ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 12, Issue 2, February 2025

Electrophysical Methods of Control Against Plant Diseases

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ABSTRACT: This article analyzes the available methods of combating diseases in plants. Among the methods of electrophysical combat, information on processing with high-voltage alternating current, ultra-high voltage frequency, and high-voltage electropulse current discharge methods is presented.

KEY WORDS: Plant, disease, energy, resource efficient, electrophysical, ecologically clean, nematode, ultra-high voltage frequency, electroimpulse.

I.INTRODUCTION

In the world, the development of environmentally friendly electrotechnological processing devices with high efficiency and energy efficiency is taking a leading place. Nematode cells are the longest living multicellular organisms worldwide. The number of nematodes in the composition of the soil can exceed 1 million per 1 m3 area, plays a key role in the ecosystem" [1], the development of high-quality and productive and energy-saving devices for processing plant roots is considered an important task. At the same time great attention is paid to the development of ecologically clean electrotechnological devices that ensure the fight against the nematode of vegetable-poly crops.
Diseased cultivated plants and infested weeds and their rhizomes present several favorable situations when treated by electrical methods. For example, not to further soften the soil, not to disturb the composition of the soil, to maintain soil moisture, and to use mechanical methods [2, 3, 4]. The electric method can be processed in any weather [5, 6, 7, 8], this method does not depend on the climate, and the main thing is that the electric method is very easy and environmentally friendly (it does not damage the atmosphere of the environment) [9, 10, 11, 12, 13, 14, 15, 16].

II. SIGNIFICANCE OF THE SYSTEM

The article focuses on how electropulse treatment can be used for plant disease control to kill pests in the root and soil parts of the plant. The study of literature survey is presented in section III, Methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and Conclusion.

III. LITERATURE SURVEY

Currently, after the prohibition of treating plants with chemical preparations, the use of the electric method against root residues is gaining great importance.
It took a lot of work and research to put this method into practice. The equipment had low production capacity and required a lot of money in its creation and implementation. According to the researchers, these factors prevented the widespread use of this method [17].
Only in the 70s, due to the growth of the electrical engineering industry, the discovery and introduction of new tools and electrotechnical devices and electrotechnical tools, the treatment of root residues with electric methods began to be of great importance.
Currently, the electric method is carried out as a warning (disease prevention) and mass extermination method. For example, the available control methods against nematode diseases are shown in Fig. 1.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 12, Issue 2, February 2025

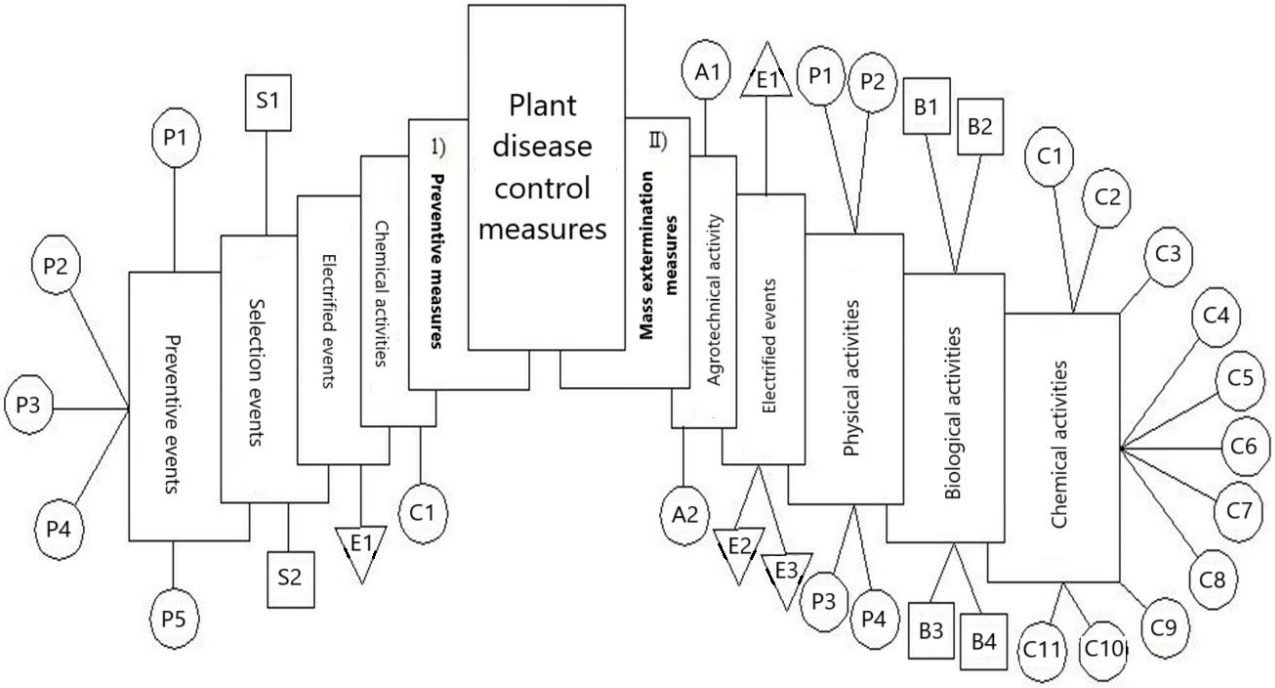

Fig 1. Current methods of control of nematode diseases.

Markings given in the picture: I) Preventive measures: P1-removal of weeds, P2-growing of healthy seedlings, P3-provision of work tools, P4-special devices for treatment, P5-observance of cleanliness; S1–creation of new varieties, S2–seed processing and separation of seeds using the device; C1–chemicals that destroy weeds and diseases; E1–sorting of seeds before planting. II) Mass extermination measures: A1-rotation, A2-tillage; P1–covering with paper or polyethylene films (plastic mulching), P2–using electric current (ultraviolet, ultrasound), P3–use of laser rays, P4–boiling water; C1-dazomet, C2-DD, C3-bromomethyl, C4-DDB, C5-triazone, C6-ammonia nitrate, C7-super phosphate, C8-oxymethyl, C9-heteraphos, C10-nemacur, C11-vidate; B1–Arthobotys, Trichoderma, Aspergucks various small and predatory fungi in open and closed areas, B2–Royal–350 preparation, formalin solution, B3–capturing plants (peas, Russian horseradish, beans and other plants), B4– wild parasitic plants; E1–high voltage alternating current, E2–extremely high voltage frequency, E3–high voltage electropulse current discharge.

IV. METHODOLOGY

The method of warning (disease prevention) is designed to sort the seeds of cultivated plants from diseased seeds using an electrostatic field in various devices. For this, DKTsM-1,2, SDF and etc. equipment are offered.
This method is ineffective for the following reasons;

- if the permittivity of the seeds of cultivated crops, weeds and diseased plants is exactly the same;
- if the growth and development of weeds and diseased plants continue from the seeds and rhizomes that are already accumulating in the soil;
- if the foci of the disease in the soil remain in the next year, or serious comprehensive measures are not taken to eliminate infected plants.

From the above reasons, it is clear that the only warning method based on the cleaning of infected seeds will not solve the problem.
The electric method of gross destruction is based on the effect of electric current against the diseased plant roots and other foci of the disease, causing biological decay. For this purpose, it is proposed to apply continuous direct electric current to the plant or plant residues, which are foci of the disease, and for this use high-voltage frequency of electricity, high-voltage current and electric discharge current, and electric spark current and current discharge [5, 6, 7, 18 , 19].
These methods can be highly effective in controlling diseases in soil-based roots, rhizomes, and plant residues that contain disease foci. The main controversial problem in the method of electric control is the different interpretation of the

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
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mechanism of the effect of current on the plant by scientists [5, 6]. However, since plants are composed of many organic compounds, they conduct electricity differently.

According to English scientists [20, 21], when the current passes through the living tissues of the plant, it heats up and dies as a result of biochemical processes in the plant. At the same time, it was clear from the experiment that the time period affecting the plant and leading to its death is directly related to the level of the stress. In order to achieve the death of a living organism at low voltage, exposure to the electrode for a longer period of time is necessary. The change in current through the plant naturally depends on the resistance of the plant. The rate of change of the resistance depends on the voltage. An increase in voltage from 1 to 5 kV can change the resistance from 100 to 3700 Ohm/s.

Resistance stagnation (R_s) means that the living tissue has died. R_s can be different in healthy and diseased plants, which usually have the same geometric size and shape.

It is enough to know the difference between the initial (R_i) and the final (R_f) to accurately assess the level of exposure in living tissues. That is $R_o, \left(\frac{R_\delta}{R_o}\right)$ does not depend on the level of voltage and the electrophysical properties of the plant [21].

According to W.Q.Dykes, the factor that causes the death of cells in living tissues, the breakdown of intercellular communication, is energy. According to the results of the study [22], depending on the period of growth and development, energy is required from 40 to 3000 J. That is, 10-15 times different energy is needed to destroy exactly one type of plant tissue.

Based on the laws of electrical engineering, the energy dissipated in tissues can be written as follows.

$$W = \frac{b}{R_t} \quad (1)$$

In this b - constant pointer ; that is, at a constant voltage and during the exposure of the energy, the energy dissipated in the plant is inversely proportional to its resistance.

If we consider that the energy acting on living tissue only causes its temperature to rise and heat up, then ΔT can be considered as a function of its mass (M) and specific heat capacity C.

$$\Delta T = \frac{b}{R_t \cdot M \cdot C} \quad (1.2)$$

The plant's resistance, mass, and specific heat volume can vary greatly, and heating can vary indefinitely depending on the amount of energy supplied.

Next research of the results as shown of the plant with a chain exposure reaction, his in the composition has been and of cellulose participation with depends being resistance and conductivity evaluates. This in the plant time together amount of dissipated energy evaluates. This evaluates the amount of energy dissipated in a plant per unit of time.

According to scientists [22, 23, 24, 25, 26, 27], this method guarantees high results in the loss of seeds. When living tissues are exposed to ultra-high frequency (UF) energy, thermal phenomena occur. This condition depends on the dispersion of dielectric permittivity and tissue conductivity.

In other words, they are related to the frequency of radiation - they affect the metabolic processes in biological processes. Researchers [2, 14, 16, 28, 29, 30, 31, 32, 33] have studied the developmental or destructive effects of high voltage on plant seeds.

For example, according to research conducted at the Chelyabinsk Institute of Mechanization and Electrification of Agriculture (CHIMEA) and the Siberian Scientific Research Institute, if 1.2 to 30 J/h of energy is consumed by using electromagnetic fields with Very high frequency (VHF) at a frequency wave of 2375 MHz, the growth rate of seeds increases, Higher than 44 J/h of VHF -energy had a negative effect on seed germination [23, 24, 28].

It is worth noting that achieving a high level of negative impact of electromagnetic field energy with high voltage on damaged seeds and weed seeds of cultivated crops requires solving the problem of energy receptivity to seeds in the soil. This problem is related to the following issues: It is known that the soil composed of complex elements not only transmits high voltage frequency energy to seeds, but also absorbs electromagnetic field energy and receives heat energy passing through seed cells. Therefore, the effectiveness of the impact of the electric magnetic field of VHF depends on the amount, moisture and composition of microelements in the soil.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
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According to the researchers [24, 34], the application of the energy of high voltage against plants requires a large amount of energy and has a negative effect on plant efficiency.
Infected plant and annual weed lawns require 10 or more times more energy than seed. It required 50–100 times more time and energy to achieve a positive result by affecting the rhizomes of perennial weeds and the roots and stems of infested crops.
According to the authors [3, 4, 35], tissues and cells are affected by the pulse current and, as a result of the current passing through them, create a shock wave that erodes the cell walls. The results of the experiments showed that the pressure of the shock wave varies from 8.1 to 79 atmospheres. The inductance of the circuit varies from 5.3 to 110 MGn. The energy pulse was obtained by applying a voltage of U=6 kV from a capacitor with a capacitance of C = 0.33 kF.μ
As the pulse energy increased from 0.1 to 0.8 J, the amount of current passing through the plants also changed. As the pulse energy increased, so did the rate of injury and death. In order to create a shock wave, when the current flows through the flat volume of the plant surface, a force is generated that leads to mechanical erosion, for this it is necessary to affect each centimeter of the surface with a voltage of at least 2.5 kV [25, 40].
According to scientists [21, 22], the influencing factor in cutting living tissues in developed plants is pulse energy, and for tissues in newly growing plants, it is a shock wave.
When the current passes through the plant, its body parts are affected, especially the cells in the central tissue of the plant have been proven to be more affected.
From this it became clear that tissue cells perform different functions, their sizes are different and the current affects them differently. The central (core) cells have a large size, the membrane shell is thinner and thinner compared to the cells located at the edge. The cell membranes of the outer cortex are thicker and are designed to protect against external influences. This structure explains the different distribution of vines in plant tissues. At the same time, the large static pressure in the central, core cells is the reason for the large cell size. The dimensions of the external cells can be small due to external influences: evaporation, mechanical strength, resistance to the negative effects of the environment. Their resistance is greater compared to the central cell.
Researcher [36] Hoffman R stated that the effect of mechanical loading on plant tissues creates two types of excitation that cause disruption of cells and their binding forces. At this time, the fluidity of the plant samples is characterized by the accumulation of the fluid mass formed as a result of tissue decay, firstly as a result of cracks and perforations in the cell membranes, and then spreading to the whole plant body.
According to these theoretical concepts, it is possible to evaluate the fluidity of the tissue and the complete absorption of the tissue with a sharp decrease in tension, assuming different pressure forces on the tissue.
Scientists [37, 38] points out with an electrical impulse discharge processing when given common of mass heating up so much high not ($1–2^0$ C). of cells to decay take coming cause, flow passing hydrodynamic effect of current is the result .
We compare plant cells to a container filled with liquid, and its membranes to a material that conducts electric current poorly. When the membrane is punctured, impulse currents pass through the cell. A small transverse lightning, the current flowing through the channel leads to an increase in the energy density in this area, the formation of a discharge plasma, energy release, an increase in the pressure in the energy channel, and several microshocks due to the expansion of the channel.
The shock wave creates a high-pressure hydrodynamic force that causes the cells to rupture. The impulse current passes through the intercellular space and causes the erosion of the boundaries. The resistance in this section of the tissue is somewhat weaker than that of the cell membrane. The current flowing through the intercellular space creates a pulse discharge and causes cell disorder. In addition, the effects of electric and magnetic fields, light and ionizing radiation, in combination with lightning discharges, prove the idea that tissues are damaged.

V. EXPERIMENTAL RESULTS

Experimental studies of scientists [35, 38, 39, 40, 41] proved that these effects are not significant.
A mobile experimental device affecting weeds and plant residues with alternating current was developed by the US company "Lasco" [42]. Currently, this company has developed and is testing devices of various capacities and voltages (15 to 220 kV).
This equipment consists of the following: a current generator, a contactor with an electronic control system, a high-voltage transformer and working electrodes. All equipment is installed on the weeding cultivator and then hung on the tractor.
This equipment works as follows: the alternating current voltage from the generator is transferred to the high voltage transformer through the contactor. One end of the wires is connected to the grounding electrode, and the other to the

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
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processing electrodes that touch the top of the plants. When an electric current is applied, a high-voltage electrode forms a circuit through the plant and grounding electrode, through which the current flows and the plant dies [42].
According to the authors [20], this type of device was produced in England and [43, 44] in France. It is also worth noting that the way the devices work is similar, that is, high-voltage alternating current is sent from the top of the plants to the roots, forming a circuit through the ground.
There are defects of this technological solution and the following is required to eliminate it;
- The treatment of weeds and damaged plants is carried out during the growing period of cultivated plants, so the height of the treated plants is required. Otherwise, the processing efficiency is not guaranteed. In practice, it is not natural for infected plants and infected weeds to be taller than healthy plants;
- the effect index of electric current is directly related to the type of diseased plants affected, growth and development vegetation, soil composition and humidity [45]. To achieve high indicators, it is necessary to install the processing electrodes at the maximum contact level with the plant, to clean the surface of the electrodes, to keep them moist for better contact, and to carry out additional watering measures to supply the soil moisture at the required level.
At the Chelyabinsk Agricultural Mechanization and Electrification Institute of Russia, such an experimental device with a working width of 1.5 m and a speed of 2 km/h was created. The processing device was moved by an MTZ-80 tractor, and an overhead line with a voltage of 0.4 kV was used as a power supply source [39].
According to laboratory experiments, the duration of pulse current exposure to plants is 10 -6 sec, voltage amplitude values are from 5 to 50 kV, and when each plant is exposed to 20 - 30 J of energy, all annual weeds are completely killed within 4 - 6 days.
The same results were obtained in Poltava Institute of Agriculture and Russian Research Institute of Agricultural Mechanization. That is, when 0.1-0.22 J of energy was applied to infected one-year weed buds and grasses, all plants dried up [47].
Another electrical method is exposure to living plant tissues with extremely high frequency of electromagnetic energy current oscillations. It is designed to act directly on the seeds of weeds and infected plants in the soil and on the surface, and it outperforms traditional methods by providing superior results in soil science where soil protection systems are available.
A number of research scientists led by professor A. Mukhammadiev worked with electric impulse treatment of plants in our republic. Research work has been carried out on the development of electrical indicators for disinfection against cotton root wilt disease [12, 48, 49].
The work done by T.M.Bayzakov [15, 48, 49] is dedicated to the electrical treatment of cotton before cotton picking, and is designed to solve the necessary problem of creating electrotechnological devices that treat cotton before cotton picking without using toxic chemicals.
N.T. Toshpulatov [15, 48, 49] carried out work on processing the veins of perennial weeds with the help of electrical equipment. In field studies, 7000 V of electrical equipment was used to kill up to 70% of the plant debris in 30 days on the roots of sedge and finger weed. Weed residues are carried out in two stages, as this work is carried out by means of electrode equipment installed on the potato digger combine KTS-3A.
Until now, the results of the researches have been applied to the seeds of cotton and other agricultural products, in the fight against diseases and pests in fruits and vegetables, with certain positive results being achieved.

VI. CONCLUSION AND FUTURE WORK

According to the results of the scientific and technical data on the application of electric impulse discharges to diseased cultivated plants, it is clear that the use of high voltage current discharges against nematode galls on cucumber and tomato rootstocks has not been sufficiently studied.
At present, insufficient research of this issue allows defining the goals and tasks of future research in solving such issues as influencing factors, composition and structure of the device, and subsequent consequences during processing.

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