International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

The Review on Pesticides

Tejaswi Sanjay Gaikwad[1], Pooja B. Mairal[2*]

[1,2] Swami Vivekanand Sanstha's Institute of Pharmacy Mungase Malegaon
*Corresponding Author: Assistant Prof. Pooja B. Mairal.

Abstract:

Pesticides are the natural or synthetic agents designed to kill all types of pests. Pesticides are used in different fields like agriculture, forestry, aquaculture, food industry etc. Due to its gross use these pesticides threaten public health and ecosystem. Classification of pesticides done according to various criteria like its toxicity or hazardous effects, its use or purpose, its chemical composition, its mode of action, how or when it works, its formulations, its source of origin. By giving importance to public health, WHO has done classification of pesticides on the basis of hazardous effects With the comprehensive knowledge of classification of pesticides, gross use of pesticides can be minimized by using it judicially and it is helpful to public health & ecosystem.

Keywords: Pesticides, Classification, Toxicity, Ecosystem.

INTRODUCTION:

Pesticides are chemical compounds that are used to kill pests, including insects, rodents, fungi and unwanted plants (weeds). Pesticides are mainly used for benefits like crops protection, preservation of food materials and prevention of vector borne diseases. Uncontrolled application of pesticides can contaminate soil and may kill other nontarget organisms. Pesticides can damage soil biomass and microorganism such as bacteria, fungi, and earthworms. Microbial biomass is a labile component of soil organic matter and has an important role in the soil nutrient element cycle [1]. S. A. Reinecke and A. J. Reinecke (2007) studied earthworm biomass and cholinesterase activity affected by pesticides [2]. The authors concluded that earthworms were affected detrimentally by the pesticides due to chronic (chlorpyrifos) and intermittent exposure (azinphos-methyl). Other research also showed that malathion exposure gave a significant reduction in body weight and decreased sperm viability of Eisenia fetida adult species. The organism also had an adverse impact on growth and reproduction by the chlorpyrifos exposure, and the cypermethrin exposure also gave the significant reduction in cocoon production [3].

They are also used in different field like agriculture, forestry, aquaculture, food industry, processing, transportation and storage of wood and other biological products.1 Gross use of pesticides cause damage to public health and ecosystem. Incidence of poisoning, as reported, is 13- fold higher in developing countries than in highly industrialised nations, which consumes 85% of world's pesticide production. Most pesticide related poisoning in developing nations can be attributed to lack of training in their use, poor legislative control and carelessness in providing protection to the body during their application. Pesticides have different distribution and persistence patterns in the environment, even if all of them are distributed in some way through air, soil and water.3 Pesticides are classified on the basis of various criteria. Most commonly used criteria for classification of pesticides are its mode of entry, its chemical composition and target it kill. But giving importance to public health, World Health Organization (WHO) and Globally Harmonized System (GHS) classified pesticides according to their toxicity or hazardous effects. Without ignoring risk factors of pesticides, we must have to use it for better crop

production & food preservation. But by using it judiciously with the help of different classification of pesticides, its gross use, exposure and toxic effects can be minimized.[4]

Materials and Methods:

Time and Study Area. This research was conducted from August 2016 until January 2017 located at Wanasari Subdistrict, Brebes District, Central Java Province, Indonesia. The location of the study was selected based on the shallot productivity criteria level and pesticide usage behavior.

Interview and Questionnaire:

This study was a quantitative and qualitative research. Sources of data were collected from observation, questionnaire, and in-depth interview. The respondents for quantitative study were shallot farmers who planted shallot during the last three years (n = 60). The interviews were conducted with three official officers from the local agricultural extension center, known as Balai Penyuluh Pertanian (BPP). Data were presented descriptively by outlining the existing findings of observations and respondents interview. Interviews were conducted to determine the pattern of shallot planting in the study area, the pattern of pesticide usage, which includes the types of pesticides, how to mix the pesticides for spraying, and time of pesticides use based on the planting period. Instruments used in this study are questionnaires, notebook, and recorder. The questionnaires were inputted to Microsoft Office Excel fordescriptive analysis. The data analysis was presented in tables and graphs. In-depth interview was carried out to determine the role of BPP in the use of pesticides and also to validate the findings of the questionnaires.[5]

Soil Sampling and Organophosphate Residue Testing:

Soil sampling methods were done randomly. Soil samples were taken throughout the sampling locations at the same time. The sampling was conducted during the dry season. Soil samples were taken at 25–50 cm depth, and the top soil was not included in the sample. Soil samples were collected using a tube sampler and then stored in a clean plastic bag. Samples are labeled according to the date of sampling, sample locations, and types to be tested. Then the samples were sent to the lab to be tested. The measurement method of pesticide residues is using Gas Chromatography-Mass Spectrometry (GC-MS) in the Agrochemicals Residue Laboratory, Indonesian Ministry of Agriculture. The result is expressed in units of mg/kg.

Tools and Materials:

The tools used in this study were mechanical shaker (shaker), Florisil columns, glassware, rotary evaporator, homogenizer, vacuum pump, Buchner filter, water bath, analytical scales, and a Gas Chromatography set (GC-2014 Shimadzu) equipped with ECD and Rtx-1 columns (column length 30 m, inner diameter 0.25 mm). Materials used in the study were acetone (E. Merck), n-hexane (E. Merck), anhydrous Na2SO4 (E. Merck), Florisil, activated carbon, Celite 545-magnesium, filter paper, aquadest, standard solution of organophosphate pesticides, and soil samples.[6]

Soil Sampling:

The ground surface to be sampled is flattened and cleaned; then the soil was dug with a soil corer perpendicular to the layer. The soil was taken to 25–30 cm depth. Next, the soil around the tube was dug up with a shovel. About 1-2 cm of the topsoil was removed. Then ± 250 grams of soil was leveled and sampled. The soil samples were then placed on the sample plastic and labeled with sample codes,

sampling dates, sample locations, and test types. Samples that had been prepared then were immediately sent to the laboratory. Sample delivery should be safe to avoid damage or torn plastic. The delivery time was about 2-3 days.[7]

Preparation of Soil Samples.

Dried soil sample (by aerated method) weighed about 25 grams and then was put into a round bottom flask and 100 ml acetone solvent was added and then closed. The round bottom flask containing the sample was shaken with a shaker for 20 minutes at a sufficient rate. After 20 min, the extraction was repeated by rewinding with the same time and velocity; then the separating funnels were placed on the iron stand with clamp and remained until separation occurred between the solvent and the sample; then separation between filtrate and residue occurred. The filtrate was evaporated with an evaporator, extracted with 25 ml of n-hexane 2 times, and then cleaned up by passing the sample on the chromatographic column filled with Florisil and anhydrous sodium sulfate. [8]

Classification of Pesticides

Pesticides are classified on the basis of various criteria such as toxicity (Hazardous effects), pest organism they kill and pesticide function, chemical composition, mode of entry, mode of action, how or when they work, formulations, and sources of origin.

Classification of pesticides on the basis of toxicity

The toxicity of pesticides mainly depends on two factors namely dose and time. Hence, how much of the substance is involved (dose) and how often the exposure to the substance occurs (time) give rise to two different types of toxicity- acute and chronic toxicity. 6 Acute Toxicity- Acute toxicity refers to how poisonous a pesticide is to a human, animal or plant after a single short-term exposure. A pesticide with high acute toxicity is deadly even when a very small amount is absorbed. Acute toxicity may be measured as acute oral toxicity, acute dermal toxicity and acute inhalation toxicity.[9]

Chronic toxicity:

Chronic toxicity is the delayed poisonous effects from exposure to a pesticide. Chronic toxicity of pesticides concerns the general public as well as those working directly with pesticides because of potential exposure to pesticides on/in food products, water, and the air.

World Health Organization (WHO) has highlighted only acute toxicity for the classification of pesticides. According to WHO, pesticides are classified by acute oral and acute dermal toxicity using the estimated respective lethal dose LD50 (the pesticide dose that is required to kill half of the tested animals when entering the body by oral or dermal route). At present, widely used 'WHO recommended classification of pesticides by hazard' suggests allocating pesticides to 'the specific WHO Hazard classes'. After revision in 2009 these classes were harmonized with the 'Globally Harmonized System (GHS) Acute Toxicity Hazard Categories.[10]

Classification of Pesticides on the basis of Chemical Composition:

This is the most common and useful method of classifying pesticide which is based on their chemical composition. Pesticides like insecticides, fungicides, herbicides and rodenticides are also classified on the basis of their chemical compositions as follows

Insecticides:

On the basis of chemical composition insecticides are classified as Carbamates (Carbaryl), Organochlorine (Endosulfan), Organophosphorus (Monocrotophos), Pyrethroids (permethrin) Neonicotinoids (Imidacloprid), miscellaneous pesticides such as Spinosyns (Spinosad), Benzolureas (diflubenzuron), Antibiotics (abamectin), etc.[11]

Fungicides:

Fungicides are classified as aliphatic nitrogen fungicides (iodine), amide fungicides (carpropamid), aromatic fungicides (chlorothalonil), dicarboximide fungicides (famoxadone), dinitrophenol fungicides (dinocap) etc.[12]

Herbicides:

The herbicides are anilide herbicides (flufenacet), phenoxyacetic herbicides (2, 4-D), quaternary ammonium herbicides (Paraquat), chlorotriazine herbicides (atrazine), sulfonylurea herbicides (chlorimuron), etc.

Herbicides that are included in pesticides are also classified on the basis of mode of action as follows:

a) Growth regulators- Compounds thatdisrupt hormone balance and protein synthesis by which plant ultimately dies. e.g. 2,4-D

b) Amino acid synthesis regulators – Compounds that inhibits specific enzyme which is responsible for synthesis of amino acids. e.g. Glyphosate

c) Lipid synthesis inhibitors – Prevents formation of fatty acids which are essential for production of lipids. e.g. Clodinafoppropargyl

d) Seedling growth regulators- inhibits cell division and lipid or protein synthesis in seedling. e.g. Butachlor

e) Photosynthetic inhibitors – inhibits the electron transfer in photosynthesis and conversion of sunlight into chemical energy. e.g. Atrazine

f) Cell membrane disrupters – disrupts cell membrane. e.g. Paraquat g) Pigment inhibitors- preventthe formation of pigments necessary for photosynthesis. e.g. Clomazone

Rodenticides – They are classified as inorganic rodenticides (Zinc phosphide, Aluminium Phosphide), and coumarin rodenticides (organic) (bromadiolone, coumatetralyl).[13]

Results and Discussion:

Planting Time Pattern in the Study Area. Wanasari Subdistrict is one of the shallot agricultural centers in Brebes. Wanasari Subdistrict drained the Pemali River which is used for irrigation. Pemali River flows throughout the year, but the reduction of water discharge may occur in the dry season. These hydrology conditions influence the shallot planting time and productivity based on its area. Shallot planting times vary depending on the region. Wanasari Subdistrict stretches from north to south covering an area of 7,226 ha consisting of 2,123 ha of agricultural land using technical irrigation area, 632 ha using semitechnical irrigation, and a rainfed area of about 1,346 ha. In general, Wanasari Subdistrict has four shallots planting periods per quarter throughout the year, the first planting is from January–March, the second planting is in April to June, the third growing season is from July–September, and the fourth

growing season is in October–December. In addition, farmers also plant paddy, red peppers, green beans, bitter melon, peanuts, eggplants, tomatoes, cucumbers, and beans. Shallot was grown throughout the year, while rice and chili are planted during two periods. Paddy field for planting shallot has the widest area compared to other crops. Data from the Agricultural Extension Center of Wanasari Subdistrict showed in 2014 shallot harvest in Wanasari reached 6120 hectares; then the paddy areas are about 3800 hectares. The irrigated areas by Pemali River were Dukuhwringin, Dumeling, Glonggong, Jagalempeni, Kertabesuki, Lengkong, Pesantunan, Siasem, Sidamulya, and Wanasari village. [14]

The small part areas of the irrigation river are Pebatan and Sawojajar village. Areas that do not irrigate by the Pemali River are Keboledan, Klampok, Kupu, Sigentong, Sisalam, Siwungkuk, Tanjungsari, and Tegalgandu, but there are discharge channels as a source of irrigation. Pemali River flow across most of villages in Wanasari Subdistrict has benefit for agricultural area. Farmers can plant shallot along the year because of the abundance of water. The rainy season which occurs in the range from October to March also brings benefits for the area as a part of irrigation system in the location. With the availability of sufficient water, it can guarantee that shallot can be continued to be planted in this area. 3.2. Pesticides Usage Pattern among Farmers in the Study Area. Observations and interviews with farmers showed the classified patterns of pesticides excessive application. When spraying, farmers mixed the pesticide at least 2-3 types and there could even be 5–7 types. The doses used were 30–40 ml per type. Certainly the application of pesticides was tailored to the pest attack and shallot plant disease. The excessive pesticide applications become uncontrolled in a pest explosion event, when the pests attack less than usual the usage of insecticides reduced. When spraying, farmers used the spray tank that has 15 or 17 liters' capacity. For the fields of 1000 m2 , it takes at least two tanks for spraying once. If farmers used pesticides of at least 3 mixtures of 30 ml per species, then a tank containing 90 ml of pesticides was sprayed. For the 1000 m2 land at least 180 ml pesticides were sprayed. When this amount is calculated up to the time of the year it could be demonstrated that there were many pesticides absorbed by the ground. The pattern of insecticides usage in shallot agriculture varies. The amount of insecticides used has different mixed pattern in each cropping period, or with the fungicides usage.[15]

However, farmers often mixed between insecticides and fungicides. In the first growing season in January to March farmers generally use four types of mixtures (variations between insecticides and fungicides). The types often used in this season were Arjuna, Tumagon 100 EC, Daitin, and Vondozeb. The second planting season is in April, May, and June; an increasing number of the mixtures are used, which can be up to five mixtures. In the third growing season from July to September the farmers do not use fungicides. When the second and third growing season are in dry season and pests attack increased, the use of insecticides is done in large numbers. Shallot had little of plant disease and it was not found during the dry season. This has led to the reduction of fungicide usage. In the fourth growing season in October–December, the opposite things occurred. These months already entered the rainy season so pests diminish. The study showed that Arjuna was the type of favorite pesticide most used by farmers (96%). Arjuna is a kind of insecticide that contains chlorfenapyr active ingredient from the pyrrole group. The insecticide was classified as moderately hazardous by WHO. Furthermore, there was Tumagon insecticide used by 90% of respondents. Trigard insecticide which contains cyromazine active ingredient is widely used by 83% of farmers, and 81% of farmers use Antracol insecticides. Other types of insecticides that are widely used are Xtreme (80%), Dursban (75%), Sumo (52%), and Marshal (48%). [16]

Active ingredients contained in widely used insecticides are pyrrole, carbamates, tiadiazin, and organophosphates In this study, methidathion residue active ingredient only is found in one sampling

location from Sisalam village about 0.014 mg/kg. Methidathion is a nonsystemic insectticide. Methidathion degradation in the environment is influenced by temperature and pH. The half degradation of methidathion is reported during half day up to 41 days depending on the temperature and pH. The higher the ambient temperature is, the easier the methidathion will be degraded. Methidathion easily degraded at alkaline pH. In acidic conditions, hydrolytic cleavage occurs mainly on the C-S bond, and under alkaline conditions, cleavage occurs on the P-S bond. Methidathion has low water solubility of about 240–250 mg/l at 20∘ C.These conditions increase the potential of methidathion compound to move off-site into the water surface depending on the conditions and environmental factors. Methidathion compound adsorption coefficient on clay is about 2.8% with *K*oc = 310.[17]

DISCUSSION:

Various classification of pesticides from different sources are reviewed in this article. These pesticides are used for different benefits such as for better yielding of crop production, protection of plants & preservation of food materials. Judicious use of pesticides may ensure quantity and quality of product, gives economic benefits and decrease man power whereas injudicious use of pesticides affect the public health and ecosystem. [19]

Following important points can be explored from this reviewed articleIt seems that toxicity-based classification of pesticides recommended by WHO help to minimize the use of highly hazardous pesticides by knowing their dose and toxicity level. Pesticides classification on the basis of pests they kill, their chemical composition, their mode of entry, their mode of action and how or when they work help to kill specific targeted pests and its vague use can be restricted.[19]

Conclusions:

Farmers and the persons who are coming in contact with pesticides are unaware about types of pesticides and their hazardous effects. With the thorough knowledge of classification of pesticides, its gross use, exposure and toxicity can be minimized by using it judicially and it is helpful to public health & ecosystem. The study showed that different insecticides and fungicides were used in each growing season. This study found that farmers apply a lot of pesticides. Pesticides are applied once every three or four days. The mixtures for insecticides and fungicides used at least three types of variations with doses of 30–40 ml for each type.

References:

1. S. Yasmin and D. D'Souza, "Effects of pesticides on the growth and reproduction of earthworm: a review,"Applied and Environmental Soil Science, vol. 2010, Article ID 678360, 9 pages, 2010.
2. O. Espinoza-Navarro and E. Bustos-Obregon, "Effect of mala- ´ thion on the male reproductive organs of earthworms, Eisenia foetida," Asian Journal of Andrology, vol. 7, no. 1, pp. 97–101, 2005.
3. S.-P. Zhou, C.-Q. Duan, H. Fu, Y.-H. Chen, X.-H. Wang, and Z.-F. Yu, "Toxicity assessment for chlorpyrifos-contaminatedsoil with three different earthworm test methods," Journal of Environmental Sciences, vol. 19, no. 7, pp. 854–858, 2007.
4. S. Zhou, C. Duan, X. Wang, W. H. G. Michelle, Z. Yu, and H. Fu, "Assessing cypermethrin-contaminated soil with three different earthworm test methods," Journal of Environmental Sciences, vol. 20, no. 11, pp. 1381–1385, 2008.
5. Algimantas Mieldazys, Ramunas Mieldyzys, Gedimanas Vilkevicius, Aleksandaras; Agriculture use of pesticides/ plant protection products, Forestry operations and OSH issues OSHWiki. [Cited on 2018 April 24]. Available from https://oshwiki.eu./wiki/Agriculture

6. Krishan Vij; Agrochemical poisoning, Textbook of Forensic Medicine and Toxicology, 3rd edition, Reed Elsevier India Private limited; 2005. p. 734-749.
7. World Health Organization; Pesticides: Children Health and the Environment 2008. [Cited on 2018 April 7]; available from: http://www.who.int.ceh/pesticides.pdf .
8. FAO- Food and Agricultural Organization of United Nations, Internal code of conduct on the distribution and use of pesticides, Rome 2002 p.36. [Cited on 2018 April 7] available from http://www.fao.org/docrep/005/ y5544e/y4544e00htm .
9. Overview of Ecological Risk Assessment process in the office of pesticides programme, U.S. Environmental Protection Agency, Endangered & Threatened species Effect Determination. Office of pesticide programmes, Washington D.C. Jan, 2004. [Cited on 2018 April 8].
10. Pesticide Management division, NIPHM; Pesticide classification on use, chemical nature, formulation toxicity and action, etc, Hyderabad p.1-17 [Cited on 2018 May 5] available from http://www.niphm.gov.in.
11. Algimantas Mieldazys, Ramunas Mieldyzys, Gedimanas Vilkevicius, Aleksandaras; Agriculture use of pesticides/ plant protection products, Forestry operations and OSH issues OSHWiki. [Cited on 2018 April 24]. Available from https://oshwiki.eu./wiki/Agriculture
12. V. V. Oberemok, K. V. Laikova, Y. I. Gninenko, A. S. Zaitsev, P. M. Nyadar, and T. A. Adeyemi, "A short history of insecticides," Journal of Plant Protection Research, vol. 55, no. 3, pp. 221–226, 2015.
13. S. Y. Gebremariam, M. W. Beutel, D. R. Yonge, M. Flury, and J. B. Harsh, "Adsorption and desorption of chlorpyrifos to soils and sediments," in Reviews of Environmental Contamination and Toxicology, vol. 215, pp. 123–175, Springer, New York, NY, USA, 2012.
14. K. D. Racke and J. R. Coats, "Comparative degradation of organophosphorus insecticides in soil: specificity of enhanced microbial degradation," Journal of Agricultural and Food Chemistry, vol. 36, no. 1, pp. 193–199, 1988.
15. J. H. Cink, "Degradation of chlorpyrifos in soil: effect of concentration, soil moisture, and temperature," in Retrospective Theses and Dissertations, Iowa State University, Ames, Iowa, USA, 1995.
16. CDPR, "Methidathion risk characterization document," Department of Pesticide Regulation California Environmental Protection Agency, 2007, http://www.cdpr.ca.gov/docs/emon/ pubs/tac/tacpdfs/methidathion/envfate_mthd.pdf.
17. V. I. Tsipriyan and N. I. Martsenyuk, "Toxicological evaluationof photolytic degradation products of pesticides," Cig. Sanit, vol. 8, pp. 77–80, 1984
18. Pesticide Management division, NIPHM, syllabus, Pesticide classification on use, chemical nature, formulation toxicity and action etc, Hyderabad p.1-17, [Cited on 2018 May 5] available from http://www.niphm.gov.in./ASO.PMD.pdf
19. I.C. Yadav, N.L. Devi; pesticides classification and its impact on Human and environment environ.sci & engg.vol 6: Toxicology 2017 p.140-158.[Cited on 2018 May 8]