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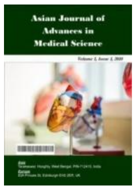

BIOPESTICIDES ARE THE NEED OF PRESENT TIME FOR SAFE ENVIRONMENT AND HEALTHY HUMANS

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration of all authors. The author SG designed and analysed the work. Author JG interpreted the work. Author HS prepared the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

India is one of the most populous countries in the world therefore food problems are of prime importance. Poor population of India amounts to more than 300 million people therefore to achieve food security; grain produced must be protected from depredating agents such as insects and other pests during harvesting as well as storage. The easy handling and relatively cheaper synthetic chemical pesticide controls measure are very common and most widely used in India. One of the major causes of cancer in agriculture workers is excessive use of chemical pesticides. These chemical pesticides cause negative effects on human health and quality of the environment. Ecofriendly alternatives to chemical pesticides are biopesticides because they generally affect only the target pest without any negative effect on human health and the environment. The aim of this review study was to explore the need of biopesticides in present time due to their useful aspects and also due to biological ill effects of synthetic chemical pesticide.

Keywords: Biopesticide; carcinogenic; health hazards; fumigation; food security.

1. INTRODUCTION

"According to the Global Hunger Index Report, India continues to be in a category of those nations where hunger is 'alarming'. India is one of the most populous countries in the world and food insecurity and malnutrition are seen in India" [1]. In view of the immense emerging population of India the food problem is of prime importance. We have to escalate the production and productivity of food and on the other hand protecting them from the insect pests in the harvest and storage [2]. "India is now facing an acute shortage of food. Indian soil is unable to feed her growing population, for which huge quantities of food grains are imported from foreign countries. Poor population of India amounts to more than 300 million people, with almost 30 percent of India's rural population living in poverty" [3]. Current population in India is about 1.32 billion and annual increase in population has been estimated to be 1.2%. Therefore, grain production alone will not help achieving food security; grain produced must be protected from depredating agents such as insects and other pests during storage [4]. "In India alone 30% of the crop yields potential get lost as a result of insects, disease and weeds, corresponding to 30 million tons of food grain" [5].

The crop losses caused by pest are coupled with other problems like water shortages, recurrent drought, environmental disasters inclement weather, farmer's limited access to technology and poor soil conditions [6]. "Due to undermine food security, when farmer see their agricultural crops suffering with insect pests and diseases as well as decrease in yield, they often expect a dramatic, magical treatment to make them lush, green

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and healthy again, so that higher production is ensured As a result, they start using chemical pesticides such as chlorinated hydrocarbons, organophosphates and carbamates disregarding their future ill effects" [7]. Some of the major classes of chemical pesticides are presented in Table 1.

The easy handling and relatively cheaper chemical controls measure are very common and most widely used in India. Amongst the chemical, the use of fumigants is a most commonly adopted measures [8, 9]. "Status of fumigation of different fumigants of various stored grains to protect them from their pests and regulatory laws for using fumigants in India. As mixing of residual insecticides with food grains is not permitted in India from the beginning, we are greatly dependent on fumigants in the preservation of food grains. Supplementary control measures in grain storage premises include space sprays (fogging and misting) and hard surface sprays with contact insecticides such as deltamethrin, malathion and pirimiphos-methyl. However, for treating food grains, phosphine and ethylene dichloride-carbon tetrachloride mixture alone have been approved; methyl bromide is allowed for quarantine and preshipment fumigations only" [4, 10].

2. BIOLOGICAL ILL EFFECTS AND ENVIRONMETAL HAZARDS OF SYNTHETIC PESTICIDE

Cancer is one of the leading diseases affecting human health. Its impact worldwide is significant in all the levels of human society and there are several projections emphasizing the increasing dimensions of the problem with both the developed and human population. Cancer in INDIA is one of the leading causes of morbidity and mortality. It is a multifactorial, multifaceted and multimechanistic disease requiring a corresponding multidimensional approach for its treatment, control and prevention [11, 12].

One of the major causes of cancer in agriculture workers is excessive use of chemical pesticides. Toxic effects of phosphine and methyl bromide fumigation on field and godowns workers are founded [13, 14, 15].

"Excessive use of chemical pesticides initiates soil and water resources pollution, destroy the insect communities, and causes pathological changes in birds and mammals" [16]. "In addition they cause negative effects on human health, by decreasing the quality of the environment and food" [17, 18, 19] and also causes death through organ malfunction, Immune suppression, neurotoxicity, impairment of reproductive function, carcinogenicity, paralysis. These ill effects of chemical pesticides have forced people to search of the alternatives from where the concept of biopesticides came [7].

"Pesticide poisoning is a global public health concern, with almost 300,000 deaths every year worldwide. Pesticide exposure is inevitable; there are multiple methods in which people are exposed to pesticides. Workers in the pesticides sector, transporters of these hazardous substances, farmers, crop vendors, and customers are subjected to various pesticide concentrations. The risk of pesticide contamination related to health hazards depends not only on how harmful the products are, but also on the extent of the exposure dose. Pesticides toxicity is commonly known to cause only life-threatening diseases such as many types of cancer such as neuroblastoma, leukemia, soft tissue sarcoma, Burkitt lymphoma, non-Hodgkin lymphoma, Wilm's tumor, lung cancer, ovarian cancer, and rectum cancer. Pesticide exposure may lead to the exacerbation of asthma and diabetes. Exposure to organophosphate pesticides could increase sperm abnormalities and Teratogenic effects in fetal growth. These chemical pesticides cause DNA damage and gene mutations" [20].

"These synthetic chemical pesticides such as organochlorines, are least biodegradable. Water pollution is on the rise due to these pesticides, even at low concentration, these pesticides have serious threat to the environment. Honey and wax obtained from commercial hives were reported to contain a mixture of pesticides. Since 2006, each year, honey bee populations have dropped by 29–36 %. Since pre-agricultural times, 20–25 % of the bird populations have declined. Fungicides can indirectly reduce birds and mammal populations by killing earthworms on which they feed as reported by Mahmood et. al in 2016" [21].

Table 1. Some of the major classes of chemical pesticides

Types of synthetic chemical Pesticides	Names or examples of Pesticides
Organochlorines	DDT, Dieldrin, Heptachlor, Chlordane, Endosulfan, decofol and methoxychlor etc.
Organophosphates	Glyphosate, Malathion, Parathion, and Demethoate etc.
Pyrethroids	Permethrin, Resmethrin, and Sumithrin etc.
Neonicitinoids	Acetamiprid, Clothianidin, Dinotefuran, and Imidacloprid etc.
Carbamates	Aldicarb, Carbofuran, and Ziram etc.

3. BIOPESTICIDE AND THEIR TYPES

"Biopesticide are usually inherently less toxic than conventional pesticides they generally affect only the target pest and closely related organisms, in contrast to the broad-spectrum conventional pesticides that may affect organisms as different as birds, insects and mammals" [22].

Biopesticides fall into three major categories such as Microbial pesticides, Plant- Incorporated-Protectants (PIPs) and Biochemical pesticides [23]. Microbial pesticides contain a microorganism (bacterium, fungus, virus, protozoan or alga) as the active ingredient. Microbial pesticides can control many different kinds of pests [24,25]. The most widely known microbial pesticides are varieties of the bacterium *Bacillus thuringiensis* (Bt) which can control certain insects in cabbage, potato, and other crops. Bt produces a protein that is harmful to specific insect pest. The Cry 1 and Cry 2 endotoxins of *Bt* are active to varying degrees against nearly all insect species [26,27].

Granuloviruses are efficacious against the vast majority of codling moth (*Cydia pomonella*) populations but development of resistance to the virus in Germany and France in certain populations is also reported [28, 29]. Fungus (*Beauveria bassiana*) is applied for effective control of insect pest [30]. In apple orchards many pests like, Codling moth (*Cydia pomonella*), Oriental fruit moth (*Grapholita molesta*), Lesser apple worm (*Grapholita prunivora*), Tufted apple budmoth (*Platynota idaeusalis*) and Apple ermine moth (*Yponomeuta malinellus*) can be controlled by microbial pesticide successfully [31].

"Plant- Incorporated-Protectants (PIPs) are pesticidal substances that plants produce from genetic material that has been added to the plant. The gene for the Bt pesticidal protein is isolated from bacteria and introduced into the plants through genetic engeneering. Then the plant, instead of the Bt bacterium manufactures the substance that destroys the pest.The adoption of genetically modified (GM) crops has increased dramatically in the last 11 years. These proteins have been commercially produced, targeting the major pests of cotton, tobacco, tomato, potato, corn, maize and rice" [32,33, 34].

Biochemical pesticides are naturally occurring substances such as plant extracts, fatty acids or pheromones that control pests by non-toxic mechanisms Conventional pesticides, by contrast, are synthetic materials that usually kill or inactivate the pest. The use of plant-based botanical insecticides and resistant plant varieties to minimize the damages promoted by different pest are demonstrated by Gonçalves et al. (2019 and 2017), [35,36]. Formulation of plant extracts insecticides and synthetic chemical insecticides are shown by Luo et al. (2011), [37].

"Biochemical pesticides include substances that interfere with growth or mating, such as plant growth regulators, or substances that repel or attract pests, such as pheromones. Man-made pheromones are used to disrupt insect mating by creating confusion during the search for mates, or can be used to attract male insects to traps. Pheromones are often used to detect or monitor insect populations, or in some cases, to control them" [38,39,40].

"Term biological control is used to describe the introduction of exotic insect natural enemies for the permanent suppression of insect pest. These natural enemies include parasites, parasitoids. predators, antagonists, competitors and phytophages for weed control" [41].

4. CONCLUSION

The various health hazards those are associated with synthetic chemical pesticides such as, dermatological, gastrointestinal, neurological, carcinogenic, respiratory, reproductive, and endocrine effects. As well as high occupational, accidental, or intentional exposure to pesticides is resulted in hospitalization and death [42]. "Synthetic chemical pesticides are very important to the fight against pests and diseases. However, their widespread and long-term use is resulted in insecticide resistance and biomagnifications of insecticides. The use of synthetic chemical pesticides in crop to control pest around the world are caused tremendous damage to the environment, pest resistance to insecticides, and lethal effects on non-target organisms" [43].

"The biological nature of biopesticides makes their degradation fast, prevents accumulation in the environment and eliminates the formation of pollution in water and soils. The contact of biopesticides to air, moisture, high temperatures, and the sunlight adequately degrades their constituents. For example, a compound of thymol found in *Thymus vulgaris, Zataria multiflora*, etc., degrade under sunlight in about 28 hours and about eight days in soils" [44].

Fenibo et. al. in 2021, [45], described that the excessive use of synthetic chemical pesticides is resulted as many negative externalities including environmental hazards and pest resistance. Consequently, their use in commercial farming is attracting regulatory restrictions leading to 2% decline per year in synthetic pesticides use in favor of 10% increase of biopesticides as alternative agrochemicals.

Pests are inhibited through biopesticides by multiple mode of actions such as growth regulators, gut disruptors, metabolic poison and neuromuscular toxins. The limitation of the full adoption of biopesticides are the high cost, less global market demand, dose determination of active ingredients and slow action among others synthetic commercial chemical pesticides [46, 47].

Use of harmful chemical pesticides should be replaced with other alternatives like Biopesticides that are safe to humans and environment. Microbial pesticides, biochemicals derived from micro-organisms, phytochemicals and genetic modification of crops should be used as Biopesticides for pest control during harvesting and storage of food grains. Awareness of people, farmers and other agriculture workers towards the maximum use of biobesticides should be done. Industries and marketing of biopesticides should be enhanced. Governmental supports should be provide to agricultural workers for this aspect as well as effective governmental policies should be formed for environmental safety, food security and good human health.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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