

The Risks of Residues of Plant Protection Chemicals in the Environment and Agricultural Products in Vietnam

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Abstract

Plant protection chemicals are widely used in most sectors of the agricultural production activities to prevent or reduce losses by pests and thus can improve yield as well as quality of the produce. The most effective methods of pest control are based on the use of the plant protection chemicals to maintain agricultural production and contribute to economic growth. In Vietnam as well as some countries have agricultural production activities, plant protection chemicals are widely used in almost all agricultural production fields to prevent or reduce losses due to pests, improve productivity and quality of the product. Plant protection drugs contribute to the protection and increase the productivity, it's about 20% - 30% for crops such as vegetables and fruit trees. However, residues of plant protection drugs in agricultural products are also very high, exceeding the permitted level of 10% - 20%. This paper focuses on the risks of residues of plant protection chemicals in the environment and specific agricultural products in Vietnam.

Keywords: Plant Protection Chemicals; Residues of Plant Protection Drugs; The Harmful Effects of Plant Protection Drugs; Agricultural Production Activities; Agricultural Products

Introduction

Plant protection chemicals, also known as plant protection drugs, are plant protection chemicals or crop protection products, which are made to fight and kill pests or other harmful substances, disease vectors. In addition, growth-promoting drugs, which help plants achieve high yields, are also a form of plant protection chemicals. Basically, plant protection chemicals are toxic, capable of destroying cells, affecting the growth and development of pests, weeds and even plants, so when they enter the environment, they cause harmful effects on the environment, causing many direct and indirect impacts on many subjects. The use of plant protection chemicals, pesticides has immediate and quick effects, but has serious consequences on many long-term aspects. With widespread use, plant protection chemicals and pesticides cause a health risk for farmers, people who direct contact with them, these effects can exist, causing harmful impacts for a long time.

In developing countries, such as Vietnam, farmers use a lot of plant protection chemicals and it is difficult to control usage. They face great risks of exposure due to the use of banned and restricted toxic chemicals, incorrect application techniques, poorly, often the reuse of

old pesticide containers for food and water storage. Most plant protection drugs, pesticides show a high level of toxicity because they are produced to kill harmful insects. Besides, they create many dangers, harmful factors to human being and the environment [4]. Decades ago, plant protection chemicals were introduced to increase crop yields and protect crops from pests. Due to the growing insect resistance and resistance to chemicals, an increasing number of new chemical compounds are produced every year to protect crops, causing unwanted side effects. The use of pesticides is still a common practice of farmers, especially in the tropical regions [15]. Chemical compounds such as DDT, HCH, lindane have a long shelf life in the environment, although they have been prohibited for use in developed countries but still popular in developing countries, like Vietnam. As a result, the residues of these chemicals remain in the food and disperse in the environment, causing many serious effects.

The process of using plant protection chemicals in the world

In the world, plant protection chemicals play an increasingly important role in pests control, production protection, and food security. Some sources consider the 1940s and 1950s to have been the start of the “pesticide era”. According to experts in the field of agriculture, in the 70s, 80s and 90s of the 20th century, plant protection drugs contributed to protection and increased yields, about 20% - 30% for major crops such as vegetables and fruit trees [1,2]. Actual process of using pesticides in the world for many years, can be divided into 03 stages of using [5,9]:

1. Balance use: High requirements, effective use.
2. Excessive use: Using too much, affects the environment, reduces effectiveness.
3. Pesticide crisis: Overuse of plant protection drugs, creat risks, harmful effects to crops, the environment and public health are seriously affected, reducing economic efficiency of agricultural production.

The period of excessive use (stage 2) from the 1980s - 1990s and the crisis period (stage 3) from the early years of the 21st century. Developing countries (including Vietnam) use plant protection products more slowly than developed countries, so that the process of using plant protection drugs as mention above is back about 10 - 15 years. Over the past half century, the use of pesticides in the world has always increased, especially in the 70s, 80s and 90s. According to Gifap, the value of pesticide consumption in the world in 1992 was 22.4 billion USD, in 2000 was 29.2 billion USD and in 2010 about 30 billion USD, in recent 10 years in 6 Asian countries have growing rice, farmers using pesticide increased by 200 - 300% but productivity did not increase. Evaluation results in Asian countries in the 10 years since 2010, the situation of fertilizer use has increased by 100%, the use of pesticides has increased by 200 - 300% but the productivity has been almost zero. The number of pesticide sprays did not correlate or even inversely correlate with productivity [6,8].

Current situation and prospects of using plant protection chemicals in Vietnam

In Vietnam, pesticides were first used in Northern Vietnam in the 1955s, and since then, plant protection chemicals are considered an effective tool to quickly kill pests and other diseases [3]. According to the data of Plant Protection Department of Vietnam, from 1981 to 1986, the amount of plant protection drugs used was 6.5 - 9.0 thousand tons of commercial products, increasing to 20 - 30 thousand tons in the period 1991 - 2000 and from 36 - 75.8 thousand tons in the period 2001 - 2010. The amount of plant protection chemicals per cultivated area (kg/ha) also increased from 0.3 kg (1981 - 1986) to 1.24 - 2.54 kg (2010 - 2015). Import value of pesticides also increased rapidly, in 2016 was 472 million USD, in 2018 was 537 million USD [7]. The number of registered plant protection drugs also increased rapidly, before the year of 2000, the number was 77, trade names were 96, the year of 2000 were 197 and 722, and the year of 2018 were 1202 and 3108. Thus, within the past 10 years (2008 - 2018) the number of pesticides used increased by 2.5 times, the number of imported drugs increased by about 3.5 times. In 2018, the amount of plant protection drugs that Vietnamese used is equal to 40% of the average usage of the four big countries using many pesticides in the world (USA, France, Japan, Brazil), while GDP of Vietnam is only 3,3%

of their average GDP. The number of plant protection chemicals registered for use in Vietnam is currently approximately 1,000 types, other countries ranges from 400 to 600 types, such as China 630 types, Thailand, Malasia 400 - 600 types. Using pesticides per capita in China is 1.2 kg, in Vietnam is 0.95 kg (2018) [10].

According to the data of Plant Protection Department of Vietnam, the network of plant protection drug business is rapidly increasing and difficult to control. The statistics in 2018 show that: there were more than 300 companies producing plant protection drugs; 93 factories, drug-manufacturing establishments and 28,750 stores, agents trading in plant protection drugs [15]. Meanwhile, the system of inspection and supervision of the use of plant protection drugs is very weak, thin (very few people do this), so that inspection and supervision activities face many difficulties. In fact, the negative impact of plant protection drugs is very large, the amount of pesticide residues on agricultural products is widespread and still high, especially on vegetables, fruits and some specific fruit trees such as mango, longan and dragon fruit [10].

Effects of plant protection chemicals on environment

Plant protection drugs are important chemicals in agricultural production activities, it will have a marked effect on crops if used properly. But it also causes soil degradation and water pollution. According to research results of the Institute of Agricultural Science of Southern Vietnam, when spraying the crop, 50% - 60% of the pesticides will fall to the ground. The drug exists in the soil and is gradually resolved through the biological activity of the soil and through the action of physical and chemical factors. However, if there is a large amount of chemical residue, the rate of pesticide resolution will be very slow, especially in areas with weak biological activity (for example, soil in the Mekong Delta) [15]. At that time, pesticides will be washed down the canals and contaminate water sources.

The transformation of pesticides through the soil depends on the properties such as pesticides, dosage, soil type, weather condition, irrigation method, crop variety, and soil microorganisms. In addition, there are many durable pesticides, so the retention time in soil is very long. Pesticides accumulated in the soil mainly belong to two groups: the carbamate group and the organic phosphorus group (organic phosphate source). In particular, the drug contains elements such as lead, arsenic, mercury with high toxicity, long retention time in the soil, including agro-drug residues in the soil from 10 to 30 years. These drugs can accumulate in fruits and leaves, then enter the body of humans and animals through the food chain, thereby affecting health. Pesticides are used to kill pests but at the same time they are toxic to beneficial microorganisms and insects, and to top consumers. Moreover, it is possible that after a long period of use of pesticides, some pests will become resistant [15,16].

In Vietnam, the current investigation and survey is mainly inventory of areas polluted by plant protection drugs. As a result, many pollutant sites have been discovered in provinces and cities. Typically, the research project "The current status of pesticide residues seriously affects the soil, water, air, humans and organisms in the land and water" of the Vietnam Environment Administration, has published data on the effects of retention of plant protection drugs in the environment. Currently, Vietnam has 1,562 points of discovery or suspicion of pesticide residue in soil (According to QCVN 53 = 4:2013/BTNMT of Ministry of Natural Resources and Environment on National technical regulation on remediation target values of persistent organic pesticides according to land use) [15,16].

With the above information, the residue of plant protection drugs will cause serious environmental pollution, especially causing great impacts on human health. In addition to negative impacts on the ecosystems and public health, the misuse of plant protection drugs also disrupt the sustainability of agricultural development, in particular: increasing drug resistance and causing depletion of the parasite - natural enemy system; increase chemical residues for agricultural products and the environment; and affecting agricultural consumption.

The risk of accumulating pesticide residues in soil and agricultural products in Vietnam

Plant protection chemicals have been widely used in Vietnam since the early 1960s to eradicate pests for crop's protection. In addition to the positive aspects of plant protection drugs that are destroying the harmful organisms for plants, these pesticides also cause

serious consequences such as disrupting the flora system in the field; eliminating useful insects; destructing of aquatic resources; and causing soil degradation. However, in the system of plant protection measures, the use of plant protection drugs has so far occupied a very important position, which can be said to play a decisive role in agricultural activities. The increasing use of pesticides has led to many harmful effects on agricultural production, environmental degradation, and public health effects, threatening the sustainable development of agriculture. Plant protection drugs also destroy groups of insects and beneficial organisms, and cause the degradation of soil flora and fauna communities, thereby creating conditions for more outbreaks of disease. The use of pesticides that do not comply with technical regulations will quickly cause resistance to pests and diseases also stored in the soil, affecting human and biological health. This is the main cause of the decline in the quality of products and the competitiveness of Vietnamese agricultural products in the market that requires high quality.

According to the analysed results from 2010 - 2014 of the Plant Protection Department of Vietnam, the number of samples collected in Hanoi and Hochiminh City areas has a high amount of pesticide residues in excess of the technical regulation from 10% - 26%, and from 10% - 30% respectively. The survey results in 2018 showed that residues of pesticides on vegetables were still high, exceeding the technical regulation from 10% - 20%. Statistics in the period from 2010 - 2012 show that, in developed countries, despite having a very strict inspection program on food safety, there is still a high level of residues of pesticides on agricultural products, specifically: the US has 4.8% of the sample exceeding the permitted standard; EU, 1.4%; Australia, 0.9%; Republic of Korea, 0.8%; and Taiwan, 1.3%.

In 2016, a study evaluating the residues of pesticides (Organophosphative and Pyrethroid) and fungicides (Triazoles and Chloronitriles) in fruits and vegetables was conducted in Xiamen, China. Gas chromatography (GC-ECD) was used to analyze the concentrations of 22 pesticides. Of the 1,135 samples (37.7%) with pesticide residues detected, so cabbage, legumes and mustard leaves were detected the most frequently, with 17.2%, 18.9%, and 17.2% of samples have exceeded the technical regulation. Regarding the most frequently detected pesticide residues, cypermethrin was found in 18.7% of analyzed samples. The data collected is then used to estimate the potential health risks associated with exposure to these pesticides. Although plant protection drugs have been developed for agricultural activities with safety and minimal risk to human health and the environment. But in fact it is difficult to determine the dosage exactly. Due to the consequences and adverse effects of pesticide abuse, many countries around the world have been implementing an innovative strategy for using pesticides. In Vietnam, the agricultural program has also shifted from "safe and effective use of plant protection drugs" to "strategies to reduce risks of plant protection drugs". Since 2016, reseachers from Vietnam and some Asian countries have focused on the main studies, namely: (1) basic safety issues related to the use of plant protection drugs; (2) common factors affecting pesticide exposure; and, (3) common indicators used to predict adverse effects of plant protection drugs on the human health and the environment, as well as the reliability and the accuracy of risk assessment of adverse effects.

Conclusion

Based on the results discussed above, this overview report provides a detailed summary of the main findings of the current situation of using the plant protection chemicals in Vietnam as well as some countries around the world. In addition to the basic benefits that pesticides bring to the agricultural sector, plant protection chemicals have been causing serious problems for the environment, ecosystems and public health.

In the coming time, it is necessary to carry out the specific studies in each locality to suggest the appropriate measures and thoroughly handle the difficult problems to bring the positive effects for the agricultural economy as well as to ensure the food safety for human safety and environmental protection.

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