

THE EFFECT OF CORONA DISCHARGES IN THE CONTROL OF GRANARY WEEVIL (*SITOPHILUS GRANARIUS* L.), MAJOR PEST OF STORED CEREALS

EFECTELE DESCĂRCĂRILOR CORONA ÎN COMBATERICA GĂRGĂRIȚEI GRĂULUI (*SITOPHILUS GRANARIUS* L.), DĂUNĂTOR MAJOR AL CEREALELOR DEPOZITATE

Adrian DINUȚĂ*, Horia BUNESCU, Marian PROOROCU**, Ilonka BODIS****

**Regional Environmental Protection Agency Cluj-Napoca, Romania*

***University of Agricultural Sciences and Veterinary Medicine, Cluj-Napoca Romania
Dorobanților Street 99, Cluj-Napoca, Romania, email: adrian_dinuta@yahoo.com*

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 brush-type 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 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 2002-2008. The recorded results after the tests in different corona discharges concluded that in the future these could be an unpolluted and low energophagous technology to protect the agricultural stored products.

Rezumat: Având în vedere faptul că tratamentele chimice sunt în general poluante, utilizarea lor în protecția cerealelor este în mod general acceptată, dar în același timp supusă unor limitări stricte în cazul stocurilor destinate consumului uman și animal. Lucrarea prezintă rezultate ale unor teste de laborator privind efectele descărcărilor corona, ca o posibilă metodă non poluantă de combatere a adulților gărgăriței grâului. Descărcările corona au fost generate între un electrod superior tip perie, conectat la o sursă electrică de voltaj mare, ajustabilă și un electrod tip placă conectat la împământare. Metoda de testare constă în expunerea directă a stocurilor de cereale infestate cu adulții gărgăriței grâului în câmp corona. Efectul câmpului corona a fost studiat la diferite tensiuni de generare și timpi de expunere a stocului infestat, în cadrul Laboratorului de Entomologie al Facultății de Agricultură (USAMV Cluj Napoca) și în cadrul Universității Tehnice din Cluj Napoca, în perioada anilor 2002- 2008. Rezultatele obținute în urma testelor efectuate în câmp corona de diferite tipuri, pot duce la concluzia că în viitor acestea pot constitui o metodă nepoluantă și slab energofagă pentru protejarea produselor agricole stocate.

Key words: corona discharges, granary weevil, pest, stored cereals

Cuvinte cheie: descărcare corona, gărgărița grâului, dăunător, cereale depozitate

INTRODUCTION

Biological effect of corona discharges produced by the electric fields on different living organism (seeds and pest) is certainly, although the biophysical mechanisms which can influence the biological functions are now insufficiently known. Corona discharges produced in the case of both, continuous and alternative electric current, are effective, the efficacy being dependent on the nature of the constitutive parts of the target organisms (SUĂRĂȘAN et al., 2005).

Depending on the electric field voltage, intensity and on the time of exposure, the living material may be differently affected, from the stimulation to the inhibition of its biological functions (DINUȚĂ et al. 2005).

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 to control the pests of 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) (SUĂRĂȘAN, et al., 2006)

The ionic bombardment produced by the punctiform corona elements is established between two metallic electrodes, one superior having the form of a brush and one inferior, the „ground” electrode, flat. The bottom and the walls of Petri dishes, which contained the “target” sample, act like a dielectric obstacle for the electric corona discharges. This ionic punctiform bombardment, relatively uniformly distributed in the whole corona discharge, with values between 0,01 and 4,0 mA, is able to determine the destruction of the microorganisms and harmful fauna and the same time to induce an electro-stimulation of germination and the plant growing in the first days after germination (DINUȚĂ, 2006).

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.

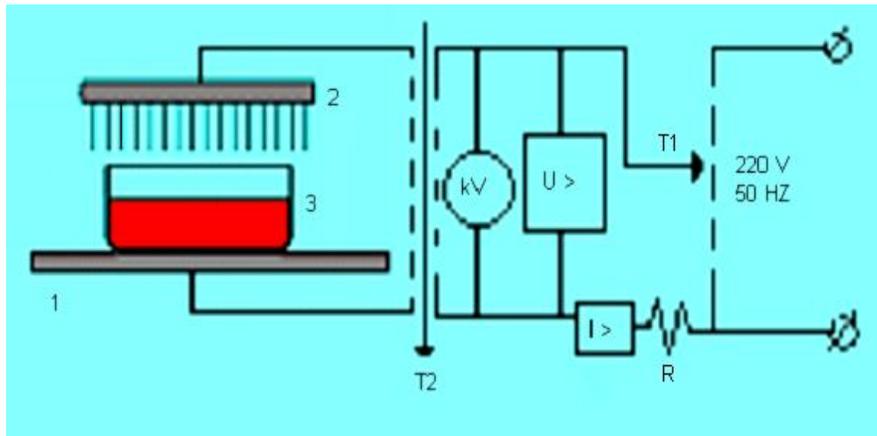


Figure 1. Treatment stand with punctiform corona discharge of infested cereals stocks: 1) ground flat electrode; 2) brush electrode; 3) Petri dishes; T1- autotransformer; T2- transformer; R-a limitation resistance of the electricity of short circuit; an electric protection at overweight and short circuit (I>, U<) (SUĂRĂȘAN et al. 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 punctiform discharges is realized between the „brush” electrode (2) and a ground flat electrode (1), connected to the high-voltage source.

The „brush” electrode, has 21 rows of wolfram filaments (0,5mm and 20 mm length). On each row there are 192 emissive points, as on the total surface of the brush there are 4032 emissive points. 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 about 2 mm, the diameter 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 by 100 young adults (imago) of *Sitophilus granarius* L., having the age of about 24 to 48 hours. These adults were selected from a middle infested wheat seed stock, according the color (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 DISCUSSIONS

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 is showed the mortality of the *Sitophilus granarius* L. adults, after different time periods from the exposures of the infested seed samples in the corona discharges.

Table 1

The mortality of *Sitophilus granarius* L. adults, induced by corona punctiform discharges after the exposure of infested wheat seed stocks (Cluj-Napoca 2007)

Voltage	Exposure time (minits)	Mortality (%) observed after:						
		24 h	48 h	72 h	96 h	120 h	144 h	168 h
5 kV	30	34,33	62,33	77,33	82,66	89,33	98,66	100,00
	45	39,00	66,66	82,33	88,66	95,66	100,00	100,00
	60	48,00	74,33	88,00	95,33	100,00	100,00	100,00
10 kV	30	55,66	81,66	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	76,66	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		72,22	88,38	95,00	97,22	98,74	99,88	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 voltages at 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.

Table 2

The mortality of *Sitophilus granarius* L. adults, induced by corona punctiform discharges after the exposure of infested corn seed stocks (Cluj-Napoca 2008)

Voltage	Exposure time (minits)	Mortality (%) observed after:						
		24 h	48 h	72 h	96 h	120 h	144 h	168 h
5 kV	30	30,66	54,33	66,00	73,33	79,33	95,00	100,00
	45	38,00	63,33	71,66	80,33	94,66	100,00	100,00
	60	46,00	68,33	85,33	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	60,33	83,33	95,66	100,00	100,00	100,00	100,00
	60	71,00	91,66	100,00	100,00	100,00	100,00	100,00
15 kV	30	66,33	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		71,22	85,35	92,08	95,41	97,83	99,58	100,00

The 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 *Sitophilus granarius* L. adults.

CONCLUSIONS

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

- The corona discharges in alternative electric current (50 Hz, high voltage) may control the adults of the granary weevil, *Sitophilus granarius* L.;
- There are no significant differences between the results obtained on infested wheat and corn seed samples;
- The lowest mortalities were obtained by the variants treated with the lower voltage (5 kV) and the lower time of exposure (30 minutes), 168 hours were needed to record 100% mortality;
- The maximum mortalities (100% after 24 hours) were recorded by the variants treated with highest voltage (15kV and 20kV) and longer exposures (45-60 minutes);
- The other combinations between the different voltages and times of exposure obtained intermediate results, the mortality increases proportionally with voltage and exposure time;
- 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.

BIBLIOGRAPHY

1. DINUȚĂ A., I. GHIZDAVU, I. SUĂRĂȘAN, H. BUNESCU, 2005 - The mixed effects of the intense electric fields and generated ozone on the granary weevil (*Sitophilus granarius* L.), Buletin of the University of Agriculture Science and Veterinary Medicine Cluj-Napoca, 96-100.

2. DINUȚĂ A., 2006 - Cercetări de combatere neconvențională a gărgărițelor din genul *Sitophilus*, dăunătoare cerealelor depozitate (Researches of unconventional control of the weevils from *Sitophilus* genus, pest of stored cereals), Teză de doctorat, Universitatea de Științe Agricole și Medicină Veterinară Cluj-Napoca, Facultatea de Agricultură, p. 355
4. SUĂRĂȘAN I., A. DINUȚĂ, I. GHIZDAVU, R. MORAR, S. BUDU, 2005 - Ozone and intense electric fields upon some pests present in cerrealiere depots, 5Th International Conference on Electromecanical and Power Systems (SIELMEN 2005), Chisinau, Republic of Moldova, vol. 2, 760-763.
5. SUĂRĂȘAN I., I. GHIZDAVU, A. DINUȚĂ, S. BUDU, 2006 - Ozone and high intense electric fields – ecological factors in the control of the diseases of the stored corn and wheat seeds, 5^{ième} Conférence bi-annuelle de la Société Française d'Electrostatique (SFE 2006), Grenoble, France, 333-336.