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Control of Pests With Electromagnetic Energy

By Donald W. Thayer

The proper application of electromagnetic energy can provide an important part of an integrated pest management program. Integrated pest management is defined as a method of determining if pests (of any kind — i.e., microorganisms, insects, rodents, birds, etc.) suppression treatment(s) are needed, when they are needed, where they are needed, and what mix of treatments are required to obtain the best solution for pest control based on predicted economic, ecological, and sociological consequences. The applied treatments may involve any combination of physical, chemical, and biological methods. Ideally, combinations of methods will be chosen that produce synergistic results. The physical methods involving various forms of electromagnetic energy will be discussed here.

At least eight forms of electromagnetic energy can be successfully applied to the control of various pests. Practical applications have been made of some forms. Resourceful managers will probably make practical use of the other forms. The major forms of electromagnetic energy of interest are the following: radio waves, microwaves, infrared light, visible light, ultraviolet light, X-rays, gamma rays, and accelerated electrons. They form a spectrum ranging from very low energy to very high energy (Fig. 1). The principal modes of action reflect the energy level of radiation forms ranging from heat generation to disruption of chemical bonds and potentially atomic changes. Electrons can be accelerated to potentials sufficient to produce atomic changes which occur at about an energy level of 10.4 million electron volts (mEv). It is also possible to generate X-rays with sufficient energy to cause atomic changes. Thus, the energy level of electrons is restricted to a maximum of 10 mEv and X-rays to a maximum of 5 mEv for food applications. The major, but not the only, effect of radio waves, microwaves, and infrared light on living organisms is the generation of heat which, if severe enough, can result in death. The energy of the photon is inversely proportional to the wavelength which means that the shorter the wavelength the greater the potential effect on matter. Starting with visible light and increasing with shorter wavelength chemical bonds are affected by the radiation. High energy X-rays and electrons may have sufficient energies to cause nuclear changes. Heat is generated by the absorption of all forms of electromagnetic energy, and even radio and microwaves may generate mutations. Thus, the interactions of these energy forms with biological matter may be complex. Because energy forms from opposite ends of the energy spectrum have predominantly different modes of action, the use of, as an example, microwave energy or infrared energy with ionizing radiation, such as gamma rays, may produce results that are greater than would be expected. The combination of either microwave or infrared with gamma ray treatment of winter wheat produced greater than expected kill of the lessor grain borer. Treatments with either microwave or infrared, especially if in vacuum, will result in drying of the product. This may be an advantage in some cases or a disadvantage in others. The trick is to put together the treatments that achieve the greatest benefit, and that is where the manager earns his or her income. Treatments with electromagnetic energy have one obvious advantage over traditional chemical methods in that there are no potentially toxic residues, but these same treatments suffer from the lack of residual protection of the product. (One should not assume, however, that because there are no residual chemicals that the treatments may not have resulted in the formation of potentially toxic products in a food. This is especially true of any process which results in significant heating of the product.) How can these electromagnetic energies be used in a pest management program?

Radiofrequency (RF) energy produces heating in materials which absorb it and thus can be used for insect control. RF has been of particular interest to investigators because insects tend to absorb the energy more readily than grains and because it has great penetrating power. This means that the insects can be killed by exposure to RF

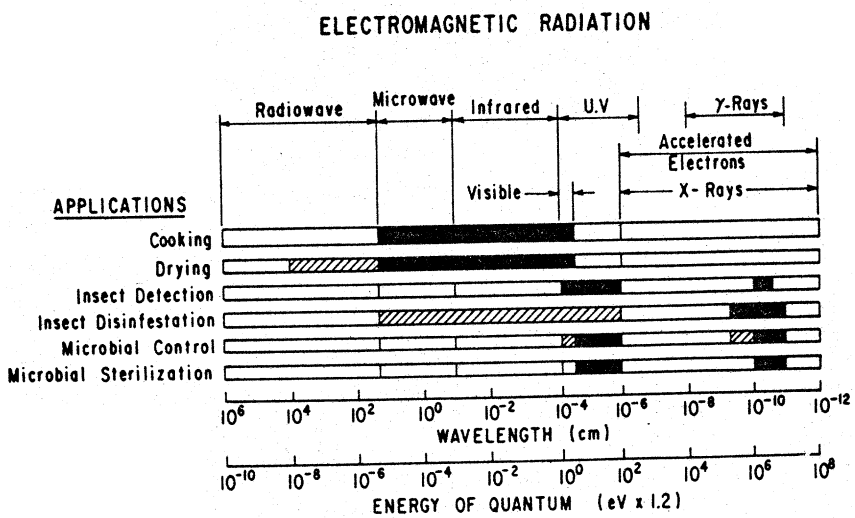

Fig. 1. Electromagnetic radiation. The electromagnetic spectrum is presented in terms of wavelength and energy of the quantum. Applications of electromagnetic radiation to pest management are indicated by solid bars and areas of potential application indicated by shaded bars.

ABOUT THE AUTHOR

Dr. Donald W. Thayer, Chief, Food Safety Laboratory, Eastern Regional Research Center, U.S.D.A., submitted this paper to the Food Protection Committee for its publication. This paper is an Executive Summary of a more thorough involved study.

& S.H. Thompson & Co. Ltd.; H.R. Williams Mill Supply Co.; and Creason Corrugating and Machinery Company Inc. for hosting this superb luncheon today.

We would like to bring to your attention the Continental Breakfast sponsored by Kice Metal Products Inc. Kice Metal Products began their sponsorship of this breakfast two years ago to help reduce the congestion at the hotel restaurants in the morning rush. We sincerely thank Kice Metal Products for their thoughtfulness in looking for more and better ways to improve our conference of which one was the sponsorship of this breakfast.

Your National Officers have attended most of the district meetings throughout this past year. Attendance at the meetings has been excellent with many good papers being presented and strong support by our allied trades people.

I have visited many of the districts during the past two years. My only regret is that I was unable to visit all districts within the association. These two years have been extremely interesting and educational with good fellowship everywhere that I went. A.O.M. is changing and growing in stature and goodwill. I would like to think that I have had just a small input to this and have no doubt of our association's future success.

In closing I feel it should be brought to our membership's attention that we are extremely fortunate in having a person such as Bob Coughenour as our Executive Vice-President with his capabilities and dedication in running our head office in Kansas City. Bob, along with Connie Dulin, have done an excellent job. I consider it a great honour to have served as your President. Thank you. ■