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THE EFFICIENCY OF MICROBIOLOGY IN THE PROCESS OF PESTICIDE BIODEGRADATION

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Abstract

This study aims at recognizing Pesticides and how the process of pesticides biodegradation by microbiology took place, and the effect of environmental condition on this process.

And how the research uncovered the efficiency of microbiology in the biodegradation process of pesticides, as the perfect temperature for the biodegradation process is 40 °C and humidity effect on pesticides efficiency, when high humidity reduces pesticide efficiency and the perfect acidity to increase bacteria efficiency is 7, for the incubation period, it was found during the previous studies that the best incubation period is 5-7 days, in this period the bacteria imprint on pesticides and increase biodegradation of it.

Keywords: Pesticides, Microbiology, Biodegradation, Perfect conditions, Environmental impact.

كفاءة الميكروبات في عملية التحلل الحيوي للمبيدات

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الخلاصة

تعتبر المبيدات من اهم ملوثات التربة، اذ لا يمكن التخلص منها بسهولة كون العديد منها له نصف عمر أكثر من سنة الى عشرة سنوات، في هذه المقالة سنتعرف على المبيدات واهميتها، وكذلك كيف تتم عملية التحلل الحيوي لها، ومدى تأثير معدل نمو الميكروبات عند تعريضها للظروف البيئية المثلى.

كشفت الابحاث السابقة عن مدى كفاءة الميكروبات في عملية التحلل الحيوي للمبيدات حيث ان درجة الحرارة المثلى لعملية التحلل الحيوي هي 40 م°، وان الرطوبة تأثر سلبا على فعالية المبيدات حيث تؤدي الرطوبة العالية الى التقليل من فعالية المبيد كما ان درجة الحموضة المثلى لزيادة فعالية البكتريا هي، اما بالنسبة لفترة الحضانة فوجد خلال الدراسات السبقة ان أفضل فترة حضانة هي 5–7 ايام حيث يزداد خلالها تطبع البكتريا للمبيدات وزيادة التحلل الحيوي لها.

كلمات مفتاحية: مبيدات، احياء مجهرية، تحلل حيوي، ظروف مثلى، أثر بيئي.

Introduction

Bacterial and fungal fertilizers as a vital fertilizer are one of the modern techniques to reduce the excessive use of chemical fertilizers; it has an economical importance in agriculture as it increase the absorption of some elements such as phosphorous and nitrogen or through their ability to decompose organic waste, also it role in the excretion of some growth regulators and its importance in biological control (11).

Also (26) pointed out that soil pollutants can leak from several human and natural sources such as landfill sites or other sites, including petroleum production sites or petroleum products, solvents, pesticides, lead and other heavy metals These pollutants may enter the surface water or they may seep from the contaminated soil into the ground water. These pollutants differ in their tendency to “stay in the water of soil, or leak out to underground water through wash processes inside the soil, or it volatilize or evaporate into the atmosphere and return to the soil again, and it has a good bonging processes inside the soil. Fate of these pollutants is affected by certain soil features which affect the general behavior of pollutants including soil, amount of organic material, content levels, soil minerals, pH, humidity content, temperature and the presence of chemical.

Compounds and elements, also some pollutants are biological or vitality, and depend on many soil features and their solubility (17).

What are pesticides?: Pesticides are substance or mixture of substances used to protect, destroy, fight and stop or decrease the impact of a pest (20).

Pesticide could be a chemical substance, an item or biological agent factor (such as a virus or bacterium), antimicrobial, disinfectant or bactericidal or even a tool is used against a pest. In this case, the pest may be an insect, weeds, mollusks, birds, mammals, fish, nematodes, and microbes which destroy properties and spread diseases or transfer diseases or a source to annoy humans. In spite of there are benefits of using pesticides, it has a serious side effects, such human poisoning or even animals poisoning. According to Stockholm convention about persistent organic pollutants, ten of twelve persistent and dangerous chemical compounds are Pesticides (24 and 25).

Pesticides are classified according to the type of pest which it specializes dealing with: Insecticides, Fungicides, herbicides, nematocides, bactericides, acaricides, rodenticides, molluscicides (13 and 20).

Insecticides: Farmers use insecticides to protect their corps, and public health officials use them in urban areas to eliminate mosquitoes and other insects. Also, these insecticides are used in houses and other buildings to eliminate some pests, such as ants, moths, cockroaches and termites. It is classified to (13):

- Inorganic compounds: it used against insects with a biting or licking mouth, it is very poising for human, and the important types among them are: arsenic salts (lead arsenate), fluorine salts (sodium fluoride), phosphorous and mercury.

- Botanical compounds: it is one of the contact poisons, most of them are harmless to invertebrates, the most important types among them are: nicotine and pyrethrin which is used a lot to control household insects.

- Synthetic compounds: it is the largest part of insecticides, it includes chlorinated hydrogen carbon, which is considered infectious poisons and contact poisons for many types of insects, and it include wide spread D.D.T pesticide which used in controlling household and agricultures pesticide and it has been banned because of it long toxic effect .and organic phosphate compounds which toxicity is less than chlorinated charcoal, and it disintegrate in plant very fast and it affect by contact or in digestive system, including high toxic parathion. A large number of them have been discovered; the most important type commonly used systematic compounds.

Herbicides: It reduces or eliminates weeds which grow in the wrong places. Farmers use it to get rid of weeds which grow near their corps. And it is used to eliminate weeds which grow near railway bars, gardens, parks, lakes and ponds. Human uses herbicides in their gardens to eliminate weeds such as dandelion and other weeds (12).

Fungicides: Some types of fungi cause diseases, and it may infect plants, animals, and human. Fungicides are used to control plant diseases that infect food crops such as apples and peanuts. Most chemical disinfectants used in homes, hospitals, and restaurants contain fungicides (15)

- Non- systematic fungicides: it includes copper pesticides or copper mixtures, mercury, sulfur, organic tin compounds, and dithiocarbamate compounds which used in eliminate many diseases. Some of these fungicides developed to be used in seeds and soil treatment.

- Systematic fungicides: most of them are based on (MBC) methyl–benzymidazol carbamite, including benomyl, carbendazim and thiabendazole, and these pesticides are effective against Asymptomatic and deficient fungi. Pyrimidine such as ethyrmol and fenarimol and others which used to eliminate powdery mildew and acyl alanine which is used against oomycetes.

Rodenticides: It is used in urban areas where mice and other rodents cause health problems. Mice transfer the bacteria which cause diseases such as rabies, mouse bite fever, rabbit fever, and typhus. Mice also destroy large quantities of food and cereals, so Rodenticides help to protect places where these products are stored (15).

Weeds pesticides:

- Inorganic herbicides: they include sulfuric acid, sodium chlorate, calcium cyanate, most of them are total herbicides.

- Organic herbicides: they include many groups of pesticides which differ in their composition and effectiveness; they include phenols, thiolcarbamates, carbamates, urea, nitril, amide, heterocycles. These types are classified into general and selective herbicides, which are the most important and widely used the general pesticides (16).

Genetic bases of biological resistance to pesticides: Resistance arises when genetic/gene mutations happen naturally, allowing a small percentage of the total pest to survive. And if it happens and it survive from pesticides effects, this trait remains with the resistance; it will multiply and thus continue to use the same pesticide, these individuals will carry the genetic changes that cause resistance from the parents to the new generation. During this process in which resistant individuals are selected, their numbers multiply and eventually the numbers become many, and pesticide treats may fail. It is important not to confuse the term "resistance" with the term "tolerance", which means the ability of the organism to exposure to doses of the pesticide under deadly conditions Still, the trait of tolerance is not passed on to the new generation (18 and 23).

Resistance to herbicides occurs in many mechanisms including increasing pesticide creation rates which considered one of the common resistance mechanisms in weeds,

for example resistance to acetyl -CoA inhibitors, acetolactate synthase (ALS), and the photosynthesis system II (PS2) by increasing the creation rates of herbicide (14).

Physical factors which effect on the decomposition of pesticides: Salinity is one of the important factors in biodegradation, the activity of many organisms is high at low salinity concentrations, compared to high salinity which causes a reduction in biodegradation rate (9). When studying the rate of pesticides creation in degrees of salinity ranging from 3 to 30% (weight to volume), it found that there is an inverse relationship between pesticides creation and salinity. The creation rate of these compounds decreases with increasing salinity despite the availability of oxygen and nutrients, and the difference in salinity concentrations effect on permeability of cell wall, which is reflected in its ability to these compounds (1).

(22) noted that the biodegradation rate is very slow at low temperatures, and it is believed that it happened due to the decrease in enzymatic activity. It increases when the temperature increases, and its increasing enhances the metabolic rates of pesticides and other compounds, also it found that the decomposition of naphthalene increases ten times when the temperature increases from 20 to 35 °C, while some studies proved that biodegradation rate is good at 40 °C (21).

The advantages of bioremediation: Here we note that bioremediation has several advantages related to cost and efficiency, as it can be used or applied in those areas which cannot be reached without drilling. For example, leaks or spills of hydrocarbons and some chlorinated solutions may pollute groundwater. Still using the purifier cleaner which receives pollutants for this (appropriate bacteria); it may reduce pollutant concentrations even after a long time, due to the process of bacterial adaptation to pollutants. Where this process is inexpensive compared to the process of digging and excavation, which may be followed by the necessity to dispose of those pollutants in another place, or the applying the soil washing method or any other method of treatment in the site, in addition to the bioremediation method allows to reduce or eliminate the necessity of "pumping and treatment", which represent a common policy used in sites where hydrocarbons pollute clean groundwater (27).

The environmental impact of pesticides: The use of pesticides increases environmental risks. As more than 98% of the sprayed insecticides and 95% of the herbicides reach a far place away from the target species, to non–targeted species such as other insects as well as air, water and soil.

Drift process pesticides which suspend in air as particulates and transports them to other areas, and when wind carries pesticides which suspend in air as particulates and transports them to other areas, which may contaminate them. Here we note that pesticides are one water pollution reasons, and some pesticides considered persistent organic pollutants and contribute in soil pollution. In addition to the use of pesticides reduces biodiversity, and reduces nitrogen fixation, contributes to decreasing pollinators, destroying habitats, especially birds, above all pesticides threaten endangered organisms (4).

The effect of pesticides on living organisms: Organic phosphorous pesticides represent 50% of insecticides used worldwide. Their effects on the health of male production as a result of exposure to it become a subject of great concern both at the environmental and professional level of humans and wildlife as they penetrate testicular barriers and effect on spermatogenesis. Work through its effects on hormones (6), and environmental exposure to pesticide effects on the type and number of sperm and causes DNA damage, causing futility and deforming in sperms (10 and 25).

Some environmental factors impact on pesticide effectiveness: There is a set of processes that determine the fate of pesticides in the environment, it work to create the appropriate condition for the effectiveness of these pesticides, or make them less toxic forms, and these processes affected by a group of environmental factors that help in converting pesticides into other forms.

(19) pointed to the stages that pesticide goes through when it used in the environment, including adsorption, transportation then comes decomposition. There are many factors which affected on pesticide decomposition including sun light, organic material, humidity, temperature, and PH, soil tissue, soil microbial content, the pesticide in turn affected by the factors mentioned above; these factors directly and clearly affect all pesticide crushing operations. It noted that decomposition of pesticides by microorganisms influenced by a set of factors; The biodegradation process become high in fat in warm, humid weather, well-ventilated soils and a neutral pH.

And the process of decomposition by microorganisms by enzymes multiplied every 10 m, an increase between 10-45 C, while the enzymatic activity decreases when temperature rise or fall (3).

We note a second effect of temperature, we notice an increase in pesticide toxicity in certain temperature, but at a higher or lower temperature we notice a decrease in toxicity and this known as the Negative Temperature coefficient, or heat become responsible for enzymes activity that destroys pesticides as well as effect on physical and chemical properties of the pesticide (8) and the effect of temperature and humidity on pesticides cause pesticides decomposition, which may reduce or increase their effectiveness, and then increase it consumed quantities, and cause problems and side reactions in pesticides, especially during mixing, and this reflected on the lack of efficacy of the pesticide or its expiration date ends faster, or reactions may occur and increase its toxicity to plants, humans or other organisms. The increase in temperature lead to transfer pesticides to the gaseous state (rapid fumigation), which will increase air pollution and spread to farther areas, especially in cities near agricultural areas (5). In agriculture, pH is very important, whether in growing crops, determining soil alkalinity and acidity, and make benefit from added fertilizers, or using water to make spray solutions (which consist of pesticides and water), and here the effect of pH number on the amount of utilization of the use of agricultural pesticides and fertilizers become clear, the problem of pesticides ineffectiveness increases when the

spray solution is left for hours or a day or more after mixing the pesticide with the base water, which means that the effectiveness of the pesticide decreases when the period between mixing the pesticide with the base water and the time of spraying it on crops and when the soil base increases. The researchers noted that the best activity of bacteria analyzing the pesticides was at pH7, which supports degrading enzyme activity compared with higher and lower pH values (7).

Chemical insecticides and herbicides are affected by many physical and biochemical factors, one of the most important factors which effect on the effectiveness of insecticides is temperature and humidity, the speed of most chemical insecticides decomposition increases by temperature and Insecticide aquatic by high temperature and high air humidity in stored materials, although this relationship is not always linear, and the effect of high or low temperature on pesticides effectiveness may be due to several factors, including those related to the pesticide, such as the permeability of pesticide through insect's body and the increase or decrease in the evaporation of the pesticide, and other factors Related to the pest, such as an increase or decrease in insect activity (4), High humidity also cause a decrease in pesticides effectiveness. This effect may be due to an increase in pesticide dilution to water with high humidity in the soil causing the pesticide hydrolysis. Other research has confirmed the negative effect of relative humidity on Pesticide effectiveness (2).

Conclusion: We conclude from this scientific article that pesticides are substances with a complex chemical composition, some of which decompose quickly and others require long periods of time for decomposition, in addition to the fact that there are environmental factors that affect the process of decomposition of pesticides, and that the best way to remove pesticides is by the action of microorganisms, whether they are bacteria or fungi or parasites.

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