THE DEFINITION OF ELECTRO IMPULSES USED IN WEED CONTROL

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Abstract: In modern agriculture the use of chemicals and machines in weed control is not environmental and soil friendly. The use of electro impulses is offered to traditional ways of weed control. The researches done on technical characteristics of such operation and influence of these results on ecology gave picture that the use of electro impulses in weed control is harmless for environment and that is very effective. The basis for the technical project at designing of the electro impulse installation used with standard wheel tractor obtained data about values of electric energy doses that can make damage in various kinds of weeds.

Key words: the electro impulse weeding, an electric energy dose that can cause damage, a vegetative tissue damage rate.

Introduction

The weed control is a very important problem in modern agriculture. For control of undesirable vegetation, various ways of control are used with main objective to destroy weeds and to decrease their number. The traditional mechanical way has high efficiency (up to 70... 95 %), their efficiency can be 100%, but chemicals are very expensive and they are not environmental friendly. In Russia and foreign countries weed control based on weeds’ physical destruction is developed and this way is very safe. Weed control by electric energy is very safe and it reduces the cumulative energy expenses [3].

Electric energy used for weed control can be considered as: 1) the application of pure ecological technologies in agriculture; 2) the attempt of suppression and destruction of the most harmful persistent weeds; 3) the possibility of selective weed control; 4) the introduction of modern systems of the automatic control
and technical realization of developed units (systems of the satellite control of contaminated centers, automatic dispensing of energy etc.).

Many researches in the USA, France, England and USSR were directed toward creation of electro technological installations (LW-5, l’Agrichoc, Erpic, etc.) in weed control and the use of high voltage alternating current. Also the influence of high voltage impulses on weeds was studied, but not so intensively. Comparing these two directions it is possible to ascertain with the confidence, that pulse influence is more perspective, as it demands smaller expenses of energy that affects: on reduction of the applied equipment capacity and therefore on its bulkiness; on decrease in influencing pressure amplitude, and this in turn allows to increase safety of carrying out such works; on expenses of cumulative energy reduction [1, 2, 3, 4].

At the present stage of agricultural machinery development there are no accurately formulated requirements of electro impulse destruction of weeds yet; there is no deep and full explanation of vegetative tissues electro impulse damage process; electric equipment and its modes are not completely investigated; the electro security concept of operation of such installations is not developed; there is no substantiation of the optimum form of an electrode systems surface and a variant of electrode system execution as a whole. In the Volgograd State Agricultural Academy, at the Faculty of agricultural electrification, the researches of an electro impulse cultivation variant are carried out with the further designing of the electro technological unit for the realization of this technological operation in plant growing [2,4].

To receive the best economic indicators in application of electro impulse destruction of weeds, it is necessary to achieve that electro technological operation would be technologically effective, energetically economical and would be carried out by simple and cheap means. Technological efficiency of weeds’ destruction is defined by their vegetative tissues irreversible damage. Power indicators of such operation depend on minimum quantities (doses) of electric energy which are necessary for application, than size of weeds tissue damage and especially root system. A design complexity of the electro technological device and its cost are defined by pressure of processing.

Material and Methods

In 2003 till 2005 the experimental researches were carried out. Electric energy was brought to weeds by one of the listed ways: 1) «a hinged electrode - a plant stalk - a plant root - buried electrode»; 2) «one hinged electrode - a stalk of one plant - a root of the first plant - soil - a root of the second plant - a stalk of other plant - other hinged electrode». Non polarised immersian electrodes in the form of unprofitable clips were used as hinged electrodes, and buried electrodes were made in the form of cores in the length of 20... 25 cm from a corrosion-proof wire in a diameter to 5,0 mm. The generator of impulse pressure (GPP) was collected on the basis of the measuring high-voltage transformer and also the
high-voltage condenser battery was used. The energy of influencing impulses was changed by the regulation of target pressure of the high-voltage transformer at invariable value of accumulating capacity.

The most permanent weeds were exposed to electro impulse influence: a sow-thistle pink (*Cirsium arvense* L.), a field sow-thistle (*Sonchus arvensis* L.), spurge willow (*Euphorbia waldsteinii* L.), Tatar lettuce (*Lactuca tatarica* L.), field bindweed (*Convolvulus arvensis* L.). All weeds were approximately in the same period of the development corresponding to phase «the flowering terminations - the fructification beginnings». It is necessary to notice, that the processing by high voltage impulses was carried out during this period when the weeds had enough resistance on value of vegetative tissues. This circumstance demands the big expenses of energy for destruction of weeds in comparison with their other development phases. But at the same time it is necessary to underline, that the damaging values of energy found in experiments define such doses of influence that will damage the weeds which are in any period of earlier development. Definition of electric energy lethal doses for successful weed control by high voltage impulses series for each plant was carried out. The purpose of these experiments was the search for minimum quantity of electric energy (doses) necessary for damage and destruction of weeds. Every offset of weed plant which was exposed to electric influence was marked by the means of a hinged label and data of that process were registered, and then after one - two weeks the visual supervision was carried out.

In the works devoted to the application of electric energy in weed control [3], the minimum lethal dose of energy was not estimated. For the successful destruction of various kinds of weeds including permanent ones, researchers obviously used overestimated values of pressure during the experiments, they observed cases of processed weed plants’ ignition, rubber rims of electrodes system copying elements and also mechanical destructions of vegetative tissues were reached, and that was accompanied even by the acoustic sound phenomena during the processing. Carrying out of experimental researches by the definition of the minimum values energies of electro impulse effect should influence a choice of processing pressure that will affect overall dimensions of developed installation, its cost and safety in operation.

**Results and Discussion**

At electric influence on plants of a sow-thistle pink (*Cirsium arvense* L.) and a sow-thistle field (*Sonchus arvensis* L.) when the processing current necessarily proceeded on the root system (the first way of electric energy leading), reliable damage and the destruction of weeds subsequent were observed at energy of influence \( W = 140 \ldots 200 \, \text{J} \) and \( W = 100 \ldots 120 \, \text{J} \), amplitude of impulses \( U_0 = 18 \ldots 20 \, \text{kV} \) and frequency \( f = 1 \ldots 2 \, \text{Hz} \) and thus tissues’ damage rate (the relation of
plants tissues’ resistance before the processing by electric impulses and after it) reached values as $S_n = 10...15$ (figure 1). Thus a serious difference between variants with buried electrode (a way 1) and without it (a way 2) is not fixed: damaging dose of energy, both with the earthed electrode and without it was practically identical on value. The root system of the processed weed plants, at considered variants of energy leading to weeds, has been destroyed on depth of 10...19.5 cm (figure 2). It is also necessary to notice, that total values of lethal doses of energy for stalks and root system sites of sow-thistle pink and sow-thistle vegetative tissues, found at laboratory experiments, made a range of values equal from 100 J to 140 J.

Field experiments of weed destruction caused by electro impulses in Tatar lettuce (*Lactuca tatarica* L.) and spurge willow (*Euphorbia waldsteinii* L.) also defined values of electric energy necessary to cause damage in these weed plants. At the same time the power applied on Tatar lettuce made damage $W = 50...80$ J at amplitude of impulses $U_0 = 18...20$ kV, frequency as following $= 1...2$ Hz and vegetative tissue damage rate $S_n = 7...10$, and for reliable damage spurge willow - $W = 600...800$ J, $U_0 = 18...25$ kV, $= 1...2$ Hz, $S_n = 4...6$. It is necessary to notice, that spurge willow plants were in developmental phase known as «flowering - the fructification beginning», this fact can explain the increase of electric energy expenses. Quantity of energy that can cause damage, found in laboratory experiments in Tatar lettuce and spurge willow, reached values of $W = 60...100$ J and $W = 650...1020$ J. The results obtained during the field experiments confirm these conclusions made after laboratory researches that spurge willow vegetative tissues are sensitive to electric influences and for its destruction the higher doses of electric energy are required. During the processing it was visually possible to observe the change of Tatar lettuce stalk color from green to brown, which according to our opinion testifies the beginning of destruction process. The similar reaction of color change was observed while carrying out laboratory tests with samples of this weed plant.
Figure 1. The photo of a sow-thistle pink (Cirsium arvense L.) plants in process of application of electro impulses: a) - prior to the beginning of processing; b) - at once after processing (dimness of external tissues of a stalk below electrode); c) - in 3 days after the processing; d) - in a week after the processing.

Figure 2. Photos after electro impulse application: a) - plants of a sow-thistle pink (Cirsium arvense L.) (in a photo it is visible that the root was damaged on the depth of almost 20 cm); b) - plants of a sow-thistle pink (Cirsium arvense L.) (external tissues dimness of a stalk); c) - plants of a sow-thistle pink (Cirsium arvense L.) (sow-thistle plants are completely damaged, live (dug out a plantation), damages are presented, but it is not a lethal dose); d) - field bindweed (Convolvulus arvensis L.) plants, Tatar lettuce (Lactuca tatarica L.) and a sow-thistle pink (Cirsium arvense L.)
Field experiments of electro impulses’ application on bindweed (*Convolvulus arvensis* L.) have also defined values of necessary electric energy (figure 2). Thus the power consumption on the bindweed was $W = 180...220$ J at amplitude of impulses $U_0 = 18...20$ kV, frequency $= 1...2$ Hz and vegetative tissue damage rate $S_n = 3...4$. It is necessary to notice, that these weed plants are also less sensitive to electric influences and for their destruction, in our opinion, it is required to spend more quantity of electric energy.

Practical interest is also to obtain information about vegetative tissue damage rate of the weed located in natural conditions after application of electric influence. To observe how weeds react to various energy values, the experimental researches were done on Tatar lettuce (*Lactuca tatarica* L.). In this observation some of plants were treated by (plants 7-7) $W_1 = 0$ J and others by (plants 3-3 and 4-4) $W_2 = 202,24$ J; $W_3 = 101,12$ J. The digit contour of skilled installation had following parameters: $k = 3,95$ nF; $L_p 200$ mkGn; $U_0 = 18...20$ kV. The process took a few hours. The results are shown in figure 3.

Tatar lettuce (*Lactuca tatarica* L.) weeds, which were not exposed to electro impulse influence (plants 7-7) had no damage $(S_n = 1,0)$.

Practically right after application the treated weeds started to decrease. There is decrease in humidity (drying) of the damaged tissue, reduction of its electric conductivity or increase of resistance and, hence, damage rate reduction (plants 3-3 and 4-4). Thus the big energy of processing creates higher vegetative tissue damage rate.

It is also necessary to notice, that the more energy of influence is used the closer is tissue damage in treated weed plant.

![Figure 3. The dependence of a Tatar lettuce (*Lactuca tatarica* L.) vegetative tissue damage rate ($S_n$) from the time of electro impulse processing and after.](image-url)
In twelve hours the measurements have shown that the damage rate started to decrease sharply, reaching the value equals to unit. Actually there was a decrease in humidity (drying of completely damaged tissue), reduction of electric conductivity or increase of resistance and, hence, reduction of damage rate.

Conclusion

The observed experiments have shown that the application of electro impulses for destruction of weeds had efficiency up to 96%. At the same time it is necessary to notice, that sleeping kidneys on the root system from depth 10...12 cm started to give shoots after one and a half - two weeks (see figure 2), which a week later appeared on a soil surface. Hence, it is possible to conclude, that electro impulse weeding can suppress weed for one month. The increase of impulses will allow more time.

Literature


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ODREĐIVANJE LETALNE DOZE ELEKTRIČNE ENERGIJE ZA UNIŠTAVANJE KOROVA

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Rezime