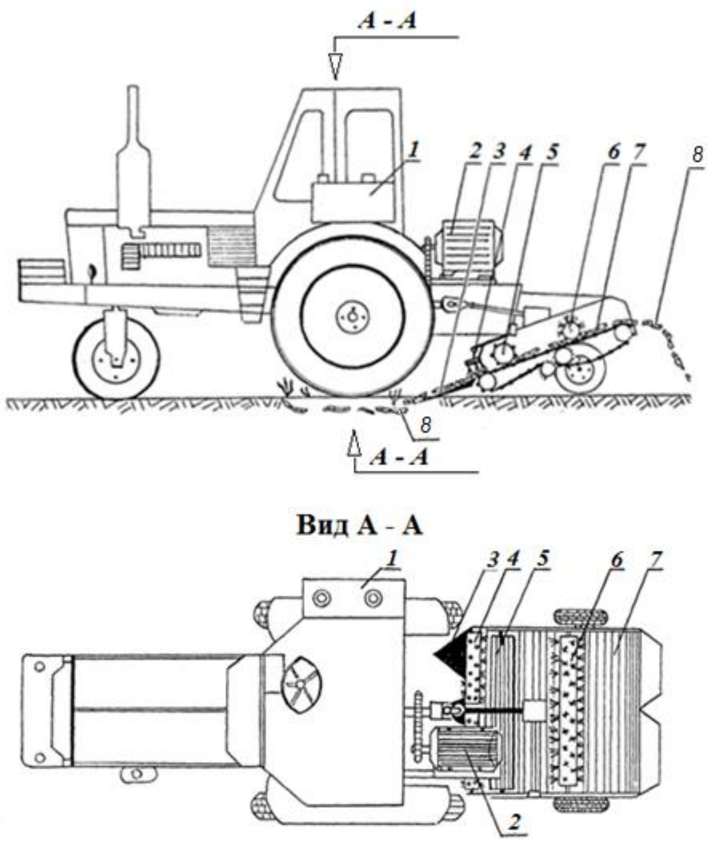

Figure 2. Scheme of a mobile electrical installation

At the first stage of electrical processing, stems with rhizomes of perennial weeds 8 are dug out of the ground with the help of plowshares 3. After that, a sieve is fed to the first tier of the conveyor.

It is separated from the soil and fed into the interelectrode space between the conveyor sieve 7 (negative electrode) and the pivotally movable processing electrode 4 (positively charged electrode).

From the power source of high-voltage discharges, using a high-voltage cable, an electric current is supplied to the spark intermediate of the positive electrode by a pulsed discharge. When the plant material closes the positive electrode 4 with the negative electrode 7, a high-voltage discharge pulse current passes through the weed, which produces microcracks in plant tissues that destroy the cellular structure.

The second stage of processing occurs when the plant material passes into the interelectrode space of the second tier of the conveyor 7 and the rotating positive electrode 6, which consists of a dielectric drum with metal rods.

The processing process takes place as follows: plant material 8 (rhizomes and weed stalks), after passing through the first stage of processing, is fed to the second stage with the help of a conveyor 7 in the interelectrode space 6 to a rotating round electrode consisting of metal rods fixed to a dielectric drum.
The voltage supply to the processing rod electrodes is carried out from the power source through high-voltage cables to the spark intermediate installed on the side of the dielectric drum.
After the primary treatment, weeds are thrown to the ground through the conveyor sieve 7. After processing, the rhizomes and plant residues of weeds can be left on the soil surface or buried.
When the rhizomes of weeds are left on the soil surface, a process of intense drying occurs due to the evaporation of plant moisture in the open air.
When the rhizome is buried in the ground, an irreversible process occurs with the penetration and reproduction of fungal-forming bacteria in the affected tissues, the treated material subsequently causes mold to form, and accelerates the intensity of decomposition.
The results of studies of the field mobile installation are shown in Table 1.

Table 1. Results of field studies of a mobile plant and the degree of damage to weed rhizomes after electric pulse treatment

Types of processing	On the day of processing	10-day after treatment	20-day after treatment	30-day after treatment
	weight/damage, (kg/%)	weight/damage, (kg/%)	weight/damage, (kg/%)	weight/damage, (kg/%)
Control (no treatment)	23.0 / 0	25.3/0	27.1/0	29.2/0
Treated with the first electrode only	23.0 / 0	20.7/13	18.1/21	16.1/30
Treated with the first electrode only	23.0 / 0	19.6/17	16.3/30	14.4/37
Treated with two (passive and active) electrodes	23.0 / 0	18.2/21	14.4/39	11.3/51

The results of field studies established the efficiency of processing a mobile electrical installation and damage to plant tissues after the first passive, second actively rotating and double (passive and actively rotating) electrodes compared with control (not processed) samples. According to the results of Table 1, on day 10, 21% were affected, on day 20, 39% were affected, and on day 30, 51% were affected, which indicates the advantage of processing electrodes of various types.

4. Conclusions

a) The results of theoretical studies have proved the possibility of achieving positive results with the use of high-voltage pulsed current in the destruction of perennial rhizomatous weeds of humai and pygmy dorsum.
b) The main active factor in the damage to the plant tissue of a weed plant is electrical impulses of high voltage current, which excites electro-hydraulic forces that destroy cell membranes.
c) The use of such advanced technology in agriculture makes it possible to increase the efficiency of weed control, clean up the environment and sown areas from potent pesticides, as well as reduce harmful nitrates and chemical elements in the composition of food products and agricultural yields.
d) This technique allows you to save resources, extraordinary treatments, labor time and strength, equipment, as well as various chemicals with all the ensuing negative consequences.

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