Journal of Hazardous Materials 165 (2009) 1–12

Contents lists available at ScienceDirect

Journal of Hazardous Materials

journal homepage: www.elsevier.com/locate/jhazmat

Review

Pesticide use and application: An Indian scenario

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ARTICLE INFO

Article history:
Received 24 April 2008
Received in revised form 9 July 2008
Accepted 10 October 2008
Available online 1 November 2008

Keywords:
Pesticide
Agriculture
Application technology
Residue

ABSTRACT

Agricultural development continues to remain the most important objective of Indian planning and policy. In the process of development of agriculture, pesticides have become an important tool as a plant protection agent for boosting food production. Further, pesticides play a significant role by keeping many dreadful diseases. However, exposure to pesticides both occupationally and environmentally causes a range of human health problems. It has been observed that the pesticides exposures are increasingly linked to immune suppression, hormone disruption, diminished intelligence, reproductive abnormalities and cancer. Currently, India is the largest producer of pesticides in Asia and ranks twelfth in the world for the use of pesticides. A vast majority of the population in India is engaged in agriculture and is therefore exposed to the pesticides used in agriculture. Although Indian average consumption of pesticide is far lower than many other developed economies, the problem of pesticide residue is very high in India. Pesticide residue in several crops has also affected the export of agricultural commodities in the last few years. In this context, pesticide safety, regulation of pesticide use, proper application technologies, and integrated pest management are some of the key strategies for minimizing human exposure to pesticides. There is a dearth of studies related to these issues in India. Therefore, the thrust of this paper was to review the technology of application of pesticides in India and recommend future strategies for the rational use of pesticides and minimizing the problems related to health and environment.

Contents

Abbreviations: BHC, Benzenehexachloride; BIS, Bureau of Indian Standards; CIL, Central Insecticide Laboratory DDT, Dichlorodiphenyltrichloroethane; DPPQS, Directorate of Plant Protection Quarantine & Storage; ILO, International Labor Organization; FAO, Food and Agricultural Organization; FFSs, Farmers Field Schools; GDP, Gross Domestic Production; GM, crops Genetically Modified crops; HCHs, Hexachlorocycloheaxnes; ICM, Integrated Crop Management; IPM, Integrated Pest Management; KVK, Krishi Vigyan Kendra; MoH&F, Ministry of Health and Family Welfare; MRL, Maximum Residue Limit; NAMP, National Anti Malaria Program; NIC, National Information Centre; NPPTI, National Plant Protection Training Institute; PCP, Pentachlorophenol; PCBs, Polychlorinated Biphenyls; RUP, Rational use of Pesticides; SAUs, State Agricultural Universities; SDoA, State Department of Agriculture; ULV, Ultra Low Volume; UT, Union Territory; WTO, World Trade Organization.

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doi:10.1016/j.jhazmat.2008.10.061

1. Introduction

Chemical pesticides have contributed greatly to the increase of yields in agriculture by controlling pests and diseases and also towards checking the insect-borne diseases (malaria, dengue, encephalitis, filariasis, etc.) in the human health sector [1,2]. The need to increase world food production for the rapidly growing population is well recognized [3,4]. One of the strategies to increase crop productivity is effective pest management because more than 45% of annual food production is lost to pest infestation. In tropical countries, crop loss is even more severe because the prevailing high temperature and humidity are highly conductive to rapid multiplication of pests [5,6]. Thus, the application of a wide variety of pesticides on crop plants is necessary in the tropics to combat pests and vector borne diseases. However, the sporadic use has been leading to significant consequences not only to public health but also to food quality resulting in an impact load on the environment and hence the development of pest resistance [7]. Through over use and misuse there is considerable waste, adding to the cost and contributing to the adverse environmental and health consequences. Inappropriate application of pesticides affects the whole ecosystem by entering the residues in food chain and polluting the soil, air, ground and surface water [7–9].

Humans are exposed to pesticides (found in environmental media such as soil, water, air and food) by different routes of exposure such as inhalation, ingestion and dermal contact [2]. Exposure to pesticides results in acute and chronic health problems. Pesticides being used in agricultural tracts are released into the environment and come into human contact directly or indirectly [1]. Increasing incidence of cancer, chronic kidney diseases, suppression of the immune system, sterility among males and females, endocrine disorders, neurological and behavioral disorders, especially among children, have been attributed to chronic pesticide poisoning [7]. Human health hazards vary with the extent of exposure. Moderate human health hazards from the misapplication of pesticides include mild headaches, flu, skin rashes, blurred vision and other neurological disorders while rare, but severe human health hazards include paralysis, blindness and even death [8]. Pesticide pollution to the local environment also affects the lives of birds, wildlife, domestic animals, fish and livestock [10]. The use of un-prescribed pesticides in inappropriate doses is not only disturbing the soil conditions but is also destroying the healthy pool of bio-control agents that normally co-exist with the vegetation. These biocontrol agents are the friends of agriculture and hence need to be nurtured, cared and developed by reducing the reliance on chemical's use in agriculture [11].

Orgnochlorine insecticides, such as DDT, hexachlorocyclohexane (HCH), aldrin and dieldrin, are among the most commonly used pesticides in the developing countries of Asia because of their low cost and versatility against various pests [3,12,13]. Nevertheless, because of their potential for bioaccumulation and biological effects, these compounds were banned in developed nations two and half decades ago [14–16]. Their resistance to degradation has resulted in contamination universally found in many environmental compartments. Such residues may be comprised of many substances, which include any specified derivatives such as degradation products, metabolites and congeners that are considered to be of toxicological significance. According to the Food and Agriculture Organization (FAO) inventory [17], more than 500,000 tons of unused and obsolete pesticides are threatening the environment and public health in many countries. Public concern over pesticide residue has been increasing during the last decade. Recovering from the euphoria of green revolution, India is also now battling from residual effects of extensively used chemical fertilizers and pesticides such as HCH, DDT, endosulfan, phorate, etc. [2,4,11].

India is predominantly an agrarian society. GDP for agriculture and allied sector during 2005–2006 was estimated at Rs. 61 Trillion at current price (USD 130 Billion), which was 19% share in GDP of total economy [11]. After independence, agriculture in India has undergone significant transformation [18]. The agricultural production increased tremendously due to introduction of high-yielding varieties, use of agro-chemicals and improved irrigation facilities [4]. However, there are several constraints for further increase in agricultural production. One of the limiting factors is the increased incidence of pests and diseases. On the other hand, increased use of chlorinated non-degradable pesticides leave residue in various living systems for prolonged periods of their span and are presumably responsible for a variety of toxic symptoms [19]. Therefore, the thrust of this discussion was to review the technology of application of pesticides in India and recommend future strategies for the rational use of pesticides and minimizing the problems related to health and environment due to inappropriate application of pesticides [12].

2. Pesticide usage in India

The use of synthetic pesticides started in 1948–49 with the use of DDT for malaria control and BHC for locust control [12,19–23]. The Indian pesticides production industry started with the setting up of a BHC technical plant at Rishra near Kolkata in 1952. Shortly after, Hindustan insecticides Ltd. set up two units to manufacture DDT. In 1969, Union Carbide set up a small plant (Union Carbide India Ltd (UCIL)) in Bhopal, the capital city of Madhya Pradesh, to formulate pesticides. The Bhopal facility was part of India's green revolution aimed to increase the productivity of crops. The industry produced various pesticides, mainly sevin brand carbaryl insecticide and temikcbrand aldicarb pesticide. All the pesticides produced at UCIL were sold in the Indian market. The Union Carbide continued pesticide production till 1984 Bhopal disaster. Today, the Indian pesticides industry comprises of more than 125 basic producers of large and medium scale and more than 500 pesticide formulations. The pesticide formulation produced in the country are mainly of the conventional type currently, dusting powder has a major share (85%) in the market followed by water-soluble dispersible powder (12%) and emulsification concentrates (2%.) The use of granules, which are advantageous in terms of lower drift, ease of application and safety to operate is still in infancy. Most of the units are in small scale industry (SSI) sector [19].