

**EFFECT OF CORONA DISCHARGES AS A POSSIBLE
NON-POLLUTANT MEAN TO CONTROL THE GRANARY WEEVIL
(*SITOPHILUS GRANARIUS* L.), MAJOR PEST OF STORED CEREALS**

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Abstract

Talking into consideration that chemical control is generally pollutant, its use to protect the stored cereal seeds is accepted in the main for the stocks but at the same time strictly limited in case of stocks destined for human and animal consumption.

*The paper presents some laboratory results of the tests concerning the effect of corona discharges as a possible non-pollutant mean to control the granary weevil adults (*Sitophilus granarius* L.). The corona discharges were generated between a superior filamentary electrode and a ground flat electrode, connected to a fully adjustable high-voltage electric source. The testing method is the direct exposure of the infested cereal seeds by granary weevil adults to the filamentary corona field. The effect of corona field was studied at different level of voltage and exposure time against the infested stock in the Laboratory of Entomology at the Faculty of Agriculture of USAMV Cluj-Napoca and at the Technical University of Cluj-Napoca, during 2002-2010.*

The recorded results after the tests in different filamentary corona discharges concluded that in the future these could be an unpolluted and low energophagous technology to protect the agricultural stored products.

INTRODUCTION

Biological effect of corona discharges produced by the electric fields on different living organism (seeds and pest) is certain, although the biophysical mechanisms which can influence the biological functions are now insufficiently know. Corona discharges produced in the case of both, continuous and alternative electric currents, are effective, the efficacy being dependent on the nature of the constitutive parts of the target organisms [3].

Depending on the electric field voltage, intensity and on the time of exposure, the living material may be affected differently, from the stimulation to the inhibition of its biological functions [1].

In the present paper the authors attempt to present how the corona discharges produced in the air, by an alternative electric current, can be used directly as an efficient unpollutant agent, in the control of the pests of the agricultural stored

products. Our experiments tried to establish the parameters which can be able to destroy the pests, the pathogen microorganisms, without affecting the normal biology of the treated seeds (or even inducing a stimulation as collateral bio-physical effect) [4].

The ionic bombardment produced by the filamentary corona elements is established between two metallic electrodes, one superior having the form of a filamentary electrode and one inferior, the „ground” electrode, flat. The bottom and the walls of the Petri dishes which contained the „target” sampe , act like a dielectric obstacle for the electric corona discharges. This ionic filamentary bombardment, relatively uniformly distributed in the whole corona discharge, having values between 0.01 and 4.0 mA, is able to determine the destruction of the microorganisms and harmful fauna and in the same time, to induce an electro-stimulation of the germination and the plant growing in the first days after germination [2].

MATERIAL AND METHODS

The treatments were made in intense electric fields, produced by device (Figure 1), in the case of different exposures, applied to the experimental samples.

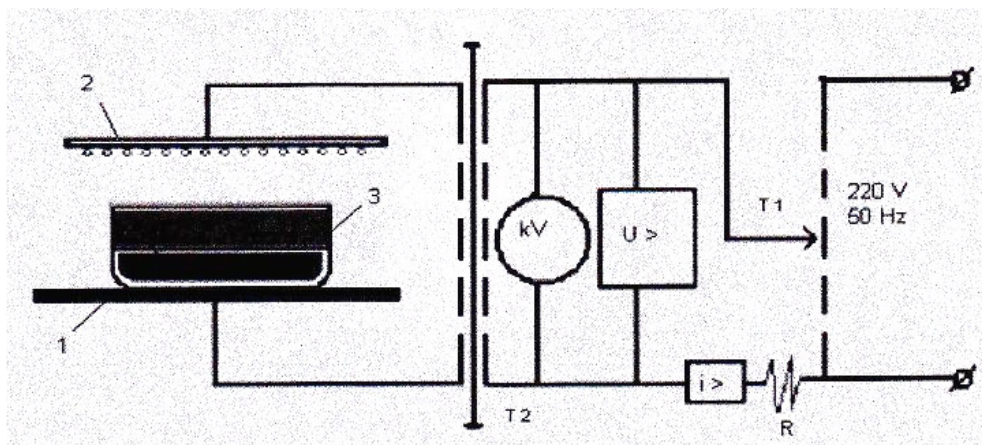


Fig. 1. Treatment stand with filamentary corona discharge for infested cereals stocks

1) ground flate electrode; 2) filamentary electrode; 3) Petri dishes; T1- autotransformator; T2- transformer; R- a limitation resistance of the electricity of short circuit; (I>, U<) an electric protection at overweight and short circuit (Dinuță, 2006)

The high-voltage adjustable source of (at 50 Hz) may assure a variable voltage between the electrodes, in the upper/higher limits of 1 kV and 25 kV. The source is composed by a transformer (T2), a limitation resistance of the electricity of short circuit (R), an electric protection at overweight and short circuit (I>, U<) and a block of measurement of high voltage (kV). The filamentary discharges is realized between the „filamentary” electrode (2) and a ground flate electrode (1), connected to the high-voltage source.

The „filamentary” electrode is made by 0,5 mm Ø wolfram wires 0,5 mm, parallel placed with 5 mm pitch. Between the two electrodes the discharge interstice was of 20 mm. In this interstice was placed the glass Petri dishes (3) contained the experimental sample. The thickness of the bottom and walls of the Petri dish were 2 mm, the diameter about 60 mm and the walls were about 20 mm high.

The experimental samples were composed by 100g of „intact” wheat or corn seeds, each sample being „freshly” infested with 100 young adults (imago) of *Sitophilus granarius* L., having the the age of 24 to 48 hours. These adults were selected from a middle infested wheat seed stock, according the colour (light brown) and the time after the appearance of the adult weevils. The „experimental culture” was obtained in a chamber with controlled atmosphere: $t = 26^{\circ}\text{C} (\pm 2^{\circ}\text{C})$ and relative air humidity of 75% ($\pm 5\%$).

The experimental variants (samples) were treated in 3 repetitions, in the corona discharges obtained in the fields of 5 kV, 10 kV, 15 kV and 20 kV voltage and the exposure times of 30, 45 and 60 minutes. After the exposures, the treated samples were transferred from the Petri dishes in little cylindrical boxes (methyl-meta-acrylate), their lid having the major surface represented by a dense metallic screen.

RESULTS AND DISCUSSION

The treatments applied on the wheat samples showed that the adults of *Sitophilus granarius* L., exposed in corona fields, manifested firstly a low answer to the mechanical stimuli, a low coordination of movements, followed by a progressive paralysis, lower level of the feeding and digestive functions, progressive dehydration and finally, the death.

All the reductions of the biological functions increased simultaneously with the increase of the voltage and with the exposure time. Finally, as a result of all these effects, the death occurred earlier in the treated samples, simultaneously with the increase of the voltage and the increase of the time.

In the tables 1 and 2 there are presented the mortalities of the *Sitophilus granarius* L. adults, after different time periods from the exposures of the infested seed samples in the corona discharges.

Table 1

Mortality of *Sitophilus granarius* L. adults, induced by corona filamentary discharges after the exposure of infested wheat seed stocks (Cluj-Napoca 2009)

Voltage	Exposure time (minutes)	Mortality (%) observed after:						
		24 h	48 h	72 h	96 h	120 h	144 h	168 h
5 kV	30	34.66	62.33	73.33	82.66	89.33	98.66	100.00
	45	40.00	67.66	82.33	88.66	93.66	100.00	100.00
	60	48.00	74.33	88.00	95.33	100.00	100.00	100.00
10 kV	30	53.66	85.66	94.00	100.00	100.00	100.00	100.00
	45	63.33	88.66	99.33	100.00	100.00	100.00	100.00
	60	78.66	97.00	100.00	100.00	100.00	100.00	100.00
15 kV	30	64.00	90.00	100.00	100.00	100.00	100.00	100.00
	45	92.33	100.00	100.00	100.00	100.00	100.00	100.00
	60	100.00	100.00	100.00	100.00	100.00	100.00	100.00
20 kV	30	94.66	100.00	100.00	100.00	100.00	100.00	100.00
	45	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	60	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mean value		72.44	88.80	94.74	97.22	98.58	99.88	100.00

Table 2

Mortality of *Sitophilus granarius* L. adults, induced by corona filamentary discharges after the exposure of infested corn seed stocks (Cluj-Napoca 2010)

Voltage	Exposure time (minutes)	Mortality (%) observed after:						
		24 h	48 h	72 h	96 h	120 h	144 h	168 h
5 kV	30	30.66	51.33	63.00	71.66	84.33	95.00	100.00
	45	36.00	63.33	74.66	83.33	94.66	100.00	100.00
	60	44.00	68.33	83.33	91.33	100.00	100.00	100.00
10 kV	30	52.33	71.00	86.33	100.00	100.00	100.00	100.00
	45	62.33	84.33	95.66	100.00	100.00	100.00	100.00
	60	75.00	91.66	100.00	100.00	100.00	100.00	100.00
15 kV	30	86.33	92.33	100.00	100.00	100.00	100.00	100.00
	45	93.33	100.00	100.00	100.00	100.00	100.00	100.00
	60	100.00	100.00	100.00	100.00	100.00	100.00	100.00
20 kV	30	96.66	100.00	100.00	100.00	100.00	100.00	100.00
	45	100.00	100.00	100.00	100.00	100.00	100.00	100.00
	60	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Mean value		73.05	85.19	91.91	95.52	98.24	99.58	100.00

The complex analysis of the two tables show insignificant differences between the results obtained on grain and corn stock. The lowest effect (mortality induced to

adult weevil population) was recorded in the case of the variant treated with 5 kV voltage, in an exposure time of 30 minutes (the mortality of 100% was induced only after 168 hours after the treatment). The reduction of the feeding and digestive functions, paralysis and a low rate of coordinating movement, was proved by the low rate of damages observed on the seeds.

Mortality increases according to the higher voltage and a longer exposure time. So, in the case of 15 kV (60 minutes exposure time) and 20 kV voltage (45 and 60 minutes exposure time), mortality of 100% was induced in the first 24 hours after the exposure. In the case of these variants, the used voltage and time of exposure proved to be the most efficient in the control of the adults of *Sitophilus granarius* L.

CONCLUSIONS

From the presented data concerning the treatment of stored seeds (wheat and corn) with filamentary corona discharges, the following conclusions are notable:

1. the corona discharges in alternative electric current (50 Hz, high voltage) can control the adults of the granary weevil, *Sitophilus granarius* L.;
2. there are no significant differences between the results obtained on infested wheat and corn seed samples;
3. the lowest mortalities were obtained by the variants treated with the lower voltage (5kV) and the lower time of exposure (30 minutes), 168 hours were needed to obtain a 100% mortality;
4. the highest mortalities (100% after 24 hours) were obtained by the variants treated with highest voltage (15kV and 20kV) and longer exposures (45-60 minutes);
5. the other combinations between the different voltages and times of exposure obtained intermediate results, the mortality increases proportionally with voltage and exposure time;
6. the presented experiments, can lead to conceive a high voltage source and a device for the treatment of cereal seeds, with a wide field of applications in the control of the stored cereal pests.

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