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Field Study on Application of Electric Pulse Processing Device in the Cultivation of Tomatoes and Cucumbers

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Abstract. This article explains the main diseases of tomato and cucumber plants that grow in greenhouses and fields. At present, the protection of the environment, especially from the effects of various chemical toxins, is one of the main problems of land and water resources of the world civilization. During the global financial and economic crisis, our country is currently using high-quality land resources, introducing advanced science and technology, agricultural technologies and cultivation of low-quality crops. Some of the important issues are the management and control of land use, the improvement of land relations, and the efficient use of land by the public in general. Electric pulse processing should be used for growing vegetables and melons. Diseases of nematodes attach and settle in the root system of plants. Inside, plant roots, nematodes form tumors and folds, do not nourish young seedlings, destroy mineral nutrients and eventually seedlings. We offer an electrical impulse to treat nematode diseases of the roots of tomato and cucumber plants and to obtain the results of electrotechnical experiments. To get the results of this experiment faster, we can clearly see that the results of experiments conducted in the scientific laboratory of the Institute of Plant Protection using electron microscopy in the processing of root stalks of tomato and cucumber plants were infected with nematodes. The use of an electric pulse device in the cultivation of tomatoes and cucumbers has been considered in the fight against nematode diseases caused by plants and its roots, and the results of preliminary studies have been presented.

INTRODUCTION

Over the last decade, the cost of agricultural products has risen from 3... 5 to 15... 30% as a result of global energy shortages, and this figure is anticipated to rise even more in the future. In addition, electricity will play a larger part in the overall energy balance [1]. In this regard, electrotechnological processing serves as a control and improvement function for product quality, as well as allowing for the efficient utilization of resources and improved protection of the environment [2]. The gradual transition from effective, ecologically dangerous chemical technologies in crop production to the use of low-energy electrotechnological approaches, as well as their practical implementation in irrigated areas, is one of the research goals. The development of an ecologically friendly electrotechnological approach for controlling nematodes in the roots of damaged vegetable crops is a pressing concern in this area [3]. Efforts are being made to conserve resources in the Republic's agricultural output and to process agricultural crops using environmentally friendly electrotechnological processes. The "Priorities for Economic Development and Liberalization" are listed in the Action Strategy for the Further Development of the Republic of Uzbekistan for 2017-2021 [4]. One of the most significant duties in completing these tasks is to verify the parameters of the electric pulse therapy device for nematodes in the affected roots of plants.

Pulse Electric Fields (PEF) is a non-thermal food preservation method that uses short electrical pulses to inactivate bacteria and has a low impact on food quality features. The goal of PEF technology is to provide consumers with high-quality foods [5]. PEF technologies has been touted as superior to other methods of killing microorganisms, such as heat treatments, because it destroys microbes while preserving the unprocessed food's original color, flavor, texture, and nutritional content. PEF technique involves applying high-voltage pulses to liquid or semi-solid meals that are sandwiched between two electrodes. The majority of PEF research has concentrated on the impact of PEF treatments on microbial inactivation in milk, dairy products, eggs, juices, as well as other liquid meals [6]. Even

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though PEF has published a large number of studies on the microbiological elements of food preservation, little is known about the impact of this technique on the constituents of food and overall quality and acceptability of the food as a whole. Using pulsed electric fields in food preparation has just come back into fashion, thanks to new research. For inactivating microorganisms, boosting pressing efficiency, and improving juice extraction from food plants, as well as for intensifying food dehydration and drying, the PEF treatment has been demonstrated to be quite successful [7, 8].

METHODS

Scientific research was undertaken on greenhouses and fruit crops in order to test and assess the performance of the high-voltage electrical pulse device in the field production process. Dedicated biologists and agronomists were assigned to the task of determining nematode-infested areas and illness incidence in manufacturing units. A high-voltage pulse discharge device was designed for this purpose, and it comprised of the following electrical equipment to process infected plants in the field.

The terminals at the input of the high-voltage pulse discharge device can be connected to an external power supply using these terminals by connecting bolts to the base insulators of the AO-10-kr brand, which are resistant to high voltage. However, it is advisable to connect the device via the AP-50 in order to prevent and eliminate accidents that occur during operation. Therefore, the device is connected to the circuit breaker on the greenhouse electric switchboard, which is the power supply via a multi-fiber copper wire KRPT 4×2.5 mm^2 cable protected by the terminals of this automatic switchgear.

The electric pulse discharge device was placed in a metal box with dimensions of 0.8 × 1.2 × 1.0 m3 and 4 wheels with a diameter of 35 cm were installed under it to facilitate the movement and transportation of the device.

Figures 1 and 2 show a single-line electrical connection diagram for an electrical pulse device. For processing sick roots in the field, Figure 1 uses energy via an inverter converter and a rechargeable battery as the primary source. Figure 2 uses electricity as the primary source using a liquid (diesel) fuel generator. In this case, the part from the input circuit breaker AP-50 to the autotransformer and from the autotransformer to the second winding of the high-voltage transformer is connected using a cable KRPT - 4×2.5 mm^2.

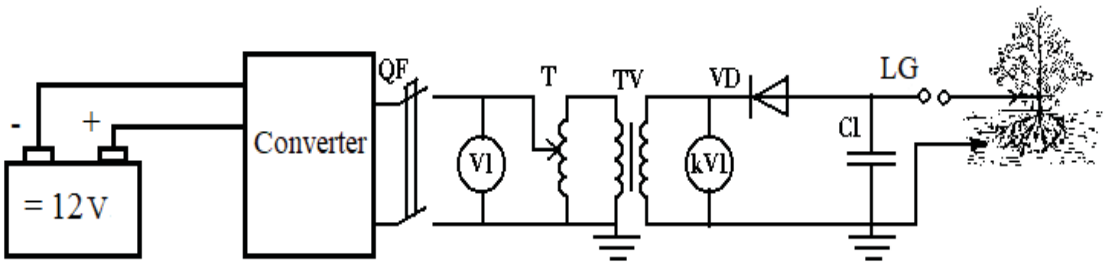

FIGURE 1. A single-line electrical wiring diagram of a high-voltage pulse discharge device

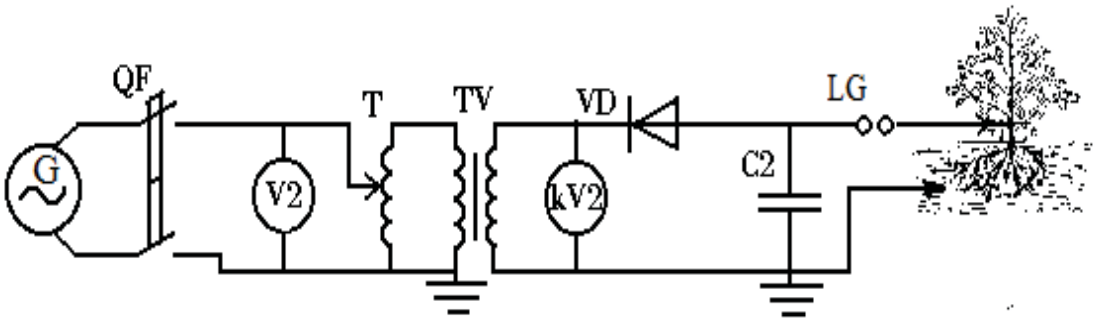

FIGURE 2. A single-line electrical wiring diagram of a high-voltage pulse discharge device

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 and it must reach from the beginning to the end or to the desired

point of the edges in the greenhouse building during processing using electric pulse discharges. The other end of the cable is connected to the processing positive and grounding negative disk electrode. The negative-polar disc electrode is attached to the processing handle at the same time as the grounding electrode during the machining process, as well as a special sliding contact electrode device on the machining handle. The function of this contact device is to ensure the reliability of the connection to the negative-pole cable even when the negative-pole wheel electrode is rotating [4, 9-15].

RESULTS AND DISCUSSIONS

The machining electrode part of the processing device is fastened to a special rod with a length of 3.5 m, protected by a high-voltage porcelain insulator with a diameter of 6 mm^2 and a length of 50 cm. made of three rows of stainless steel in the form of a bow. Plants in the greenhouse can change the shape, number and length of electrodes depending on the row spacing. The electrode's arc-shaped design is intended to decrease mechanical damage during machining as well as the resistance forces generated by the plant stems upon movement.

Processing time: for cucumbers $U_1 = 1500$, $U_2 = 2500$ and $U_3 = 3500$ V, and for tomatoes $U_1 = 2000$, $U_2 = 3000$, and $U_3 = 4000$ V with high voltage discharge $\tau_r = 0.1$ - 0.2 seconds treated with voltage over time. Capacitance C = 470 pF for both plant objects; C = 1000 pF; and C = 1470 pF. capacitors were used.

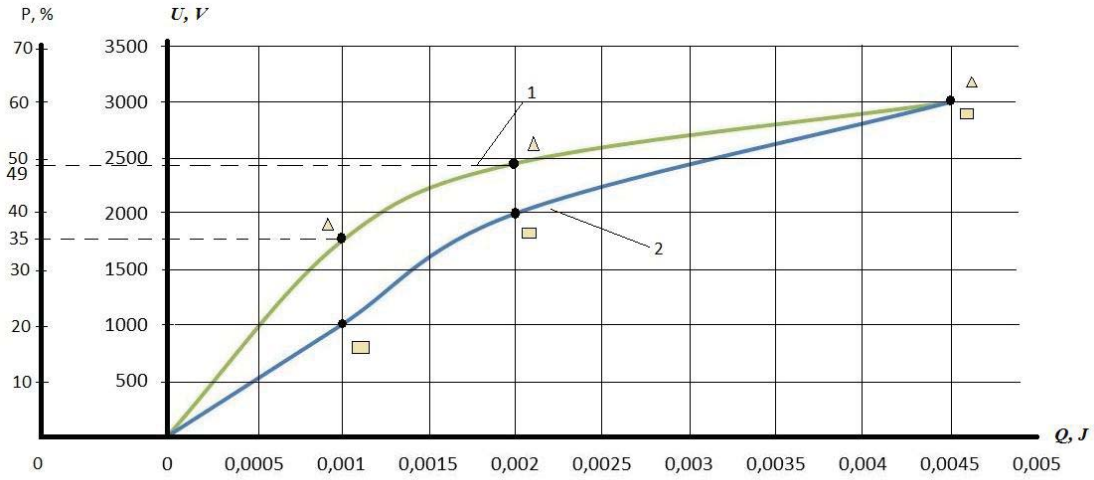

FIGURE 3. Graph of the change in the magnitude of the voltage from the time of pulses by an electric pulse current discharge for tomatoes

TABLE 1. With an electric pulsed current discharge to the affected tomato plant processing results

Experiment	Voltage value	Processing time, sec	Impulse energy, J.	Harmless rate,%
Control	-	-	-	-
1	1000	0.1	0.00025	25
2	2000	0.1	0.0010	28
3	3000	0.1	0.0023	33
4	5000	0.1	0.0023	30
5	6000	0.1	0.0023	25
6	1000	0.2	0.0010	35
7	2000	0.2	0.0020	49
8	3000	0.2	0.0045	60
9	5000	0.2	0.0045	40
10	6000	0.2	0.0045	35

Plant rootstocks and nematode infections in plants with various control options and processing parameters were electrophysically investigated throughout the 10-day post-treatment period.

The results were presented in Tables 1 - 2. Electric pulsed discharges with 3-phase arc electrodes were used at a height of 25 cm from the ground to treat cucumber and tomato rootstocks, which are the cause of worm infections. Biologists and agronomists assessed the processing parameters as well. The acquired results corroborated the parameters determined in laboratory tests. This method is used after harvesting infected plants. Tables 1-2 and Figures 1 and 2 show the results of plants of tomatoes and cucumbers by an electro-impulse experimental studies of the treatment of disease-causing current discharge. Dependencies of the degree of neutralization on the P = f (Q) for tomatoes and cucumbers are given on the voltage of the pulse U = f (Q) and the momentum energy characteristics of (Figures 3 and 4).

The control variety of nematode pathogens and larvae (in the greenhouse compartments) treated with electrical pulsed discharges dropped by 65-68 percent compared to the uncultivated plots, according to the results of agrotechnical investigations. The amount of nematode worms in the soil was 15%, according to re-examinations conducted during the pre-sowing stage for the second growing season.

The result of this 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 far from the treated root stalks or away from the channels through which electric currents pass.

According to scientific study, it is recommended to continue the procedure of electric pulse treatment of rootstocks for at least two seasons in order to attain high processing efficiency [4, 9-15].

TABLE 2. An electric pulse current is applied to the affected cucumber plant results of processing with

Experiment	Voltage value	Processing time, sec	Impulse energy, J.	Harmless rate,%
Control	-	-	-	-
1	1000	0.1	0.00025	20
2	2000	0.1	0,0010	26
3	3000	0.1	0,0023	35
4	5000	0.1	0,0023	23
5	6000	0.1	0,0023	20
6	1000	0.2	0,0010	35
7	2000	0.2	0,0020	40
8	3000	0.2	0,0045	59
9	5000	0.2	0,0045	32
10	6000	0.2	0,0045	30

Dependencies of the degree of neutralization on the P = f (Q) for tomatoes and cucumbers are given on the voltage of the pulse U = f (Q) and the momentum energy characteristics of (Figures 3, 4).

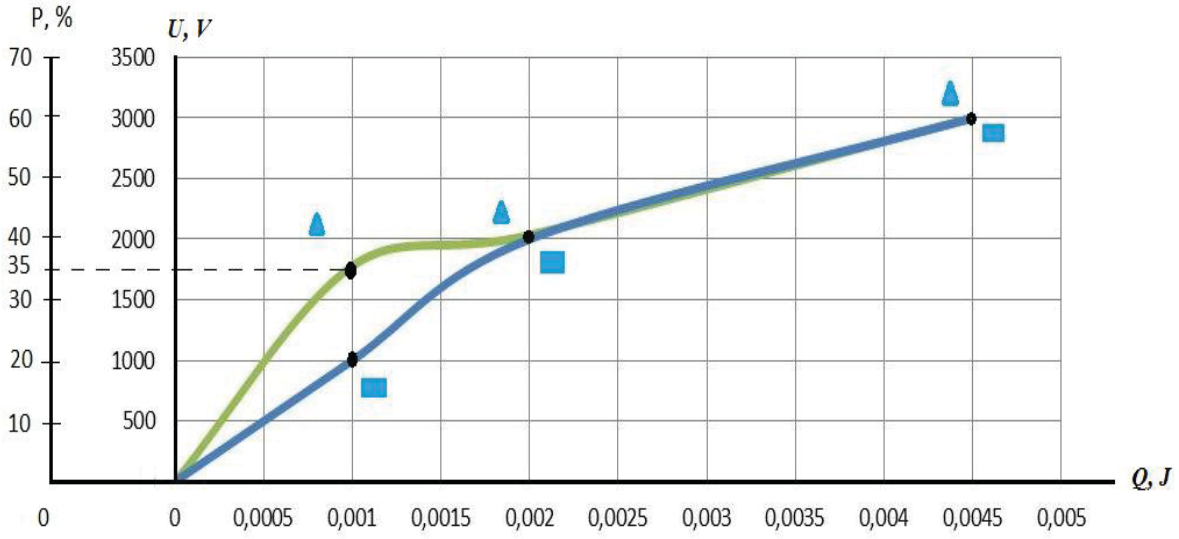

FIGURE 4. Changes in the magnitude of the voltage from the time of pulses by an electric pulse current discharge for cucumbers

CONCLUSIONS

In conclusion, electro-pulse processing of damaged tomato and cucumber plants was discovered to be capable of supplying power via inverter converters, rechargeable batteries, and liquid fuel (diesel) generators. We believe that using electric discharge to combat viruses is both practical and environmentally friendly. In the fight against nematode worms and galaxies, if the processing parameters are chosen right, significant efficiency can be attained.

REFERENCES

1. N. Toshpulatov, O. Tursunov, D. Kodirov, G. Kholmuratova, Environmentally friendly technology for the destruction of tobacco mosaic viruses (TMV) from selected species of plants, IOP Conf. Ser.: Earth Environ. Sci. **614**, 012133 (2020).
2. N. Toshpulatov, O. Tursunov, D. Kodirov, A. Maksumkhanova, Z. Yusupov, Study on issues of uninterrupted power supply, energy-saving and improving the quality of electrical energy of water facilities, IOP Conf. Ser.: Earth Environ. Sci. **614**, 012025 (2020).
3. B. Collange, M. Navarrete, G. Peyre, T. Mateille, M. Tchamitchian, Root-knot nematode (Meloidogyne) management in vegetable crop production: the challenge of an agronomic system analysis, Crop Protection **30**(10), 1251-1262 (2011).
4. E. O. Bozorov, Electrical pulse treatment against nematodes, Doctor of Philosophy (PhD) in technical sciences dissertation, Tashkent (2019).
5. K. Nowosad, M. Sujka, U. Pankiewicz *et al.,* The application of PEF technology in food processing and human nutrition, J Food Sci Technol **58**, 397–411 (2021).
6. B. L. Qin, F. Chang, G. V. Barbosa-Cfinovas, B. G. Swanson, Pulsed Electric Fields for Food Processing Technology, Lebensm.-Wiss. Technol. **28**, 564-568 (1995).
7. K. A. Taiwo, A. Angersbach, D. Knorr, Influence of high intensity electric field pulses and osmotic dehydration on the rehydration characteristics of apple slices at different temperatures, J. Food Eng. **52**, 185-192 (2002)
8. T. R. Bajgai, E. Hashinaga, Pulsed Electric Fields for Food Processing Technology, *Drying Technol*. **19**, 2291-2302 (2001)
9. N. T. Toshpulatov, T. M. Bayzakov, E. O. Bozorov, Method of harvesting plants, patent A.S. No. 3456 certified 505 reg, Uzbekistan (1996).
10. N. T. Toshpulatov, E. O. Bozorov, Method of electrical impulse treatment of plants, Patent IAP 0429 02.04.2003.
11. A. Muhammadiev, E. Bozorov, Parameters of electroimpulse processing for destruction of illnesses nematode, European Science Review **1-2**, 213-216 (2018).
12. A. Kabiljanov, E. Bozorov, Ch. Okhunboboyeva, N. Azizova, Optimization and Simulation of the Process Electro Impulse Treatment of Plants, Int. J. Engineering and Advanced Technology **9**, 4850-4853 (2019).
13. T. M. Bayzakov, E. O. Bozorov, R. F. Yunusov, Sh. Yusupov, Electrotechnological treatment against diseases found in almond trees grown in arid lands, IOP Conference Series Materials Science and Engineering **883**, 012154 (2020).
14. E. Bozorov, Electric pulse treatment of trees as an environmentally friendly mechanism for protection of orchards, IOP Conf. Series: Earth and Environmental Science **614**, 012043 (2020).
15. A. Kabildjanov, E. Bozorov, Ch. Okhunboboyeva, G. Tuhtaeva, Intellectualization of Decision Making Support in Tasks of Optimization of Complex Technical Systems based on Anfis Neuro-Fuzzy Network, Annals of R.S.C.B **25**, 6967-6979 (2020).