

Review Article

A Review on Judicious Use of Chemicals in Agriculture Scenario

Varun Athokpam*

Department of Agriculture, Lovely Professional University, Phagwara, Punjab-144411, India

*Corresponding author

ABSTRACT

The Green Revolution in India started in the 1960s. The use of agrochemicals boosted food production but also destroyed the agricultural ecosystem. Recently farmers and agricultural scientists have realized this and are eager to find other options like a non-chemical agriculture and have even revived their age-old traditional techniques of natural farming. Scientists are doing researches to find economically cheaper and ecologically safer replacements to agrochemicals. Blue-Green Algae and seaweed biofertilizers, Earthworm Vermicompost, biological control of pests like ladybugs; and natural biopesticides like neem products are showing promise. There is a “revolution” for alternative foods, which are more nutritious, cheaper and have shorter harvest cycles.

Keywords

Green revolution, pesticides, agrochemicals, biopesticides, bio fertilizers

Introduction

Agriculture is the major source of livelihood for most of the population in India. The increased use of agrochemicals started in India since 1960s on the starting of the Green Revolution. Over the past years synthetic fertilizer consumption has increased and India is now one of the leading producers of agrochemicals in the world. Many of the chemical pesticides can cause harmful toxic effects on human beings. Acute exposure to pesticides can lead to death or serious illnesses. Many people die each year due to unintentional acute poisonings. Two-thirds of these deaths occur in developing countries where such poisonings are due to excessive exposure and or inappropriate use of toxic chemicals and pesticides. The health impacts of human exposures to various agrochemicals

can be a factor in a range of chronic health conditions and diseases like cancer, reproductive, endocrine, congenital and developmental disorders. Groundwater is the major source of drinking water in India also it is an important source of water for the agricultural sector. The continued use of chemicals in agriculture has revealed its potential to percolate and reach the groundwater. There are four major ways through which pesticides reach the ground water. They may drift outside the intended area and may percolate, leach or seep through the soil, may be carried to surface water as runoff. Good management, use, and disposal of agrochemicals is an important health and environment issue. Safe pesticide management is essential for all those involved with using pesticides. The total exposure of a person to pesticide is during

different situations like mixing, applying, storing or disposing the chemicals. Exposure to pesticides and its health impacts can be reduced by appropriate and judicious use of agrochemicals, practicing recommended methods of mixing, applying, storing, disposing and practicing use of personal protective equipment (PPE). This information is for bringing about changes in the agricultural practices to reduce the risk of exposure to harmful agrochemicals.

Pesticides, A brief summary

Pesticides are substances that are meant to control pests like herbicide, insecticides, nematicides, fungicides, etc. Pesticides may be organic or inorganic. Most farmers use the inorganic pesticides as they exhibit more effectiveness as compared to the organic pesticides, but as the name suggests organic ones are much more eco-friendly and does not cause harm to humans as well as the farm ecology. Majority of the farmers have little scientific knowledge and are using the chemicals beyond the recommended doses without being aware of the type of pesticide, its toxicity level, measures of safety and hazards it can cause on health and environment (Yassin *et al.*, 2002), which will eventually lead to damage to them as well as the environment and the consumers. India is the second largest pesticide producer in Asia (WHO, 2009) and also ranks second in pesticide uses in the Asia continent (Shetty *et al.*, 2010). Pesticides are mainly used in the scenario to reduce damage by fungal diseases, disease causing insects and host weeds.

Pesticides of high toxicity level are banned and/or restricted to use in most of the countries. India has put ban on 28 pesticides but excluded highly harmful pesticides like endosulfan, lindane, phosphamidon, phorate, methyl parathion and monocrotophos. The

Indian Government has introduced The Pesticide Management bill 2020 to replace The Insecticides Act 1968.

Plant diseases

Plant disease, an abnormal state of a plant that interrupts or modifies its vital functions. Some major diseases are rusts, mildew and blights, which causes major losses to crops and farmers as well as the whole community like late blight of potato in Ireland and the coffee rust in Sri Lanka. There have been many major disasters caused by plant diseases around the world namely the Great Bengal Famine, 1943 (Padmanabhan SY.1973) and the southern corn leaf blight epidemic, 1970–1971 in the USA (Ullstrup AJ. 1972).

Plant diseases are normal and occur naturally; many cultivated crops and ornamental plants are very susceptible to disease and would have difficulty surviving in nature without human intervention. They are often more susceptible to disease than their wild relatives. This is because large numbers of the same species or variety, having similar genetic background, are grown close together, sometimes over thousands of square kilometers. A pathogen may spread rapidly under these conditions. Majority of plant diseases are caused by fungi, bacteria and viruses. Insect pests are vectors and weeds are hosts for this insect pests and sometimes for fungi and bacteria.

Viral Diseases

Many of the plant viruses cause uncontrollable and damaging diseases and often have wide host ranges. These viral diseases of plants are transmitted mostly by insect vectors, insect vectors that transmit most plant viruses are aphids, whiteflies, leafhoppers, thrips, beetles or weevil, mealy

bugs, and mites. Sucking insects appear to be the most common vectors of plant viruses. Most plant virologists named a virus based on the host plant in which it was found and the type of symptom that the virus caused in the plant. Tobacco mosaic virus was first reported in tobacco leaves in which it gives a mosaic pattern in the leaves.

Common Plant diseases caused by viruses

Viral disease can be controlled by either eradication of affected plants or control of vectors. Vectors can be controlled by trap cropping, manual removal at ETL, or by insecticides. The strategy for management will depend on the means by which a virus enters a crop, how the virus transmits between plants within a crop, and how the virus survive when the crops are not grown (Haddidi *et al.*, 1998)

Major insecticides used are:

Carbofuran

Bifenthrin

Malathion

Imidacloprid

Azadirachtin

Quinalphos

Fipronil

Dimethoate

Eco Friendly controls are:

Neem oil

Horticultural oils

Soap water

Natural predators

Hand removal

Most insecticides are broad spectrum and can be used for most of the pests. But nowadays as the revolution of Organic Farming rises most people would suggest the Azadirachtin which is made from neem oil extract and the eco friendly methods.

Fungal Diseases

Majority of plant diseases are caused by fungi. They occur when there are favourable conditions like humid climate, wet and soggy soil, diseased dead leaves etc., some strains attack many host species and some other strains are confined to a single species. (Hayden HL, Pegg KG, Aitken EAB, Irwin JAG. 1994.). Some diseases are caused by more than one pathogen like Downy mildew caused by *Peronospora*, *Pseudoperonospora*, *Plasmopara*, *Sclerospora*, and *Scleroththora* on a variety of crops like maize, onion, soybean, cucurbits, and grapes (Thakur RP, Mathur K. 2002). Pathogens thrive on nutrients from the economically important part of the plant by the production or induction of growth regulators causing loss of yields. (Strange RN. 2003).

Common fungal plant diseases

Most plant diseases are caused by fungi and they are mostly controlled by chemicals. Most common fungicides are:

Captan (Seed treatment, application)

Thiram (Storage)

Carbendazim (Broad spectrum)

Propiconazole (Broad spectrum)

Copper sulphate (Broad spectrum)

Mancozeb (Broad spectrum)

Mechanical measures of controlling fungal disease are :

Removal of dead and diseased plant parts and debris

Control temperature and humidity

Avoid excessive splashing

Watering should be done in early part of the day.

Bacterial Diseases

Bacteria invade plants through wounds caused by humans, tools and machinery, insects, and nematodes, or through natural openings such as stomata and leaf scars.

Bacterial diseases are affected extremely by temperature and moisture. Humans spread bacteria through cultivation, grafting, pruning, and transporting diseased plant material.

Common bacterial plant diseases

Bacterial diseases in plants can be controlled by

Crop rotation

Monitoring of crops regularly

Minimise mechanical damage to crops

Removal of weeds

Sterilisation of tools

Soil solarisation and removal of stubbles

Farmer must be aware and should ask experts if any symptoms arise as it would be either bacterial or fungal or viral disease; or else wrong uses of chemical without any knowledge would lead to losses.

Control

The initial step of management of a disease is to make sure that it does not exist through exclusion (quarantine) or eradication (Ebbels DL. 2003). Plant Protection Services take authority for protecting their countries from undesired spread of new pathogens and pests and to eradicate those that have recently arrived for their elimination. There are many methods in which the farmer can take to control/reduce disease incidence in the field like crop rotation, by ploughing or by adjusting planting time, by soil solarization, by flooding.

Pathogen and pest in greenhouses/protected structures may be reduced by covering the glass by materials which blocks the inflow of some wavelengths favourable to them but allowing the light of wavelengths required for photosynthesis (Reuveni R, Raviv M, Bar R. 1989). When an attack/disease is approaching in the field, there is little methods other than the application of pesticides, however, by forecasting the occurrence of favourable conditions to the pathogen, the applications done and the amount of pesticide applied can be decreased (Hijmans RJ, Forbes GA, Walker TS. 2000).

Table.1 Common Plant diseases caused by viruses

Disease	Vector	Host
1. Tomato spotted wilt virus	Thrips (<i>Thrips tabaci</i> , <i>Scirtothrips dorsalis</i>)	Tomato (Brittlebank, 1915)
2. Cauliflower mosaic virus	Aphids	Cauliflower (Brierly, 1933; Goldstein, 1927)
3. Rice tungro disease	Green leaf hopper (<i>Nephotettix virescens</i>)	Rice (Krishnaveni <i>et al.</i> , 2011)
4. Potato leaf roll virus	Aphids	Potato (Talianky <i>et al.</i> , 2003)
5. Tobacco Mosaic virus	Transmitted through plant to plant or human to plant contact.	Tobacco (Scholthof, 2000)

Table.2 Common fungal plant diseases

Disease	Pathogen	Host
Anthraxnose	<i>Colletotrichum</i>	Chilli (Rojas <i>et al.</i> , 2010)
Downy mildews	<i>Phytophthora</i> , <i>Sclerospora</i>	Maize (Nair SK, Prasanna BM, Rathore RS, <i>et al.</i> , 2004)
Fusarium rots	<i>Fusarium oxysporium</i>	Tomato (Singh VK, Singh HB, Upadhyay RS 2017)
Powdery mildews	<i>Erysipheci choracearum</i>	Peas (GanopoulosI, Mylona P, MellidouI, <i>et al.</i> , 2018)
Rusts	<i>Puccinia spp.</i>	Wheat (ShabanaYM, AbdallaME, ShahinAA, <i>et al.</i> 2017)
Karnal Bunt	<i>Tilletia indica</i>	Rice (Singh J <i>et al.</i> , 2020)
Early blight	<i>Alternaria solani</i>	Tomato (BabuAN, JogaiahS, ItoSI, <i>et al.</i> , 2015)

Table.3 Common bacterial plant diseases

Diseases	Pathogen	Host Plants
Bacterial blight	<i>Xanthomonas campestris</i>	Rice (Wongkhamchan A, Chankaew S, Monkham T, <i>et al.</i> , 2018)
Black rot	<i>Xanthomonas campestris</i>	Cabbage (Meier, D. 1934)
Fire blight	<i>Erwinia amylovora</i>	Apple and pear (Gunen Y, Misirli A, Gulcan R 2005)
Bacterial leaf spot	<i>Pseudomonas syringae</i>	Crucifers (Zhao, Youfu, <i>et al.</i> , 2000)
Bacterial wilt	<i>Ralstonia solanacearum</i>	Tomato (Lebeau, A., Daunay, <i>et al.</i> , 2011)

Many crops were protected by timely pesticides applications and remains one of the major method available for controlling pathogens and their vectors (Hewitt HG. 1998). Pesticide use is applied in systems of integrated pest management (Maredia, Dakouo, Mota-Sanchez, eds. 2003), which focuses on a sustainable balanced method to disease control, also avoiding the excessive use of pesticides whose side effects are undesired. Biological control agents are also used to control insect pests of crops, but successful cases are few in using of such methods for field management of plant diseases (Butt T, Jackson C, Magan N, eds. 2001). One of the most effective method of disease management is the breeding and cultivation of genetically resistant/modified plants. The genetic resistance to a plant disease was first clarified in 1905 (Biffen RH. 1905). The selection for disease resistance has been practiced for years by farmers and by plant breeders. Spontaneous variation in disease resistance can be selected and genes can be introduced by hybridization.

Misuse of pesticides

The misuse of pesticides, mostly broad-spectrum pesticides has caused adaptation and resistance of pests to pesticides (Yadav and Lian, 2009), because of these pesticides are required at higher doses to maintain the same level of control. Misuse of pesticides are commonly reported from farmers and traders who do not realize thoroughly that pesticides are poisonous and hazardous to human health as well as the environment.

Impact on Health and Environment

Chemical pesticides cause damaging effects on human health and the environment. In the past years, wanton use of chemical pesticides in agriculture had caused serious health and environmental problems. The large-scale use

of chemical pesticides in cultivation areas raised the issue of possible health risks. Pesticide pollution not only cause an altered human health, but also caused on ecological factors like soil surface and ground water, micro and macro flora and fauna, etc. (Pimental, 2005).

Environment pollution

Over 90% of sprayed insecticides and herbicides reach areas other than their target which are not targeted like air, water and food (Miller, 2004). Suspended particles of pesticides are carried by wind to other areas causing air pollution (Cornell University, 2007). Pesticides that are applied on fields can cause the formation of ozone (UC IPM Online, 2006) which is a causing a major crisis of the Ozone hole.

Pesticide poisoning

Pesticide poisoning is a worldwide crisis. According to Rajendran (2003), nearly 500,000 illnesses and 20,000 deaths are caused by chemical pesticides worldwide.

A recent study shows that about 5 million people die every year around the world because of intentional, accidental and occupational exposure to hazardous chemicals (Singh and Gupta, 2009). Kumar *et al.*, (2011) reported that every day almost 700 people die from the poisoning and several thousands more are affected by pesticide poisoning globally. Understanding of unfavourable effects caused by pesticide exposure is increasing among the people (Clapp *et al.*, 2008). Unfavourable health effects are more common in less developed countries because of low guidelines and the low awareness of users, limited use of personal protective equipment, improper application methods and using of hazardous pesticides.

IDM (Integrated Disease Management)

IDM is the using of chemicals only when disease incidence reached ETL and also using of bio control agents. It is a better and eco friendlier method promoting natural, economic and sociological farming methods using cultural and biological methods mostly to keep diseases below ETL.

Farmers are encouraged to have the knowledge of IDM to reduce the usage of chemicals and take more emphasis on organic farming.

The practice of storing, mixing and application of pesticides should be done following the recommended doses and safety measures. IDM should be done to reduce the drawbacks caused by chemicals. Trapping, physical barriers and natural predators should be done to control vectors. Proper hygiene and sanitation should be followed to control bacterial diseases. Fungal diseases should be controlled by IDM method to minimize losses. An awareness program regarding IDM and IPM is required to give knowledge to farmers around the country.

Exposure of farmers and their families to pesticides and intake of pesticides by consumers are a major health crisis. Ecological system have been affected entirely. Based on this review work the recommendations are.

The selection of appropriate pesticides and proper handling and use as per the label are the most important steps for safe use of chemical pesticides.

Intensive IPM and IDM programs are required.

The use of biopesticides, biocontrol agents and eco-friendly measures are recommended

to minimise the use of pesticides. Sustainable farming practices should be followed for safety to human health and the environment.

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