

About vegetative fabrics bio-damage character by through conductivity and bias currents

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Abstract: *New electrical technological operations wide application in agricultural production nowadays is restrained as the mechanism of vegetative fabrics damage at electric influence on them, cultivated plants fabrics sensitivity to the electric energy influence are not precisely clear. The carried out experimental tests and the received data analysis testify that a vegetative fabric damage by electric impulses differ in effect at a various influence modes (a through conductivity current and a bias current).*

Key words: *Electrical impulse bio-damage, through conductivity and bias currents influence, the oscilloscope diagram curves analysis.*

Introduction

Successful, economically effective development of agriculture in Russia at the present stage cannot exist without use of new innovatively necessary decisions introduced both in already existing technologies, in the form of separate devices and units, and absolutely new, developed technological operations on received agricultural production cultivation, processing and storage. It is necessary to name such innovation as application various electrical technological operations in crop growing, they can be weed vegetation electrical impulse destruction, fodder grasses before drying electrical processing, vegetative raw materials electrical plasmolise, sunflower and tobacco plants pre-harvest electric processing. New enumerated electrical technological operations wide introduction is not for a while yet restrained as the mechanism of vegetative fabrics damage at electric influence on them, the character of their bio damage during this process and plants fabrics sensitivity to the electric energy influence are not precisely clear.

Assumed that in the vegetative fabric bio-damage process cellular membranes damage under the electric field strength influence has a great importance, in carried out researches the conditions of maximum effective electric field energy use were set up, it meant to achieve durable electric influence as much as possible with a high intensity in the maximum possible volume even at the impulse energy limited size. It is possible to provide it if the vegetative fabric electric breakdown possibility will be left out, as the bio-damage efficiency at the expense of breakdown channel accompanying physical factors (temperature and pressure) is very insignificant because of its short duration and localization. The similar situation takes place in a number of other electrical technological processes – in electrical filters and in ozonizers where the digit process efficiency is estimated by the formed free electrons quantity, inclined to carry out neutral atoms and molecules ionization. In electrical filters distinctly heterogeneous field is used and a corona cover zone is limited by the pressure level, dielectric barriers interrupting streamer discharge distribution in ozonizers are used at homogeneous enough field in coaxial cylinders system. The vegetative fabric through breakdown exception during the electrical impulse influence by application of dielectric barriers problem decision was the research object in this work.

MATERIAL AND METHODS

In the technologies using a principle of electrical impulse bio-damage, the pointed electrodes providing the electric field power lines maximum concentration and the current are used more often. Our experimental works were carried out with the purpose to confirm the bio-damage fact and to search the ways of its intensification at the expense of the influence area increase.

To analyze the damaging factors electrical impulse influence on vegetative fabric research different variants were offered: series of categories in distinctly heterogeneous field of type "spike-plane" and in a uniform field between flat disks, according to inclusion between dielectric barriers electrodes and without them.

As a dielectric material for barriers Teflon 0,6 mm thick was used. Disk high-voltage electrodes diameter changed from 10 to 30 mm. Tradescantia leaves and beet laminae were used as the research objects. In various tests series the number of influencing impulses changed from one to 100.

In a impulses high-voltage source charging unit is made according to the high-frequency converter scheme and is charged from an alternating current network, providing exit voltage of 6 kV. Generator block is presented by 4 staged impulse pressure generator on the Arkadjev-Marx's scheme with capacity in the step $C_0 = 470 \text{ pF}$, here aperiodic pressure impulse in 24 kV with energy in an impulse of 0,034 J was provided on an exit, that in the quantity order is close to power influence typical modes at vegetative fabrics damage [1,2].

With the help of the oscilloscope diagram method the impulses tension in following modes were registered (fig.1): idling, at short circuit, and also at direct contact with the research object (a through conductivity current mode) and at dielectric barriers use (a bias current mode).

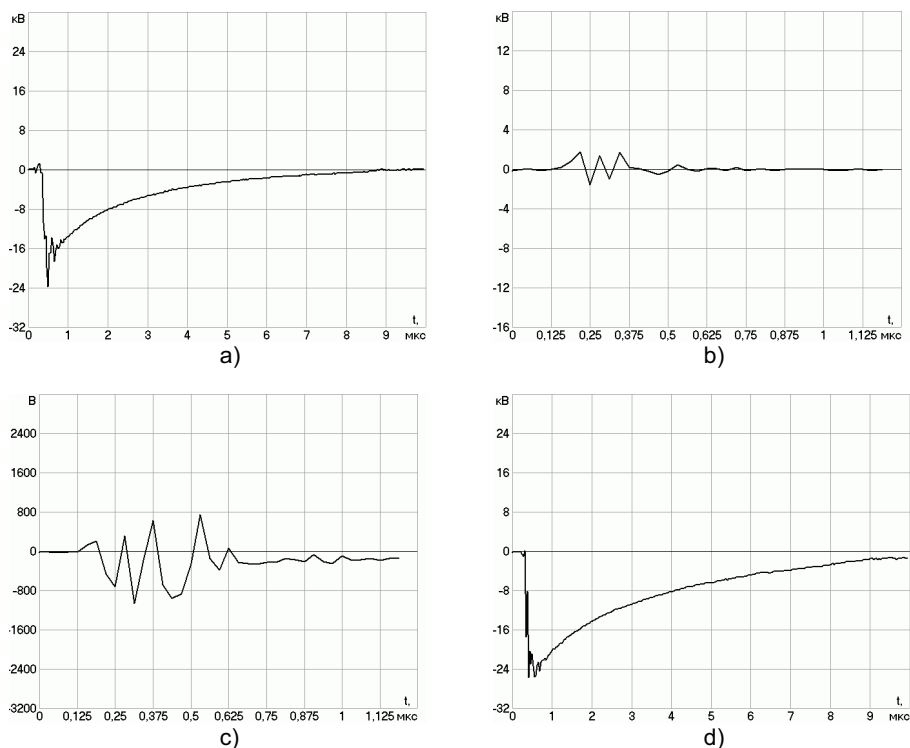


Fig.1. Oscilloscope diagrams of pressure impulses in the following modes:
a) idling mode; b) short circuit mode; c) at influence on object with electrodes direct contact; d) at influence on object through dielectric barriers

Results and discussion

The received by tests experimental tension oscilloscope diagrams analysis allowed to ascertain:

- The impulses generator forms aperiodical impulses with amplitude of an order $20 \pm 4 \text{ kV}$. The front duration is estimated by magnitude $0,1 \dots 0,2 \text{ } \mu\text{s}$;
- The short circuit oscilloscope diagram is symmetric concerning a zero line that testifies to regular errors in measurements absence;
- The impulse tension form on object during the influence on direct contact at pointed electrodes is oscillatory, on a short circuit mode type; at disk electrodes the impulse amplitude because of the leaf high conductivity does not exceed the level of 1000 V ;
- At influence on the object with dielectric barriers the increase in comparison with impulse amplitude idling (by our estimation to 1,5 times) and a time tension constant (with $2,07 \text{ } \mu\text{s}$ to $3,72 \text{ } \mu\text{s}$) takes place. The increase in tension amplitude is directly connected with additional loading current passing the tension failure on the spark interval switchboards decreases essentially. Time tension constant $\tau = R \cdot C_p$ increase, where R is the general digit resistance R_p parallel connection resistance and a pressure divider resistance $R_{\text{дн}}$, and C_p is the generator digit capacity, can also be explained - at the object $C_{\text{бo}}$ capacity connection to digit capacity of generator C_p the system capacity ($C_c = C_p + C_{\text{бo}}$) accordingly grows in whole. Thus the Time tension constant naturally decreases in tension impulses supply process (from 3,72 on the first impulse to 3,24 after 100 impulses), that is connected with loading resistance decrease in vegetative fabric bio damage process.

The qualitative picture of electrical impulse influence on the biological objects parameters change, estimating under tension oscilloscope diagrams and allowing to prove basic state about the influence variant with dielectric barriers preference, can be added by some quantitative characteristics received by impulses formation scheme calculation, shown in fig.2.

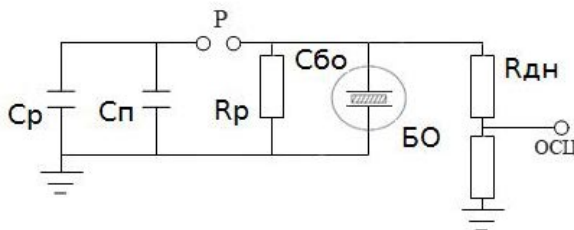


Fig.2. Equivalent circuit for a discharge time constant estimation on the biological object

At $R_p = 22 \text{ k}\Omega$, $R_{\text{дн}} = 33,7 \text{ k}\Omega$ and $C_p = 117,5 \text{ pF}$ (without installation parasitic capacity) calculated value $\tau_{\text{xx}} = 1,57 \text{ } \mu\text{s}$, that differs from experimental value on 25 %. It can be explained a little by the generator with such constructive (multistage execution) and energetic (small size of digit capacity) ratio parameters. It is enough to take into account assembling parasitic capacity for calculated and experimental values τ_{xx} full conformity and a necessary value for it in $37,4 \text{ pF}$ is a quite real estimation. By the same principles the biological object total capacity value with dielectric barriers and assembling parasitic capacity can be estimated $93,8 \text{ pF}$ in the unconfigured state and $66,4 \text{ pF}$ after 100 impulses.

The oscilloscope diagram researches principles and calculations further perfection will create presupposition for deep calculated electric field distribution estimations in biological object structural elements and the bio-damage mechanism aspects revelation.

The vegetative objects electrical impulse bio-damage effect and electrical impulse processing modes influence was estimated in that work on *Tradescantia* leaves shrinkage and beet laminae. Control object and influenced object periodic photo registration was carried out during several days, and their state change degree was visually compared at various magnitude of the energetic influence provided by submitted impulses pressure and quantity level change (fig.3).

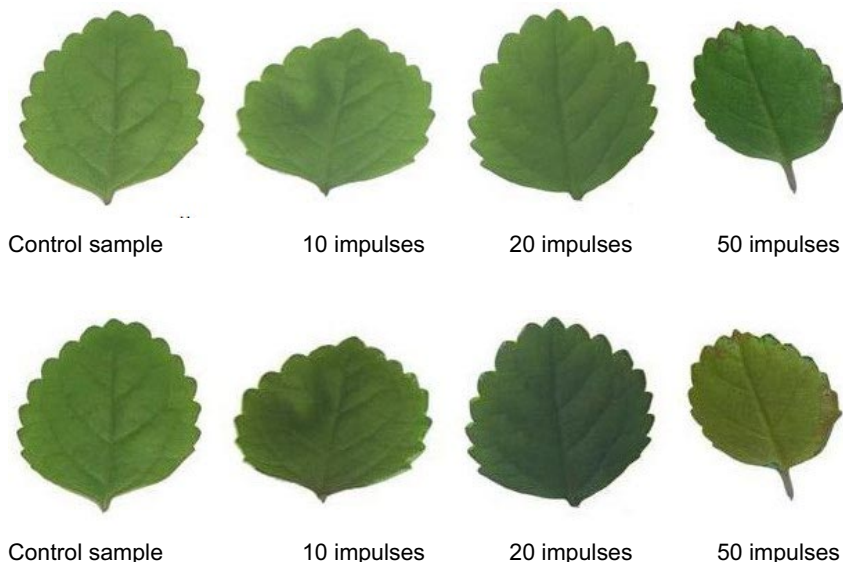


Fig.3. Photos of *Tradescantia* leaves after electrical impulse processing. In the top line: the control sample and the leaves subjected to 10, 20 and 50 impulses influence. In the bottom line – the same objects in 24 hours

Generally *Tradescantia* leaves electrical impulse bio-damage visual effect in the form of dimness with liquid droplets on the surface is notified at once after the test. Appreciable bio-damage place nigrescence is visually noticed in 3 hours after the influence, further bio-damage spot contrast increases, and in a day its shrinkage can be observed.

Conclusion

Influence on plant leaf in the spike -plane system without dielectric barriers leads to leaf localized burning-through, changing a little with impulses number increase and influencing little on the further leaf state during a period of time.

At influence on object in the disk electrodes system the dimness spots are formed on the all leaf area without dependence from dielectric barrier presence, though they have their peculiarities. In the absence of a barrier because of high conductivity of a vegetative fabric generator loading is low - ohm resistance that does not allow creating high level of pressure on object and in our case of signs burning-through sheeting it is not observed. The dimness area is accurately limited by a high-voltage electrode diameter and the dimness becomes less noticeable with increase in the contact area.

In the dielectric barrier presence, probably, it is possible to keep field's parameters in a vegetative fabric on the big contact area. In the electrodes system «a disk (of the limited

diameter) – the plane» the dimness area of in the form of a ring on the top electrode diameter, including the disk falling outside the limits, is noticed especially, that is in the area with the maximum gradients of the electric field. At the increased area electrode (to 30 cm^2) with the perforation especially intended for local sections formation with raised gradients of a field, at the same influence level the damaging effect increases proportionally the square. Electrical impulse bio-damage preference of electrode systems use with the dielectric barrier, marked at once after the influence on the leaf dimness, is clearly shown in some days at a leaf drying stage.

At the same time it is important to note the following fact. In the electrodes system "spike -plane" with dielectric barriers the dimness area, confined with the area where sliding categories developed on the dielectric barrier surface, is also noticed, i.e. the maximum field gradient (in the test it there were no more than 5 ... 10 % from the impulse submitted number) takes place.

On the electrical impulse influence on a vegetative fabric with dielectric barriers application these comparative tests basis it is possible to conclude, that bio damage by impulse electric influence has essential and technologically significant distinction in effect at the influence various mode by electric field. It allows bringing up issue about the special researches carrying out on energetic and technological process optimization expediency.

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Докладът е рецензиран.