Scientific Research

Benefits and Risks of Pesticides: A Controversial Topic

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Abstract: Pesticides have protected crops, but they are poisonous to human being. Methods to minimize pesticide pollution should be encouraged. It is necessary to develop safer alternative pesticides for growers.

Keywords: pesticides; benefit and risk; toxicity minimization; prospects of pesticides

1 Introduction

Pesticides help maximize profit by eliminating pests that reduce yields resulting in more product per acre. But the use of pesticides has become a controversial social issue. So, food safety associations urge people to rationalise and reduce pesticide usage, which requires more understanding of pesticide efficacy. For decades, discussions among scientists and the public have focused on the real, predicted, and perceived risks that pesticides pose to people and the environment. Since each use of a pesticide poses some level of risk, the public need a realistic understanding of the risks associated with pesticide use. In fact, most of us acknowledge that the benefits of pesticides outweigh the risks, for pesticides are an increaseingly important tool in providing food for all people on earth, and they also protect people and their domestic animals from many diseases[1].

But, traditional pesticides are chemical substances defined as poisons and used in certain circumstances to kill specifically targeted pests[2]. These compounds maybe last for years and decades before breaking down. They circulate globally, and persistent pesticides released in one part of the world can be transported through a repeated process of evaporation and deposit through the atmosphere to regions far away from the original source[3]. Pesticides are toxic to human health in case they do not differentiate between targeted and non-targeted species[2]. Of all the pesticides released into the environment every year by human activity, persistent pesticides are among the most dangerous[2]. Nuttall (1999) reported that the first firm evidence has been uncovered to link environmental pollution with cancer in human beings[4]. Therefore, minimizing pesticide pollution has become a worldwide issue. Reading and following labeling instructions, selecting the correct pesticides for specific application, and employing bio-pesticides as an alternative to chemical pesticides are all ways to minimize pollution.

This work was supported by the Science Foundation of College of Chemistry & Life Sciences of China Three Gorges University.

2 Selecting Correct Pesticide and Minizing Pesticide Use

Although pesticides are mainly responsible for the highest risk to food and water, they are still useful to make sure there is enough food for people. Pesticides vary in toxicity and its toxicity depends on the inherent chemical and physical properties[5]. The relative hazard of a pesticide is dependent upon the toxicity of the pesticide, the dose received and the length of time exposed[6].

In generally, every pesticide destined for use must have proper label which contains use method, safety precautions, first aid instructions and warning phrases. It is especially important that the required label states how, when, and where to use the pesticide. But, in many cases, diseases cannot be matched with any pesticide, or the pathogen which caused the disease has developed resistance to the ever effective pesticides, even though it is difficult to decide on a suitable concentration for use from a wide range of given concentrations. In vitro methods are routinely used to determine the right pesticide and its concentration, which attempts to increase efficiency of chemical use. In this experiment, tested pathogen was isolated from a crop, and then some pesticides were bought from pesticide markets and prepared according to their instructions. The in vitro screening trial was carried out to select suitable pesticide and its concentration. When a certain pesticide was proven to be effective in inhibiting the growth of a pathogen in vitro, field experiments should be conducted then. According to the field results, the right pesticide may be applied. Therefore before you buy a pesticide, make sure it is the appropriate product for your problem. So, in vitro tests not only suggest the adaptive pesticide but also its effecttive concentration. Thus, although all misuses won't be eliminated, pesticide abuse can be controlled by pesticide selection education and pesticide applicator regulation, and the amount used being minimized. Reducing the use of pesticides and choosing more effective pesticides may reduce risks placed on society and the environment[7].

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3 New Pesticides

To meet population food consumption needs, in the present time, probably the immediate response to the need for increasing production of food is a more intensive use of agrochemicals[8]. But in order to strengthen food safety, Japan has implemented "Positive List System" in chemical products of agriculture on May 29, 2006. And new residue limitation standard was executed[9]. At the same time, EU and other countries have strict requirements of pesticide residue limitation. Thus, new pesticides, which express broad spectrum, high-efficiency and low toxicity, should be discovered and widely used.

3.1 New Chemical Pesticides

Dr. Lee Wenhua delivered a speech of "Discovery and Development of Crop Protection Chemicals" at the "2009 International Conference on Crop Science & Technology" held in conjunction with AgrochemEx 2009, which focused on the current discovery and development strategies of crop protection chemicals and opportunities. In order to promote the pesticide discovery activity in China, the Chinese National 973 Program sponsored three basic research projects related to crop protection products (2003-2008) [10]. This green chemical pesticide research program aims to discover "green" crop protecttion chemicals that are not only novel in mode of action and highly selective to pest species but also possess favorable environmental and human hazard and risk potentials[11]. JS399-19 (experimental number) is discovered by the Jiangsu Branch of National Pesticide Research & Development South Center of China, and was patented in 2004[12].

Results from field experiments showed that the efficacy of JS399-19 in controlling wheat scab was better than that of carbendazim treatment[13]. The propyl 4-(2-(4,6-dimethoxypyrimidin-2-yloxy) benzylamino) benzoate (ZJ0273) is a new herbicide used in the rapeseed field with the advantages of low dosage, low mammalian toxicity, broad weeding spectrum, and environment compatibility[14]. In Japan, Metofluthrin, an exciting novel pyrethroid, was discovered by Sumitomo Chemical Co., Ltd. It was registered in 2005 and is under worldwide development for environmental health use. Metofluthrin has extremely high knockdown activity against various insect pests, as well as high volatility and low mammalian toxicity[15].

Novel chemical pesticides are effective molecules and even more they must be much safer[16].

3.2 Biological Alternatives to Chemical Pesticides

With increasing consumer pressure on both farmers and supermarkets to minimise the use of chemical pesticides in fruit and vegetables, people focus on the use of biological alternatives. Biological products, known as biopesticides (including natural product-based pesticides), can play a significant role in a more sustainable food chain than chemical pesticides. Biological control agents such as fungi, bacteria, viruses, plants, animals or their products are applied in much the same way as chemical pesticides to fight insect pests, but have obvious benefits as they do not leave toxic residues[17].

Natural products generally have a high structural diversity, possessing more chiral centers, sp3-hybridized carbons, and rings than synthetic compounds.These compounds have a high likelihood to possess some biological activity against other organisms, and their novel mechanisms of action are so deeply needed as pests continue to evolve resistance to the compounds currently available. And another important benefit of natural product-based pesticides is their relatively short environmental half-lives, which presents little danger to people's health and environment. Today, many natural products are used as herbicides, such as corn gluten, fatty acids, essential oils, pine oil, clove oil, 2-Phenethyl propionate, lemongrass oil, citronella oil, bialaphos, et al. Natural products also are used as pesticides for insect management. According to recent reports, the use of natural product and natural product-derived insecticides continue to increase, and three out of the five most commonly used insecticides classes (neonicotinoids, pyrethroids, and other natural products) are natural product or natural product-derived. Natural products for plant pathogen management have been aroused people's interests. Extract from giant knotweed (Reynourtria sachalinensis) (MilsanaTM) is used in Europe for the control of a wide spectrum of both fungal and bacterial plant diseases. Fermentation secondary products from actinomycetes are fungicidal. Chitin (N-acetylchitosan) and chitosan (poly-D-glucosamine) from fungal cell walls and arthropod exoskeletons are sold as fungicides[18]. Researchers discovered that mosquitoes carrying a malaria parasite, when exposed to surfaces coated with fungus-based pesticides had a dramatically reduced ability to transmit malaria[19]. Bacillus thuringiensis (Bt) is a natural and safe Microbial Pesticide, and the perfect example of Bt is that it can effectively control tomato hornworm[20]. Bacterial strain of B-9987, which was isolated from the halophyte of intertidal zone of Bohai, shows inhibition to some phytopathogens[21]. A fungal strain of *Trichoderma harzianum* exhibited antagonistic avtivity against *Macrophomina phaseolina* which causes root - rot of egg – plant, a popular vegetable in the world[22]. Wuhan WDLZ Biological Technology Co. Ltd. has produced a virus pesticide, biological cockroach-killer bait, which possesses high-efficient cockroach control and low-toxin to people's health[23].Some natural enemies of *Myzus persicae* have been used as biological pesticides in controlling *Myzus persicae* (Sulzer) (Hemiptera : Aphididae) , an important pest causing tobacco damage[24].

Biobased pesticides are commonly used as alternatives to synthetic compounds in organic agriculture.

3.3 Problematic Pesticide Degradation

Sometimes, synthesized chemical pesticide as well as biopesticide may contaminate land and become harmful to health, therefore methods of degrading problematic pesticide induces researching interest.

A Fe-TAML/H_2O_2 catalytic oxidation process achieves facile in-solution total degradation of fenitrothion and two other organophosphorus (OP) pesticides[25]. Qiao and Wang (2010) reported that a pyridine-degrading strain was isolated from the contaminated soil near the pesticide plant[26].

A selected microbial consortium are capable of degrading two specific herbicides, alachlor (2-chloro-2',6'-diethyl-N-[methoxymethyl]-acetanilide; AL) and atrazine (2-chloro-4-ethylamino-6-isopropylamino-S-triazine; AT), and Forty-eight percent of AT and 70% of AL was degraded in the inoculated biometer flasks[27]. Biological and chemical oxidation characteristics of two kinds of coke-oven wastewaters, A and B, were studied for selecting effective treatment processes of the wastewaters. Pollutants contained in Wastewater-A could be removed by biological process, while those which existed in Wastewater-B could not be satisfactorily removed. The refractory organic pollutants, existed in Wastewater-B,were mineralized effectively by Fenton's reagent. The results showed that a wastewater treatment process, in which Fenton's oxidation is followed by a biological treatment, was proposed for the treatment of Wastewater-B[28]. That is to say, both biological methods and chemical methods can be used to reduce or eliminate chemicals which can be dangerous to consumers, workers and close bystanders.

4 Conclusion and Recommendations

There is a common interest in natural crop protection among many researchers and agricultural extensionists, but from surveys and simple on-farm trials at the village level to field experiments and bioassays in the laboratory, knowledge of the biological environment in which the agent will be used and of how to produce a stable formulation are both critical to successful biocontrol[29]. And also, biological products may not consistently provide a high level of disease control [30]. Growers still prefer to use chemical control over biological ones. Therefore agricultural disease is controlled mainly with pesticides now, especially in China, Africa and other developing countries[31-33]. Many microorganisms communicate intercellularly by synthesising and detecting the presence of specific small molecules in a cell density-dependent fashion; this phenomenon is known as quorum sensing (QS) [34]. And these signaling molecules seem to imply a interesting pesticide-discovery, because they can be inactivated by another compound which may be a potent pesticide. This kind of pesticide can work well with small amount, and minimize the risk to environment and people's health. Strategies for control pesticide loss are effective approaches to reducing pesticide pollution of waters by minimizing the movement of pesticides to surface water and ground water[35].

Proper pesticide use decreases these associated risks to a level deemed acceptable by pesticide regulatory agencies such as the United States Environmental Protection Agency (EPA) and the Pest Management Regulatory Agency (PMRA) of Canada. Reducing the use of pesticides and choosing less toxic pesticides may reduce risks placed on society and the environment from pesticide use[36]. The use of multiple approaches to control pests, is becoming widespread and has been used with success in some countries. New pesticides are being developed, including biological and botanical derivatives and alternatives that are thought to reduce health and environmental risks. Pesticides can save farmers' money by preventing crop losses to insects and other pests. One study found that not using pesticides reduced crop yields by about 10%[37]. Some alternatives to pesticides are available and include methods of cultivation and methods of interfering with insect breeding[38].

Disease resistance genes have been characterized from different plant species that provide resistance to a variety of different pathogen and pest species by map-based cloning or transposon-tagging strategies[39]. But, for the complexity of cloning and the pathogen evolution, it is difficult to breed a new disease-resistant plant by cloning of disease resistant gene. Therefore, in a long time, pesticides, including biological pesticides, will be the main strategy for pest control. They are an increasingly important tool in providing enough food for all people on earth and also protect people and their domestic animals from many diseases. Pesticides not only have played an important role in the history but remain a important position in the future.

Nowadays, pesticides used to control organisms are considered harmful and each use of them carries some associated risk, but in the future, owing to many scientist's efforts, novel pesticides will be discovered and they don't pollute our environment for their low-toxin and easy degradation.

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