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J. Electrical Systems 3-3 (2007): 144-150

Regular paper

Study and realization of an electric process to fight against harmful insects

JES
Journal of Electrical Systems

A device for catching insects, using a high voltage electrical discharge, called KAHRATRAP, is designed and build up by the first author of this paper. The aim of this paper is to describe the electrical operation mode of this apparatus such as the high voltage supply and the electrical discharge which this supply produces for the elimination of insects. Moreover, we analyze the influence of climatic parameters such as temperature, humidity and speed of wind on the efficiency of the apparatus. This experimental device was used during 4 months in a vegetable field, operating during the night from 18h to 6h to capture harmful insects. The reading of insect numbers is done according to a procedure using a binocular magnifying glass, an entomologist tool and boxes for the collection of insects.

Keywords: **C**atching Insects Device, High Voltage Electrical Discharge, KAHRATRAP

1. INTRODUCTION

Even if the pesticides contribute in increasing the agricultural outputs against invader insects, their environmental impact is both dramatic and insidious [1-2]. Today these products are implicated in environmental pollution, especially in the areas of intensive agriculture through the contamination of the rivers and the underground waters by the pesticides [3]. The electrical solution is nowadays recommended to fight insects.

2. DESCRIPTION OF THE APPARATUS

KAHRATRAP is an electrical solution used to fight harmful insects (figure 1), it was designed with variable parameters (lamps, color of lamp’s lights, power of lamps, height of suspension, field of attraction…). The height of suspension from the ground was maintained constant, and equal to 85 cm, for the study presented in this paper. The "Tare" weight is about 24 kg, and the dimensions of the apparatus are as follows: Length = 70 cm, Width = 38 cm, Height = 75 cm. The enclosure of the apparatus consists of parallel rods, forming a metal netting (figure 2). The rods of even number are connected to the positive pole of the high voltage supply (anodic rods), and those of odd number are connected to the negative pole (cathode rods). The insect attracted by the light of the lamps, penetrates in the apparatus and gets into the space located between anodic and cathode rods. At this moment an electric discharge is produced between one of the two rods and the insect, this latter is then “electrocuted” by the discharge itself.

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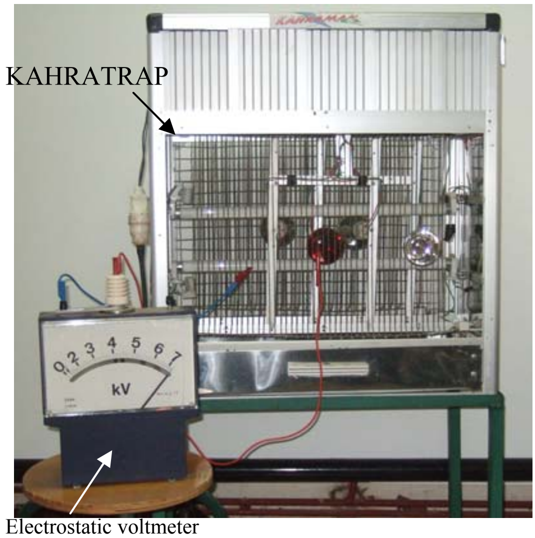

Figure 1: Photography of the realized apparatus KAHRATRAP

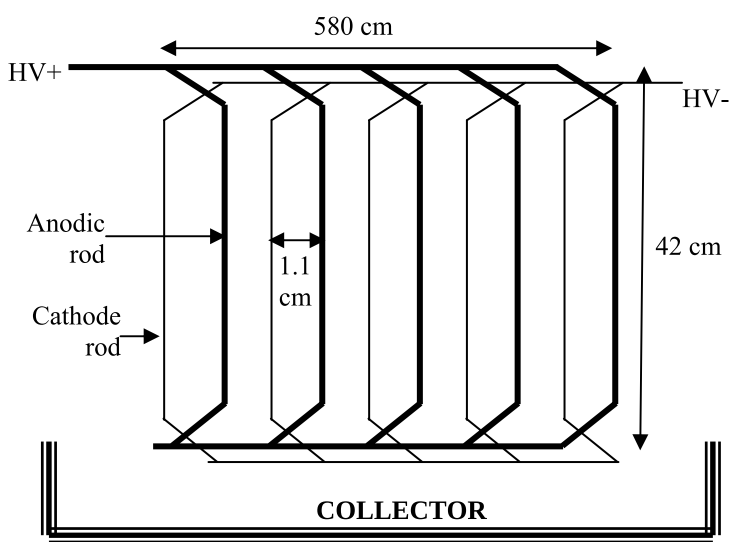

Figure 2: Descriptive diagram of the "electric netting"

3. DESCRIPTION OF THE HIGH VOLTAGE SUPPLY

The principal element of this apparatus is the direct-current high voltage generator which must support the thousands of sparks which occur during the operation of the device. Thus, we opted for a high voltage generator based on the principle of charging and discharging of condensers [4-5]. Figure 3 shows the electrical circuit of the generator, called Schenkel device. The number of diodes used in each branch is three, because each one supports 1000 V only.

Figure 4.a shows the output voltage of the generator during operation of the apparatus. The voltage is submitted to fast fluctuations due to the discharge of condensers when capturing insects, and their charge which is carried out very quickly (some microseconds). Figure 4.b shows an increasing zoom of voltage fluctuation around the average value of 7.5 kV. These curves were plotted using a plotting table (LINSEIS, standard L 250 E), and a voltage divider probe of 1200 MΩ (Metrix HT216).

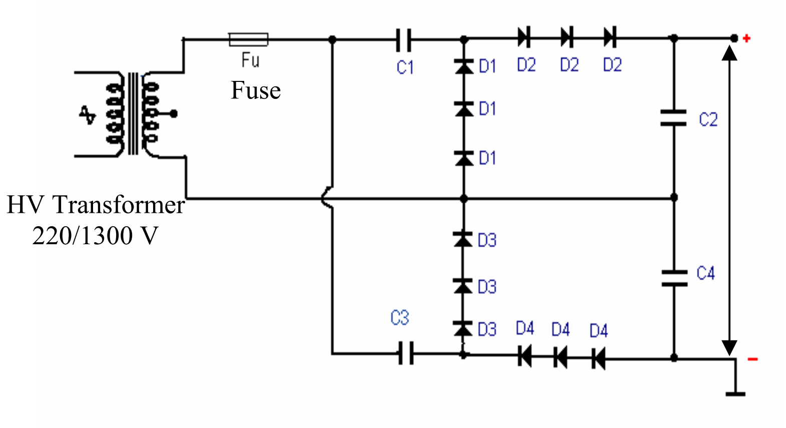

Figure 3: Electrical circuit of the high voltage supply

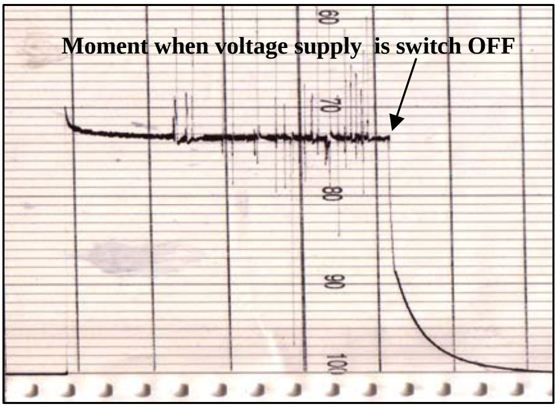

Figure 4.a: Voltage fluctuation during the operation of the apparatus

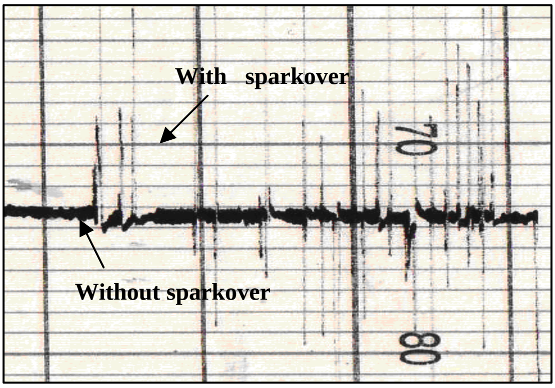

Figure 4.b: Zoom of the Voltage fluctuation

The device consumes little energy since the output current does not exceed some milliamperes. The greatest part of the consumed energy is due to the power of four "reflectors" lamps of 60W each, and two fluorescent tubes of 36 Watts each.

4. OPERATION MODE OF THE APPARATUS

The operation consists in applying a high voltage between rods of the netting. Once the insect penetrates between them, it is immediately electrocuted by means of an electric discharge. Figure 5 shows a simulation with an aluminum end where we see the discharge occurring between this one and the netting lattice.

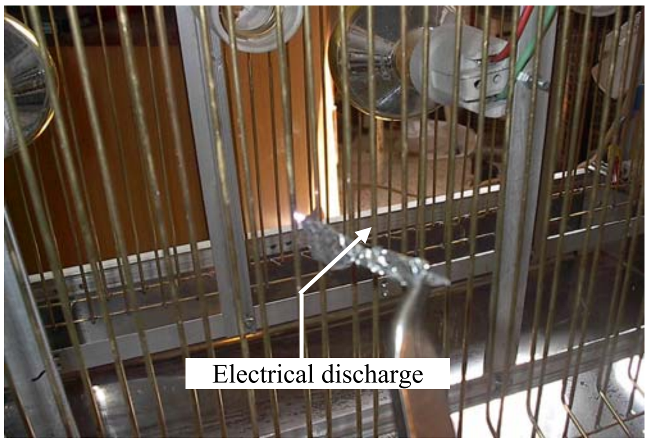

Figure 5: Simulation of the electric discharge using an aluminium end

The distribution of the electric field between two electrodes changes in the presence of an external body [6]. Figure 6 shows the change of the lines of electric field in the presence of a conducting spherical particle. The presence of a conducting particle, similar to our insect case, changes the distribution of the field and increases it on the surfaces of the electrodes. This new distribution produces a discharge between one of the electrodes and the insect, followed by another between the insect and the second electrode (figure 7) [7-8]. In this way, an insect going between the two rods undergoes a discharge, in the same way as a man walking inside a corridor of high voltage lines.

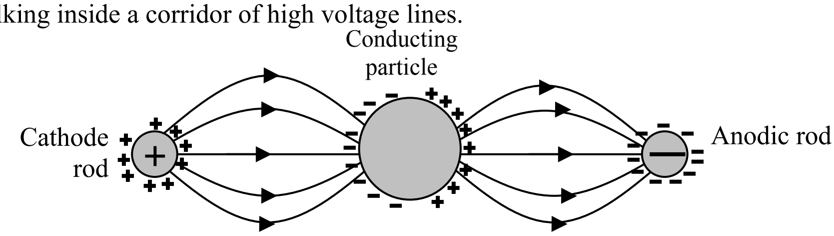

Figure 6: Charges induced on a conducting particle

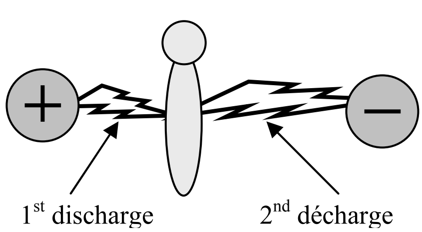

Figure 7: Electrical discharge occurring between the insect and electrodes

5. Results

The reading of insect numbers is taken daily according to a procedure using a binocular magnifying glass, tool of the entomologist and boxes for the collection. The results presented in this paper are related to a certain class of insects whose size varies from a millimeter to approximately five centimeters.

The trappings were carried out in a firm located at DOUAR EL' MCHAREF in the area of MASCARA (ALGERIA) at 478 m of altitude, for a 04 months-period (July 01st, 2004 to October 30th, 2004). The studied area is a cultivated agricultural field of two hectares of sweet peppers, three hectares of tomatoes and four hectares of water melon and melon, bordering to a field of olive-trees.

We established during this period of experimentation a set of results of insect's collections. Let us note that the values of the weather data (temperature, humidity, speed of wind and precipitations) were recorded daily, thanks to an appreciated collaboration of services of a weather station located near the experimental site. Over the 120 days of experimentation we gathered the results which enabled us to study the variation of one factor (the temperature for example) while keeping two other (moisture and speed of the wind) "almost constant" or varying slightly in a small scale.

Thus, we represent on figure 8 the obtained results according to the wind's speed for a 20-25° range of temperature and a 60-70% range of humidity. Obtained results depending on the temperature are illustrated by the curve of figure 9. They were obtained at a range of humidity values between 50 and 60 % and a speed of wind varying between 2 and 3 m/s. Figure 10 illustrates the results according to humidity at a range of temperatures varying from 15 to 20°C and a speed of wind varying from 2 to 3 m/s.

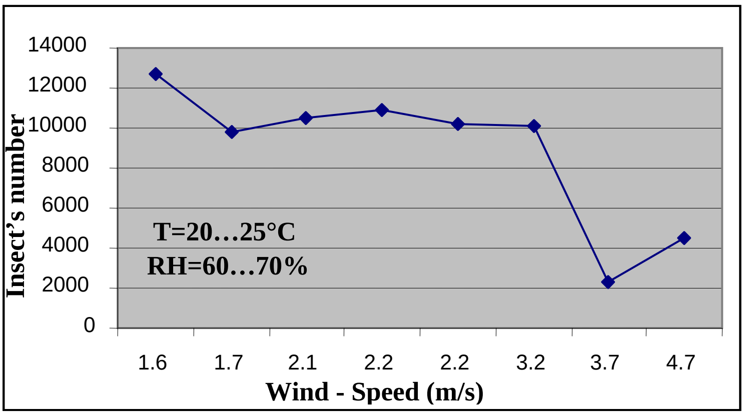

Figure 8: Variation of the insects' number according to the wind's speed

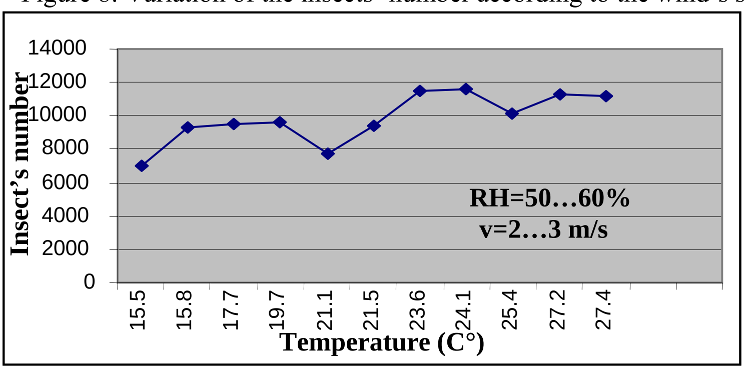

Figure 9: Variation of the insects' number according to the temperature

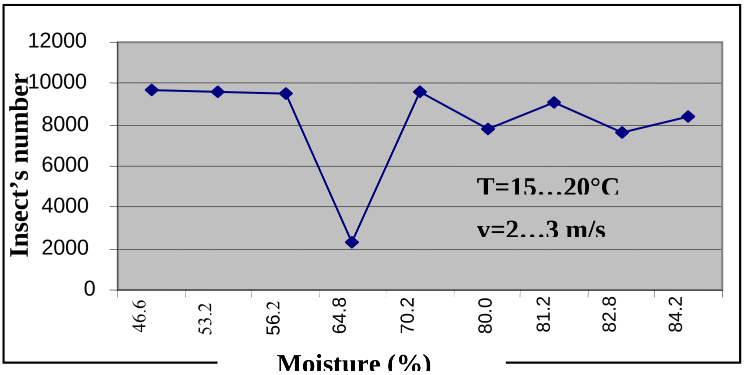

Figure 10: Variation of the insects' number according to humidity

6. Discussion

The experiments were carried out during the night from18h to 6h to trap harmful insects. The eyes of the insects made up of a great number of light sensors laid out in mosaic, have a very wide field of vision and are adapted to detect fast moving objects. Figure 11.a shows the aspect of the light emitted by the lamps at a distance of 150 m and figure 11.b at a distance of 350 m.

Figure 11.a: Light visible at a distance of 150m

Figure 11.b: Light visible at a distance of 350m

The increase of wind's speed reduces the number of caught insects and decreases the efficiency of this process (figure 8). This is due to the movement of insects which becomes at random and chases them away from following the intended flight direction. Let us note that the efficiency of the device remains high as long as the speed of the wind does not exceed the value of 3.5 m/s. Indeed, the obtained results showed that the average capture remains higher than 10000 insects/night, when the speed of the wind remains lower than 3.2 m/s. Let us note that the capture is minimal (2254 captured insects) during the 7th night because of a moderate storm, hail and rain fall at a high wind speed of 3.7 m/s.

The influence of temperature on the trapping efficiency, illustrated by figure 9, shows that the quantity of caught insects increases slightly with the rise of temperature. The efficiency of the apparatus remains almost insensitive to the variations in temperature, which proves that this process can be used at any season. Moreover, ambient humidity has a more significant influence greater than the temperature. The obtained results, illustrated by figure 10 show and confirm, indeed, this tendency. Let us note that the result corresponding to humidity of 64.8% was obtained in a night with strong winds and rain precipitations.

7. Conclusion

The electric solution against harmful insects deserves to be recognized as an efficient sector of expertise identified as well as is, for example, the biological fight. This recognition should be essential as the search for alternatives to the pesticides intensifies. Indeed, the difficulties about the implementation of the biological fight create a space favorable to the development of the electric methods of fight. The implementation of these methods supposes collaboration between professionals trained in disciplines often distant one from the other. The specialist in the electric engineering must work with a physiologist of plants, an entomologist... These people are expert in different sciences and use different languages and working tools. Moreover, the organization of research often makes so that these people work for different laboratories by pursuing, often, incompatible objectives. The results presented in this paper allow us to prove the efficiency of this electrical solution and also to understand and to quantify the influence of climatic parameters.

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