Electric pulse treatment of trees as an environmentally friendly mechanism for protection of orchards

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Abstract. This article explains the main diseases of horticultural trees and almonds, which are grown in mountainous and hilly areas. At present, the protection of the environment, especially land and water resources from the effects of various chemical toxins are one of the main problems of world civilization. During the global financial and economic crisis, our country is currently using high-quality land resources, introducing advanced scientific and technical agricultural technologies and growing low-quality crops. Some of the important problems are management and control of land use, improvement of land relations and efficient use of public lands in general. For the cultivation of almond fruit products should use the method of electric pulse processing. Diseases of nematodes attach and settle on the root system of almonds. In the roots of the almond tree, nematodes form swells and bumps, feeding the young seedlings with mineral nutrients and eventually destroying the seedlings. We propose an electric pulse treatment method against nematode diseases of almond roots and obtain the results of electrotechnical experiments. To get the results of this experiment faster, we can clearly see the results of the experiment in the scientific laboratory of the Institute of Plant Protection in the data obtained using an electron microscope when processing the root stems of almond trees infested with nematodes. The use of an electrical impulse device in the cultivation of almond trees and in the fight against nematode diseases arising from its roots has been considered and the results of preliminary studies have been presented.

1. Introduction

The development of environmentally friendly electrotechnical processing equipment, which is energy-saving and highly productive, is a world leader. The growth of energy shortages in the world has increased from 3 ... 5 to 15 ... 30% in the cost of agricultural products over the past decade, and this figure is expected to increase further in the future. In addition, the role of electricity in the overall energy balance will increase. In this regard, electrotechnological processing simultaneously performs the function of control and improvement of product quality, allows the rational use of natural resources and the strengthening of environmental protection. One of the priorities of research is the gradual transition from effective, environmentally hazardous chemical methods in botany to the use of low-energy electrotechnological methods, their practical application in irrigated areas. In this regard, the development of an environmentally friendly electrotechnological method that provides control of nematodes in the roots of damaged vegetable crops is one of the urgent issues [1, 2]. Extensive measures are being taken to save resources in agricultural production of the Republic, to process agricultural crops by environmentally friendly electrotechnological methods. The Action Strategy for

the further development of the Republic of Uzbekistan for 2017-2021, including the "Priorities for Economic Development and Liberalization" [3]. The draft National Strategy for Agricultural Development in Uzbekistan for 2019-2030 has been developed, which includes strategic priorities for agricultural development, directions and key indicators for achieving the goals of the strategy and the implementation mechanism are identified. According to the program of industrial development, by 2020 food crops will be planted on 285.5 thousand hectares of cotton and 50 thousand hectares of grain fields in 2016-2020. The program envisages an increase in the area of melons and potatoes by 1.5 times compared to 2015, and the area of orchards and vineyards by 7% [4]. In performing these tasks, one of the important tasks is to substantiate the parameters of the electric pulse treatment device against nematodes in the damaged plant root.

2. Method

In order to test and evaluate the effectiveness of the high-voltage electric pulse processing device in the field production process, scientific research was conducted on fruit crops in Jarkurgan district of Surkhandarya region. Specialized biologists and agronomists involved in determining nematode-infested areas and disease incidence in manufacturing enterprises were identified. In the first place, almond seedlings infected with nematodes for the first time were examined. For the treatment of diseased almond trees in conjunction with specialists, the damaged roots were identified and it was determined that they were indeed infested with nematode worms. When it was determined that the fruit and almond trees were infested with nematodes, it was found that the leaves of the almond trees had begun to fall off.

This is because the nematode worms located at the root of the seedling feed on the liquid mineral nutrients in the plant’s body. The problem is that as the plant runs out of liquid mineral nutrients, the resulting crops begin to die. While researching we find out that the rootstock of several almond trees infested with nematodes which is shown in Figure 1 [5-7].

Figure 1. Root stem of almond tree infested with nematodes

In the selection of samples to be processed, their vegetation period, stage of development, size, the state of infection with nematode helminthes must be close to each other. The experiments were conducted in the following order:

1. Excavation of diseased plants was carried out in the following order; we select 5 copies of diseased almond plants with similar roots, height and degree of disease from the field and number them with special numbers.

We cover each plant with a polyethylene pellicle (carpet), cut the perimeter of the plant with a shovel to 30x30 cm2, cut the soil in this section without damaging the plant's rootstock and dig it out with a

50 cm deep soil on a polyethylene carpet. We separate the diseased rootstock from the soil and place it on the soil surface. Attach the positive electrode at a distance of 25 cm from the root and body joint of the rootstock using a special clamp. We bury the negative-pole electrode under a ground pile on a polyethylene mat and, using a laboratory mock-up device, process an electrical pulse at a certain level of voltage, at a certain processing time. After processing, this measuring electrode is inserted into the rootstock of the plant and the plant part on which the electrode is mounted is wrapped with polyethylene pellicle to protect it from moisture and water.

The treated soil and rootstock are taken to a pre-prepared special area and numbered. In a separate compartment of the infected clean soil field, pits measuring 30x30x50 were dug and the perimeter wall of the pits was covered with 3 mm polyethylene bags (to prevent disease from outside soil or nematodes from diseased soil to damage the soil in the experimental area). The sample is processed at different voltages at the same time and current discharge, numbered and measured in the above order. The fifth sample is a control sample, which is buried in the fifth pit without any processing, with a measuring electrode installed and the resistance is measured and recorded in a special book.

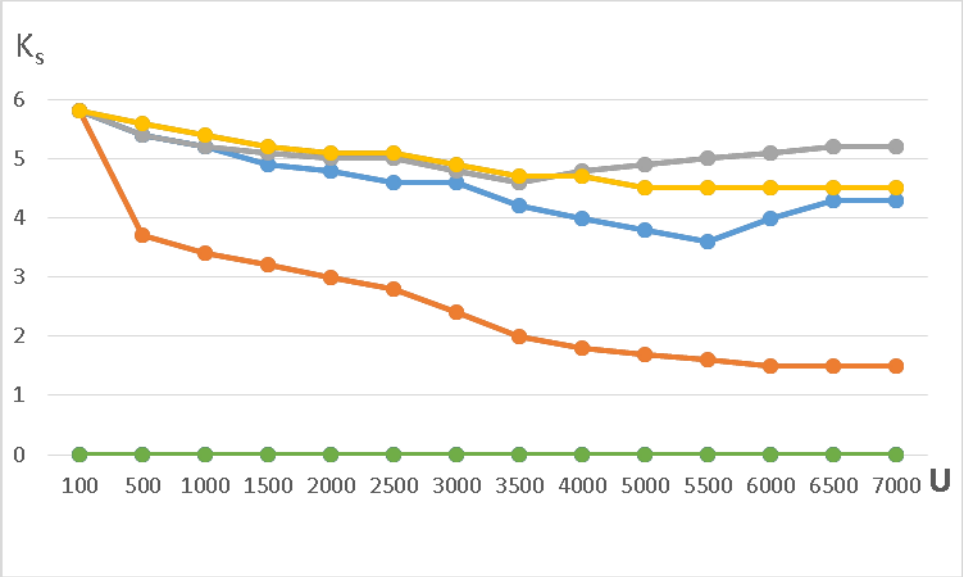
2. The diseased almond plants are dug out without separating them from the soil, treated on a polyethylene bed in the above order, and the rootstock is replanted on a special site with a needle-shaped electrode.

3. Five plants are selected for processing diseased almond plants in the field, similar in size and growth phase to the plants previously tested. The negative sternal electrode of the device with a pulsed discharge is pierced to a depth of 25 cm at a distance of 50 cm from the root stem of the plant. The positive electrode of the device was fastened to the plant stem at a height of 25 cm from the border of the root and stem of the plant (ground) with a special clamp in a position that does not mechanically damage the plant.

For this purpose, a high-voltage pulse discharge device (HVAC) was developed to treat diseased plants in the field. U_1=500, U_2 = 1000, U_3 =2000, U_4 =2500, U_6 =3000, U_7 = 3500, U_8 =4000, U_9 = 4500, U_{10} = 5000, U_{11} = 5500, U_{12} =6000, U_{13} = 6500 and U_{14} =7000 V high-voltage discharges were studied in the processing sequence range. The roots of diseased trees were treated with tension at a time interval of 0.1 to 0.2 seconds. C =470 pF in different capacities during processing of damaged almond trees; C =1000 pF; and C = 1470 pF; C = 2000 pF capacitors were used [4, 6-8]. KVG 2.5 is connected in a high-voltage cable from the primary high-voltage transformer of the high-voltage transformer to the kilovoltmeter (kV), capacitors (C1, C2, C3), lightning gaps (LG1, LG2, LG3) and processing electrodes. The length of the cable is 400 meters, so it should not move away from the processing device, taking into account the length of almond trees planted in the field and their arrangement in rows, and reach from the beginning to the end or to the desired point of the edges.

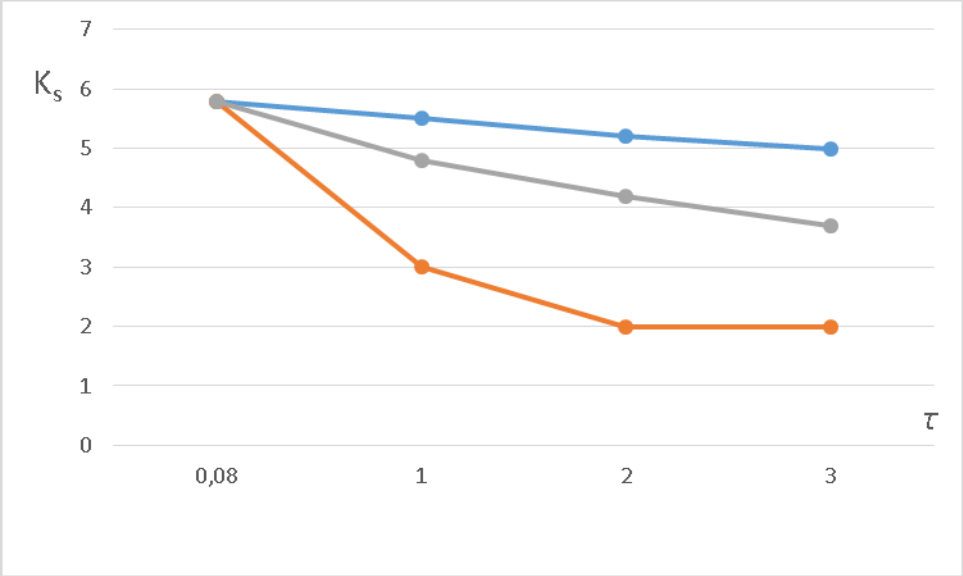
The rootstocks, which were the source of the disease in the treated nematode, were treated with electric pulsed discharges with single-phase electrodes at a height of 25 cm from the ground. The arc-shaped construction of the electrode is to reduce mechanical damage during machining and to reduce the resistance forces exerted by the plant stems during movement. Processes of treatment of diseased plants in the field with the help of high-voltage pulse discharge devices are shown in Picture 2 below [4, 6-10].

The process of electric pulse processing of almond trees is characterized by various factors. One of these is the amount of voltage (U) that generates the pulse discharge, the duration of the pulses (τ), and the time to observe the effect of the pulse processing (T). Graphical and analytical correlations with the survival coefficient K_s, which assessed the effect of the above factors on almond tissue, were identified. The relationship between the processing voltage (U) and the life factor (K_s) was plotted. The results of the study are presented in Figures 2-3. In Figures 2 - 3, research was conducted on three different factors and the optimal values were determined. Three parameters were taken as a factor: capacitor capacity and voltage and processing time. The result was evaluated by K_s survival rate of the plant. When the capacitor capacity was C = 1000 pF, the processing voltage was U = 6000 V, and the processing time was τ = 2 s, the life coefficient was observed between K_s = 1.3-1.9 and the result was achieved.



C1 = 470 pF, C2 = 1000 pF, C3 = 1470 pF, C4 = 2000 pF.

Figure 2. The relationship between processing voltage (U) and survival coefficient (K_s)



U1 = 5000 V, U2 = 6000 V, U3 = 7000 V

Figure 3. Correlation between processing duration (τ) and survival rate (K_s)

From the point of view of the effectiveness of the method of electric pulse treatment, it is necessary to take into account the growth phase of the plant, the degree of disease and soil composition in order to achieve high exposure. Because every diseased almond tree crops should be treated in a timely manner and not to miss the level of their damage.

A single-line electrical connection diagram of an electrical pulse device is shown in Figure 4. Figure 4 uses electricity using an inverter converter via a rechargeable battery or generator (diesel) fuel as the primary source for processing diseased roots in field conditions.

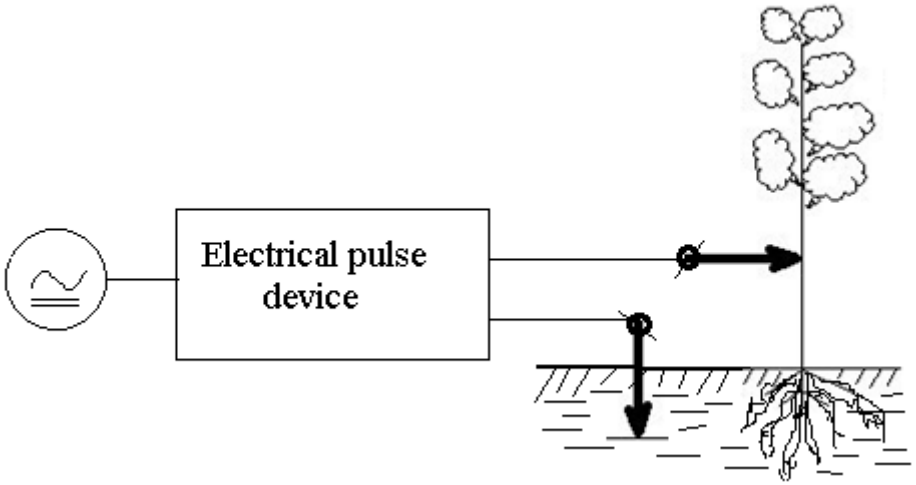


Figure 4. A single line of high voltage electrical pulse device electrical wiring diagram

3. Results and Discussion

During the 10-day post-treatment period, plant rootstocks and nematode pathogens in plants with different control options and processing parameters were studied electro physically.

The aim of the study was to observe the post-treatment of almond trees exposed to nematode grains using a mobile electric pulse device, as well as to study the biological effects of nematodes in worms, grains, cysts and larvae in plants in a manner similar to that described in scientific studies.

That is, a set of plants was selected as the object of control and processing when growing from a single cucumber and tomato plant with growth rate, phase, and location. Sequence numbers for the selected plants according to the method of control and processing were written on paper and placed in a polyethylene bag and tied with string to the stem in such a way that the plant is not mechanically damaged.

The almond trees were treated for 2 seconds in an electric pulse discharge device, bringing the voltage to U=6000 V. In the control variant and in different parameters, nematode worms were isolated from almond root stalks treated with electric pulse discharges. In the treated variants, the size decreased within 1 hour after treatment, and after 3 days, most nematodes were not even measurable, that is, they underwent a process of cellular decay.

Researchers of the Uzbek Institute of Plant Protection PhD. M.Ishonkulova and together with PhD. H. Shukurov showed the results of the experiment in the data obtained using the MBS-3, MBS-6 microscope and the electron microscope "LEICF, DME". An electron microscope control is shown in Figure 5 when the rootstocks of an almond tree infested with nematode are treated.

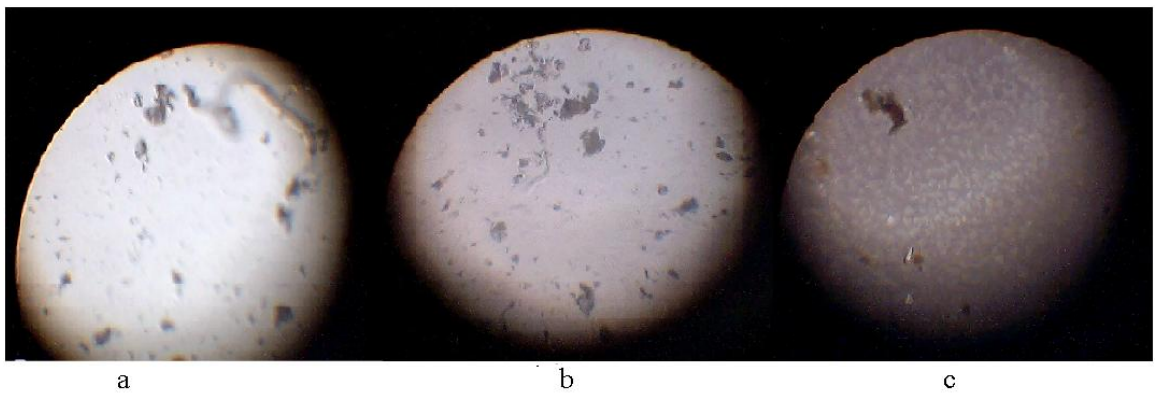


Figure 5. Electron microscopic examination of nematode worms: a - untreated (control), b - appearance after electric pulse treatment, c - condition after 3 days from the date of processing

The mature eggs of nematodes are exposed to high-voltage pulse currents during processing, during which biological and physiological changes occur. Therefore, rootstocks processed under high voltage, under the influence of the electrohydraulic force of the voltage, micro-holes are formed, from which the liquid flows and after a certain time dries out, and the process of decay takes place underground.
According to the results of agrotechnical studies, the control variant of nematode pathogens and larvae (in the greenhouse compartments) treated with electrical pulse discharges showed a decrease of 85-95% compared to the uncultivated plots. According to the results of re-examinations of crops during the spring or autumn period for the second growing season, the amount of nematode worms in the soil was 5-15%.
We treated the almond tree, which was the source of the disease in the treated nematode, using electric pulsed discharges. Processing parameters were evaluated by biologists and agronomists. The results obtained confirmed the parameters determined during laboratory studies. The results were presented in Table 1.

Table 1. Results of electrical pulse treatment on damaged almond tree

Experiment	Voltage value	Processing time, sec	Processing capacity, pF	Harmless rate,%
Control	-	-	-	-
1	5000	1	300	25
2	5500	1	470	28
3	6000	1	1000	33
4	6500	1	1470	30
5	7000	1	2000	25
6	5000	2	300	35
7	5500	2	470	40
8	6000	2	1000	85
9	6500	2	1470	60
10	7000	2	2000	49
11	5000	3	300	25
12	5500	3	470	30
13	6000	3	1000	45
14	6500	3	1470	40
15	7000	3	2000	35

This result is explained by the fact that the larvae and adult worms that are dormant in the soil cysts during processing in the device of electric pulse discharges are away from the treated root stalks or away from the channels through which electric current discharges.
According to the results of scientific research, in order to achieve high efficiency in processing, it is advisable to repeat the process of electric pulse processing on rootstocks for at least two seasons.

4. Conclusion

Scientific studies have shown that electrical pulse treatment of diseased fruit and almond trees can be used to supply electricity through inverter converters using a rechargeable battery and using liquid fuel (diesel) generators. We believe that the use of electric discharge in the fight against worms and viruses is expedient and environmentally friendly. If the processing parameters are chosen correctly, sufficient efficiency can be achieved in the fight against nematode worms.

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