TWO PRE-HARVEST AGRICULTURAL APPLICATIONS OF ELECTROMAGNETIC EXPOSURE

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Abstract: Despite the advances in bug controlling and anti-freezing operations of agricultural products programs, the devastation of Sunne pests and freezing is still enormous. Traditional treatments such as chemical insecticides for bugs and covering for freezing had not been sufficient. Therefore some modern methods including electromagnetic exposure have been suggested. Frozen product is one of the greatest agricultural intricate questoins. On the other hand, difficulties caused by agricultural pests have not been solved. Almost always, pest controlling techniques have been suggested for post-harvest stored products. In the presented, paper the idea of using electromagnetic treatment for anti-freezing operation and pre-harvest Sunne pest control are introduced. In the future, some of the practical results and more precisely case studies of these ideas will be published.

Keywords - Sunne pest, Eurygaster integriceps, electromagnetic exposure, pest control, agriculture, freezing

1. INTRODUCTION

Interactive relations between various branches of science and technology cause them to be improved helping each other. In fact, most of the research options take place in some places among these branches. Therefore, specialist from one braches usually can propose novel methods, when enter the new field, based on the previous knowledge. This interaction raises research efficiency and brings about further improvements. In this brief paper, two of the current successes of engineers in bringing up new ideas between electromagnetic and agriculture are introduced. With the growth in world population especially in third-world countries, the need to agricultural products including fruits and corns are drastically increasing. Although the production of these important foodstuffs is increased, encountered challenges of product freezing and pests control are still unsolvable.

In this paper, two upgraded methods for pest controlling and anti-freezing operations based on electromagnetic exposure is suggested. In section II, the idea of using electromagnetic waves to avoid products from freezing is discussed. In section III, based on previous works of the group [1-5], this idea is extended to Sunne pest control, which is one of the most harmful bugs in the Middle Eastern regions. In section IV, some upcoming challenge is introduced and in section V, it is discussed that how to warm up a material selectively. Finally the paper is concluded in section VI.

II. ELECTROMAGNETIC WAVES TO AVOID FROM FREEZING

One of the major dilemmas in the field of agriculture in the world and also in Iran is the problem of frozen fruits and agricultural product in unexpected colded days of the years. In many fertile areas, cutting out the temperature in a few days, while the product hasn't been grown completely, may cause huge economical injuries. These detriments will be more painful when occurs for costly productions like pistachio and citruses. By the end of winter, beginning of spring, and getting the weather delicious, plants is about to flourish. Because of the fact that the weather is not stable, it may be fallen all of a sudden. Therefore, the biological tissues of the budded pistachio or other products may be damaged. It has been found that if the temperature of the production is increased about two or three degrees, we can save them not to be offended immensely. The proposed idea is to warm up the pistachio remotely selectively using electromagnetic exposure while the other materials of the environment are not affected. The most significant work is to find the best frequency which the absorption rate of energy in pistachio and environment is the most and it depends on the electromagnetic characteristics of the objects and can be measured practically.

The previous techniques of anti-freezing have been limited to chemical, biophysical and genetic treatments. They are more expensive and harder to exploit than the mentioned solution. More over, they have some potential hazards for consumers. Additionally, they need much time than they can be exploited on demand

when the whether gets colder. We should estimate the weather condition far before the requirement while, with the use of electromagnetic waves, it is no need to exact weather guess. Regarding this advantages, it seems that they can be suitable to complement other methods in anti-freezing treatments.

The idea is founded on a characteristic of materials called susceptibility. Each material, related to its molecular structure, have a susceptibility to show how an electromagnetic wave propagates in the media. The imaginary part of the susceptibility is responsible for the absorption of the energy in which it propagates, and consequently, warming up the environment. Moreover, this characteristic highly depends on the applied frequency. Thus, finding the best frequency of warming, we can warm up the pre-harvest products remotely exposing the electromagnetic wave in the field.

Fig.1: A pistachio sprout in Rafsanjan, Kerman

The idea is going to be case studied and implemented in Iran for the fields of pistachio in Rafsanjan shown in Fig. 1 experimentally. In addition, evaluation of other aspects of the project, such as economical considerations and environmental effects will be regarded.

III. PEST CONTROL USING ELECTROMAGNETIC EXPOSURE

Locusts, Grasshoppers, Quelea, Armyworm and Sunne pest shown in Fig.2, are some of common pests of wheat in Iran. In each region, local varieties of pests can be found. In this section, as an example, we consider Sunne pest or 'Eurygaster integriceps' which is one of the most destroying sap-sucking bugs that mostly exist in Meddle east, central and east Europe and North Africa in about twenty countries. It is said that the most injures in wheat production in these regions is due to this pest. The extent of damage caused and the difficult terrain where it is traditionally found have forced governments to pay out a lot of investment on them. It has been reported that this problem has been solved in Israel and Russia but it is not appropriately worked out yet in Iran and to our knowledge, in our neighbours, however a vast part of the agricultural researches belong to this issue. All of the successes in Iranian researches were in chemical fertilizers and it is obvious that there is a lot of dilemma in wide use of these fertilizers. Iranian wheat production was about 11.7 million tons last year. Therefore considering about 10 percents of loss due to Sunne pests, we have lost 320 million dollars. In addition the tremendous price of chemical insecticides has not been included.

Traditional farmers usually use simpler chemical sprayers to control bugs. Despite their simplicity, these chemical insecticides have many disadvantages such as dropping in ozone level [6]. As a result, some modern technique such as genetic treatments and some other unconventional methods such as ultrasonic waves, and electromagnetic treatments have been suggested. While the first method usually is used to control domestic insects, the third method has been suggested for pest control of post harvest stored products such as rice, fruits and walnuts [6-15]. Formerly, some of the researchers of the group had suggested the idea for pre-harvest challenging of agricultural pests but the idea is in the first step to put into practice. Here the idea of using electromagnetic exposure to control Sunne pest in winters before their migration and attack to wheat farms has been discussed. This method is based on breaking up the biological organization of Sunne pests. Similar treatments may be applied to other kinds of pests.

(a) (b)

Fig.2: (a) A typical Sunne pest (b) A Sunne pest sucking wheat

The lifetime of the Sunne pests is only one year. By the end of March, groups of Sunne pest start to migrate to wheat farms and hurt their widest harm to flourishing wheat in 15 to 30 days. Also they start to reproduce and then they come back to mountains until the next year. Furthermore, they have a winter sleep when they are there and should use their stored energy until the next

year. Sunne pest can fly about 30 kilometers to the farms and so all of their winter quartersares are known and are smaller than wheat farms. Traditional method of spraying poison to destroy them in the winter is unsuccessful because they take crucibles as their shelters during these days. Therefore we should seek another method to reach them in this season. Sunne pests like many other insects are too sensitive to temperature and hence they don't attack to *Khoozestan* farms in south of Iran which is a warm land. In addition, Sunne pest is more sensitive to temperature in a period of sleep in winter and the variation of climate temperature in this period usually causes an immense damage on them. The reason is that they have diapause phenomena in this times which don't allow them to reproduce and nourish and so make them resistant against coldness in order to save their energy during winter. As a consequence, if we can heat up them to about 12 to 15 degrees they will wake up and their diapause will be broken. Consequently they should fly, reproduce, and move but not eat because they don't have any foods. These activities results in shedding their energy with impunity and probably they can't live until spring or if they can, they can't fly to wheat farms due to the lack of energy. If this heating up is exposed more time, their life will be threatened seriously. In the following, the idea of using electromagnetic exposure to warm up pests or products is explained.

IV. ELECTROMAGNETIC HEATING

Each material has a complex permittivity (ε) in general. According to measurements, usually this value is noticeably frequency independent. The imaginary part (ε'') of this value is responsible for absorption of electromagnetic energy to each dielectric. Eq.1 shows general case of the one of the Helmholtz equation considering ε''.

$$\nabla \times H = j\omega\varepsilon' E + J = j\omega\varepsilon' E + \sigma E$$
$$j\omega(\varepsilon' - \frac{j\sigma}{\omega})E = j\omega(\varepsilon' + j\varepsilon'')E \quad (1)$$

As a consequence, total power absorption to a specific material is achieved when it is integrated over the material volume as can be seen in Eq.2.

$$P_{Loss} = \int_V E \cdot J dV = \int_V \sigma |E|^2 dV = \omega \int_V \varepsilon'' |E|^2 dV \quad (2)$$

The basic idea is to use ε'' to warm the selected materials far from electromagnetic source. Using the absorption frequency of water in 2.4 GHz may help us in warming pest's water in their body but probably all of the other plants, animals and insects near there absorb the energy. Thus it is decided to find another frequency to expose the electromagnetic energy. In order to do this, we measured the Sunne pest effective permittivity to find the best frequency in which the difference between ε'' of pest and other material like crucibles in the environment is the largest.

Using this idea, we determined one of the best frequencies to design a good power source and we are going to test the idea in a field. If we can succeed in warming up the selected Sunne pests below crucibles on account of their ε'', increasing their temperature to about 12 affordable.

V. CHALLENGING PROBLEMS

There are six challenging problems against the implementation of these ideas: power, health effects, and biological effects, price, frequency allocation and design. Power problem is solvable if the employed frequency not to be higher than gigahertz. High power sources are now common in VHF and UHF frequencies and this problem is solvable paying much money.

Today, electromagnetic wave is known as a potential hazard of health and biological effects such as cancer, but it is reported that lowering the exposure time will reduce the hazard. Thus in our method we expose the waves for limited minutes per long time which is enough to increases the temperature of Sunne pests or products. Moreover, Sunne pest shelters are usually empty of human population and we should just protect our workers. In spite of the health effect, biological effects of electromagnetic exposure should be evaluated to ensure that it does not have a harmful effect on the ecosystem.

The problem of price is also an economic topic that should be considered by investors. The enormous detriments of Sunne pest motivate us in this investment. The problem of frequency allocation could be solved in Iran as well. Taking few frequencies to send career in probably VHF and for limited days in year is not unavailable, however we can shift our frequency to use ISM bands.

The final field problem is to design such a plan to warm up pests in different areas. For example if we use a single power source, it will be difficult to use it for a wide uneven area. Thus for each area, this problem should be solved separately and one should design a suitable array of source to cover the area. Additionally the frequency of treatment will be selected in which the absorption of energy by pest will be more that other materials.

VI. CONCLUSION

In the presented paper, we discussed over two major problems in agriculture which are freezing problem and pest controlling. In this way, the exploitation of electromagnetic to face these challenges has been presented and some upcoming challenge toward the implementation of these ideas has been evaluated.

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