Chapter 2
Technique of Plant Electrical Stimulation by Weak Electric Currents

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ABSTRACT

The impact of electricity is described on plant growth and vegetation. The application of the electrical currents is discussed from the point of view of plant cultivation improvement in horticulture. Underlining that the electricity is an abiotic stress stimulant, the electricity use ways classification is given. The application of the electric currents and other similar influences can—directly or indirectly—affect plants causing a series of physiological and biochemical reactions. This technique enables the yield optimization and the fruits quality improvement by regulating the intensity and duration of the exposure according to different types and kinds of vegetables. In the area of an effective technique development of the plant electric stimulation, there are many aspects almost impossible to be taken into account within one experiment. An option for solving such problems is the compilation of the experimental databases, the introduction of the smart control systems, and the management of the technological processes of plant electric stimulation.

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INTRODUCTION

The use of the electricity can – to a certain extent – stimulate the plants growth (Sokolov, 2018). This little-known technique called electroculture is able to accelerate the growth rates, increase the yields, improve the fruits quality and protect the plants from diseases, insects and frost (Ishikawa et al., 1990). Also, the electroculture application can reduce requirements for fertilizers or pesticides. There exist several approaches to the electroculture; they include exposure of weak and strong electric fields, magnetic fields, direct and alternating electric currents. Besides, the electricity can be applied to seeds, plants, soil, water or nutrient solutions. In particular, the application of an electrical field can – directly or indirectly – affect plants launching series of physiological and biochemical reactions. (Vallverdu-Queralt et al., 2013).

The first results of the electricity effect on plants, both positive and negative, were obtained by scientists as early as in the XVIII century. The experiments for the electricity influence studying on the plant life were conducted by the French physicist Jean-Antoine Nollet, the French abbot Bertolon, the Italian researcher Gardini, etc. (Gordeev et al., 1991). In the XIX century, some inactivity was observed until the 1880-ies, when the level of laboratory equipment provision for scientific works grew quite high. In the first half of the XX century, it was noted that the electric stimulation accelerated the plants growth and increased the yields; however, with some plants, failures were encountered. Conclusions were made that the exposure effectiveness is influenced by weather conditions, time of year as well as soil fertility. From the end of the XX century to the present time, the effects of the external electric field have been revealed on intermolecular bonds and on physiological & biochemical processes inside of the plant organism. In Russia, the experiments were conducted in the area of the seeds electric stimulation; also the acceleration possibility was studied of the scion increment process under the electric exposure. In the area of an effective technique development of the plants electric stimulation, there are many aspects almost impossible to be taken into account within one experiment. Those include: electric parameters of the plant, its surface and volume resistance, dielectric losses, active resistance of separate tissues as well as a set of such external factors as soil conductivity, atmospheric electricity, temperature, pressure, humidity, etc. An option for solving such problems is the compilation of the experimental databases, the introduction of the smart control systems and the management of the technological processes of the plants electric stimulation.

BACKGROUND

The living plant behavior under external electric influences can be attributed to its amazing properties. Inside of the plants, bioelectric potentials are generated and they themselves are exposed to the effects of the atmospheric electricity. In plants, signals are distributed; for example, the root “informs” the stem when damaged, then the irritation is transmitted to the leaves; and while responding, all of them together change their root activity. Mainly, the damaged part becomes electrically negative in the range of 20-120mV depending on the type of the plant and other reasons (Gordeev et al., 1991).

There exists a potential difference between different organs of plants, for example, between separate parts of a stem, a root, a flower, etc. (Opritov et al., 1991). In different trees, between the electrode in the soil and the one in the stem, the potential difference reaches 0.1V - 0.7V (Kholmansky et al., 2016).

Plants are not indifferent to the electricity; this was established a long ago by scientific and amateur experiments both successful and ended in failure. In 1747, the French physicist Jean-Antoine Nollet