Electrical pulse treatment of nematode-infested plants

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Annotation. This article describes measures to control nematode disease affecting rootstocks and crops of tomato and cucumber grown in the countryside by electric pulse current discharges. When an electrical pulse discharge affects living tissue, certain chemical, physical and biological processes result in pulse energy, pulse discharge current, pulse discharge voltage, pulse discharge exposure time, pulse discharge shock current and similar factors. When an electric pulse was applied to the nematode-infested rootstocks of vegetable crops and tomato and cucumber plants, their engraftment rate was determined. The purpose of this work was to identify the main factors influencing the treatment of tomato and cucumber rootstocks affected by nematodes and their larvae by electric pulse current discharges.

Keywords: agriculture, soils, plant diseases, plant protection, plant physiology, tomato, cucumbers, nematodes, biology, pulse energy, pulse discharge current, pulse discharge voltage, pulse discharge exposure time, pulse discharge current, electrophysics, electrodes, electrical equipment, energy.

1. Introduction.

Agricultural crops are evaluated by the amount of products produced on the sown areas. Yield growth depends on land bonitet, proper selection and placement of available varieties and plant species with immunity to natural influences and diseases, creation and cultivation of new hybrid plant cell cultures, development and implementation of new advanced technological methods.

During the last decade the growth of energy deficit in the world has increased from 3...5 to 15...30% in the cost of agricultural production, and further increase of this indicator is expected in the future. In addition, the role of electricity in the overall energy balance will increase. In connection with this, electrotechnological treatment simultaneously performs the function of control and improvement of product quality, allows the rational use of natural resources and enhances environmental protection. One of the priority areas of research is a gradual transition from effective, environmentally dangerous chemical methods in crop production to the use of low-energy electrotechnological methods, their practical application on irrigated land. In this regard, the development of environmentally safe electro-technological method providing control of nematodes in the roots of damaged vegetable crops is an urgent task. Extensive measures are taken to save resources in agricultural production of the republic, to treat crops with environmentally safe electrotechnological methods. The Strategy of actions for further development of the Republic of Uzbekistan for 2017-2021 defines the tasks, including "Priorities of economic development and liberalization" [1, 2, 3]. In carrying out these tasks, one of the important tasks is to justify the parameters of the device for electric pulse treatment against nematodes in the damaged plant root.

2. Method

Scientific studies were conducted in greenhouses and on fruit crops to test and evaluate the effectiveness of the high-voltage electric pulse device under field conditions. Biologists and agronomists involved in determining nematode-infested areas and the incidence of disease in production plants were identified. For this purpose, a high-voltage pulsed discharge device for treating diseased plants in the field was developed, which consisted of the following electrical equipment. A single-line connection diagram of the electric pulse device is shown in Figure 1. Figure 1 uses electricity with an inverter converter through a rechargeable battery as the main source for treating diseased roots in the field.

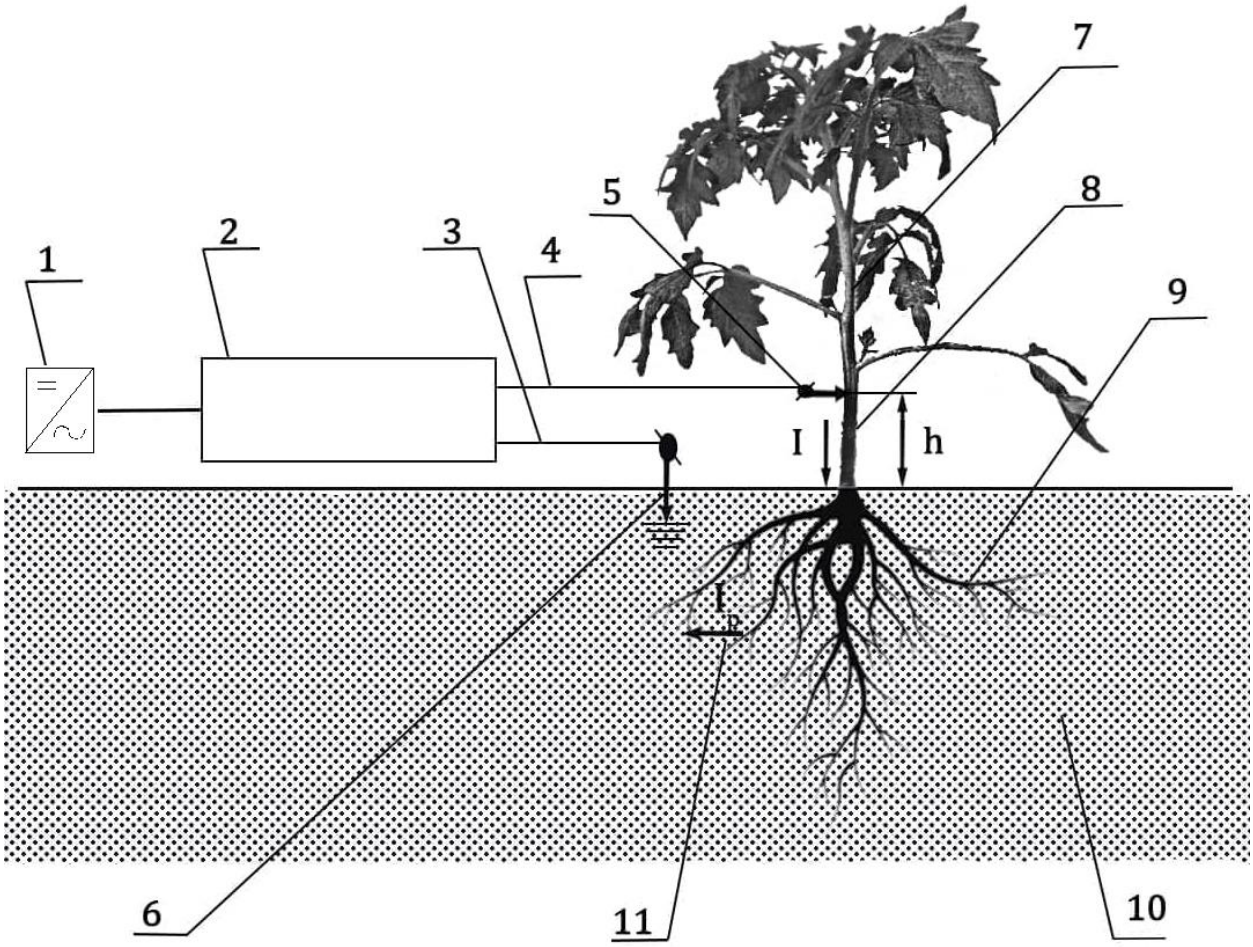

Fig. 1. Scheme of treatment with electric pulse discharges of an infected plant.
1-power source; 2-high-voltage device; 3, 4-high-voltage electric cables; 5, 6-electrodes; 7-stem plants; 8, 9-infected plant roots and neck; 10-soil (clay); 11-nematode larvae.

The proposed device makes it possible to change the discharge current, voltage pulse, discharge energy, discharge pulse strength, pulse shape, and treatment time during treatment of damaged tomato and cucumber root stems by electric pulse in an environmentally friendly electro technological method.

Working procedure according to the scheme of Fig. 1: the positive electrode 5 is brought to the bottom of the stem, the negative electrode 6 is connected to the ground 10. After connecting the device 2 to the power source 1 between the stem 8

of the plant 7 and the roots 9 begins to flow electric current 11. High-voltage discharges of electric current pass through the nematodes infected plant roots spreading disease microorganisms 11.

3. Result

The treating electrode part of the treating device is attached to a special 3.5 m long rod, protected with a high-voltage porcelain insulator, 6 mm2 in diameter and 50 cm long, made of three rows of stainless steel in the shape of an onion. The plants in the greenhouse can change the shape, number and length of the electrodes depending on the distance between the rows. Arc-shaped design of the electrode serves to reduce mechanical damage during processing and reduce resistance forces exerted by the stems of plants during movement.

Processing time: for cucumbers U1 = 1500, U2 = 2500 and U3 = 3500 V, and for tomatoes U1 = 2000, U2 = 3000 and U3 = 4000 V were treated with high voltage τp = 0.1 - 0.2 seconds. Capacitors of C = 470 pF; C = 1000 pF; and C = 1470 pF were used for both plant objects.

During a 10-day post-treatment period, plant rhizomes and nematode pathogens in plants with different control options and treatment parameters were studied electro physically. Current pulses act on the plant cell membrane and nematode virus surface, resulting in destruction and destruction of the rootstock system and nematode virus membrane. This method is applied after harvesting of infected plants. Table 1 shows the results of experimental studies of treatment of disease-causing tomato and cucumber plants by electric-pulse current discharge. The dependences of the degree of disinfection P = f (Q) for tomato and cucumber plants on the pulse voltage U = f (Q) and pulse-energy characteristics are given (Fig. 2, 3).

Table 1

Results of experimental studies of treatment of pathogenic tomato and cucumber plants by electric pulse current discharge

Experiment	Voltage value	Processing time, sec	Impulse energy, J	Harmless rate, %
Control	-	-	-	-
1	1000	0,2	0,0010	35
2	2000	0,2	0,0020	49
3	3000	0,2	0,0045	60
4	1000	0,2	0,0010	35
5	2000	0,2	0,0020	40
6	3000	0,2	0,0045	59

The dependences of the degree of neutralization on P = f (Q) for tomatoes and cucumbers are given from the pulse voltage U = f (Q) and pulse-energy characteristics (Fig. 2, 3).

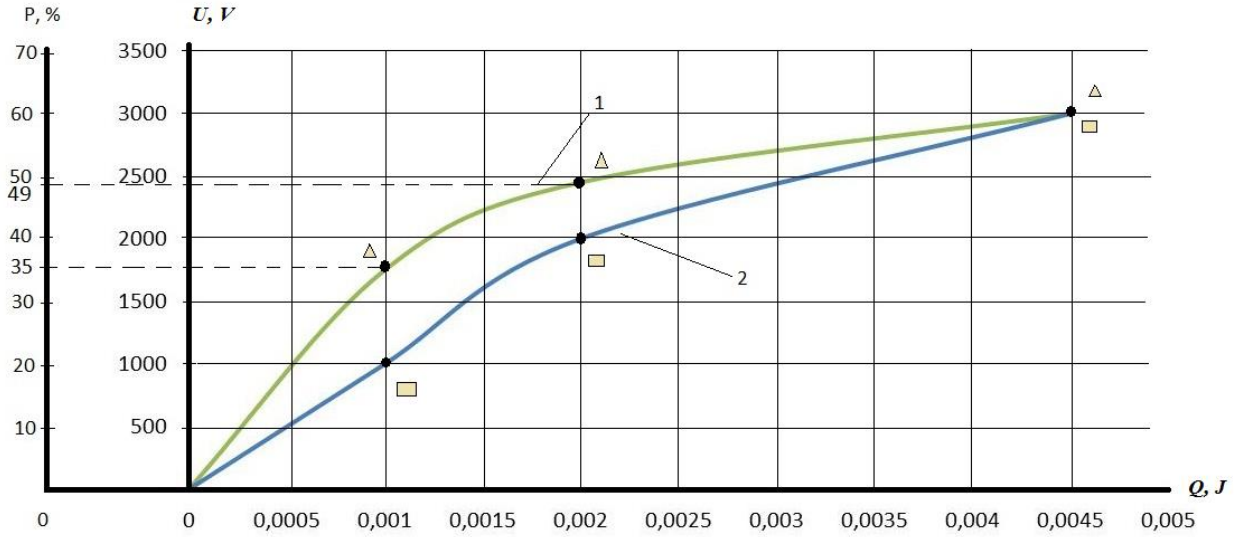

Figure 2. Diagram of voltage magnitude variation from the time of electric current pulses for tomatoes

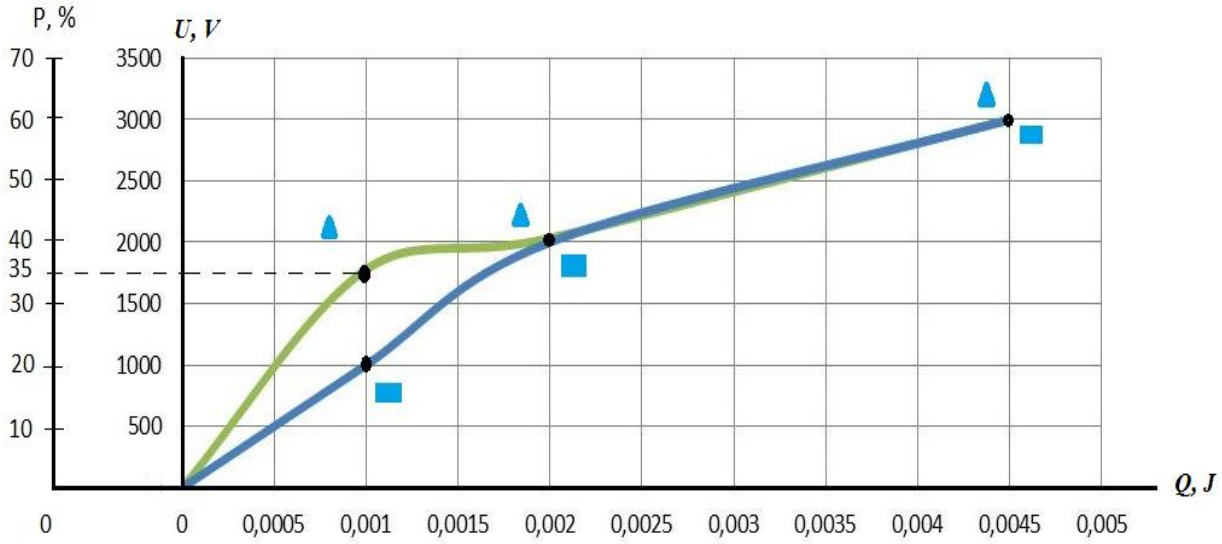

Figure 3. Variation of voltage magnitude from pulse time by electric pulse current discharge for cucumbers

4. Conclusion

To summarize, we can say that electric pulse treatment of diseased tomato and cucumber plants can be used to provide electric power through inverter converters using a battery and using liquid fuel (diesel) generators. We believe that the use of electric discharge in the fight against viruses is appropriate and environmentally friendly. With the right choice of treatment parameters it is possible to achieve sufficient efficiency in the control of nematode worms and galaxies.

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