

# A Review of Biopesticides and Their Plant Phytochemicals Information

KalpanaT<sup>1</sup>, Anil K<sup>2</sup>

<sup>1</sup>University Institute of Biotechnology, Chandigarh University, Gharaun, Kharar, Punjab-140413,

<sup>2</sup>University Institute of Biotechnology, Chandigarh University, Gharaun, Kharar, Punjab-140413

*E-mail-<sup>1</sup>kalpana.uibt@cumail.in, <sup>2</sup>anil.e8226@cumail.in*

## Abstract

Due to excessive use of chemical pesticides and due to indiscriminate use, there has been a bad effect on crop yields and quality of produce, which is not done. Due to Chemical pesticides, field crops are damaged and destroying which is not good for farmers and human beings. These are very toxic and impact on environment and ecosystem. Chemical pesticides are not involve in one way even all of them are distributed in some way through air, soil and water. Negatively health effect has been linked with organic pesticides which include among other effects for e.g.- dermatological, gastrointestinal, neurological, carcinogenic, respiratory, reproductive, and endocrine effects. Hence biopesticides are made naturally by which non-toxic material and bio-polymerization are made to control the keto which is also very beneficial for mankind. Agriculture is the important sector that is full filling the increasing demand of food due to rise in population. But, the food grown in the field is usually attack by various pests and insects and hence declining the productive yield of the crops. To overcome this problem many chemical pesticides and insecticides are in use. But, these pesticides like melathione etc. are resulting in much other type of diseases and environmental problems. Biopesticides may provide an answer to this problem.

**Keywords:** Biopesticides, bacteria, fungi, weeds and insects.

## INTRODUCTION

The agriculture sector plays a role in economic development like a backbone. That is why; it provides raw materials for mankind and industrialization. Agriculture is a main source of whole world whether they are developed or under- developed. Due to rapid increasing population in India, demand for food is increasing in developed and under-developed state. If it fails to meet the demand the rate of economic development will be affected badly, which is not right. Therefore, for economic development, it will be increasing to supply food once again. The need to live 70% of the population depends on agriculture. It is only 25% contribution of GDP in agriculture department. In the past 50 years, especially under various Five Year Plans and agriculture department are placed on the first position through national income. It also contributes greatly to the industry of the country. For e.g.- textiles, sugar, tea, etc. In India, the agronomy industry has been divided into many parts such as canned, dairy,

and processed, frozen food to fisheries, meat, poultry, and food grains etc. because of these, agronomy depends on the success of the input in the industries. A comparative study with the other countries, it is to known that under-developed countries have a lot of opportunities for employment in agriculture department. (Varadarajan,2003).

India is an agronomy-based country. Human race depends upon agriculture to fulfill its daily requirements. Agriculture is playing the important role in India's economy. All over 58% of the rural households depends upon the agriculture as their livelihood developments. According to the report in 2017, India is the 2<sup>nd</sup> largest tomatoes producer in the world after China which produces 20,708,000 tons tomatoes in year. It is very well documented that in all over the world India holds 3<sup>rd</sup> rank in terms of agriculture.

The increasing population in industrialization has resulted in the accumulation of a chemical wide variety. For this reason, the frequency of xenobiotic chemical and tried to create a new technique to contaminate and eliminate excess material from an environment. There are simple techniques like land-filling, recycling, pyrolysis and incineration to correct the pollution but over time these have had a very bad effect on the environment which would have led to the creation of toxic intermediates. (Debarati *et al.*, 2005). But these methods are not always applicable as sometimes they are not cost effective or sometimes it's not possible to execute these methods especially in case of Pesticides (Jain *et al.*, 2005).

To increase the productivity the usage of chemical fertilizer, pesticides, insects etc. is a very common practice. Frequent usage has now reached to a level where they are affecting ecosystems & thereby human health. Many farmers are using biopesticides for positive effects to get rid of all these problems. The use of chemical pesticides and fertility has deteriorated the quality of the soil, the growth of the plant and the genetic differences in them which have been severely impacting the plant as well as the human race to avoid all these. Bio-pesticides and bio-fertilizers can play an important role that does not have a very bad effect on this environment. (Suman, 2010). With the development and continuous usage of chemical pesticides/ insecticides many harmful effects have been observed in environment. Therefore, it is very important for the environment to be eco-friendly and well insect control represents a method for generating agricultural products in high quantities. Due to these reasons, there is a need to develop biopesticides which are very effective as well as biodegradable which do not harm the environment. Keeping this in view present review is designed to screen such plants that remain unaffected to various pests like *Helicoverpa Armigera*, *Chilo Infusatellus*, *Tetranychus Urticae*, *Plutella Xylostella*, *Cnaphalocrocis medinalis* (leaf folder) and *Sciropophaga incertulas* (yellow stem borer) etc. *Malvastrum coromandelianum* is an herbal medicinal plant and famous for medicinal properties and use of agriculture as a pesticide for many years. These plants are well known for their antibacterial and antifungal activities due to the presence of alkaloids, essential oils and phenolic guleoside and *parathenium hysterothorus* is and herbal medicinal plant and use of agriculture as pesticides. In order to make agriculture useful, mineral sources like N, P, K, Fe, Mn, Cu and Zn are chemical as well as *Parathenium* plant contains parthenin, hysterin and ambrosin and these chemicals cause the allelopathic effect on the crop of different types. (Srinivasan, 1997) Due

to this, the activity of nitro fixing and nitrifying bacteria has a bad effect on the nodules of the pod. In India every year he has 80000 toneof chemical insecticides. Chemical Insecticides excessive and indiscriminate are usually the one in the small city and villages which are not right and these farmers do not know how bad it will affect their health. (Jayaraj, 1989).

The other problem due to the access to the amounts of chemical insecticides and inappropriate was seen in food materials, which shows the very worrying condition that their growth in plants has been badly affected due to prolonged exposure to plants. Along with entering this chain of food, it is also found like poison in meat and dairy products. And all this trouble has been seen in India for quite long time. for eg: - The remains of DDT and HCH were found in a sample of milk and the second study as in the Punjab, collected Mother's breast milk, then the amount of residue in them was very high and the children through their mother's milk the amount of these chemicals were known to be acceptable is 21 times more than.(Jumanah, 1994).

Bio-pesticides have been used for a long time to increase the variability of farming. It is very favorable for the environment and meets the nature directly. Simultaneously, it does not affect the health, soil, animals, plant and environment of the human race at all. Bio-pesticides are found naturally from all these, they are very toxic and become biodegradable quickly. Keeping all these in mind, we must study bio-pesticides. Bio-pesticides formulations and applications as well as organic farming have also attempted to fight this problem and these have been put in the major and minor classifications which would be based on the particular ecosystem. All these are classified according to a feeding method. Usually there are some major pests which cause most damage, which is very important to control. Many pests are severely named in each agricultural ecosystem. [1]

Phytochemicals are the naturally occurring plant chemicals. On the basis of their role, the phytochemical are categorized as primary and secondary. The major role phytochemical is to provide defense against oxidative damage to the cellular machinery. Many metabolic reaction in our body results in the generation of free radicals that can led to oxidative stress. Like all animals, humans too have many antioxidant defense systems, but as we reside in highly oxidative environment, probability of oxidative damage increases. Accumulation of oxidative destruction enhances the process of ageing. (Ameset;al 1995)

## **REVIEW OF LITERATURE**

We humans have a unique relationship with the environment and agriculture, which is very difficult to describe in words. It is agriculture- based India which is all about 60-70% of its population relies on agriculture. Due to the rapid increase in population, the demand for agriculture crop has also increased. To meet the increasing demand of crops, agrochemicals like insecticides, fungicides, pesticides and herbicides are very much in use. Every year near approximately 30% of agriculture product is lost due to various pests. Emphasis on the regular use of pesticides and making them indispensable part of agriculture has now become threat to environment (Ramanathan, and Lalithakumari, 1999).

Chemical pesticides are used to kill biological organisms. The widespread use of pesticides can lead to their accumulation in agricultural produce. (Tayed et. 2013). So due to all these chemical pesticides, there is a lot of annually loss which is very harmful for the farmers. (Rajendran, 2002).

Keeping this in view, the literature was reviewed under the following headings:

- Pesticides and their diseases
- Pesticides related disease in the country
- Bio-pesticides and their effects
- Chemical pesticides and their effects
- Plant Phytochemicals
- Classification of Plant Phytochemicals
- Healthy Benefits with Phytochemicals

### **Pesticides and their diseases**

Due to the industrialization sector of the agricultural sector, the chemical burden on the natural ecological system is increasing day by day due to which there is a lot of damage in the plant and humans and due to the use of pesticides in a lot which is being used in every city area. Due to all this, there is a very bad effect on the environment, which is very pathetic. Pesticides are constituents or mixture of substances that are used in agriculture as well as public health care programs, to protect plant pests from weeds or diseases and to protect humans from vector-borne diseases such as malaria, dengue, fever and schistosomiasis. Along with all this, improvement and maintenance of agriculture sector such as urban green area and sports sector is also done.

First time in Carson, 1962 observed The sudden death of birds due to spraying of chemical pesticides (DDT) led to the change in the prevailing approach and their impact on public concern on pesticides and health and environment because of the problems of environmental pollution by pesticides. Growing pesticides that are easily applied to the surface of the land and can move downstream until reaching the water table in detectable concentrations that are reaching a long distance in aquatic environments. Therefore, the fate of pesticides is often uncertain, which can contaminate other areas from where they are originally used and destroying pesticide contaminated areas is a very complex task. (Gavrillescu, 2005). There are large percentages of pesticides available in the market such as DDT, clothianidin, dinotefuran. (Patnaik, 2003) but apart from killing various polluting pests, they are also entering the air, water, sediment and even That are ending in our diet. Salma, et al., 2011 observed that agriculture has been facing many pest problems like weeds and pests for the past several years. Pests are constantly destroying crops.

Richter in 2002 concluded that with the increasing usage of chemicals in crops, the concentration of pesticides are also increasing in food & affecting human health. Lai, 2008 observed that without using pesticides application on fruits, vegetables, legumes and cereals damage from pests would reach 32% 54% & 78% respectively. Pimentel, 2009 found that there are thousands of species of insects and mites which cause 14% damage to the crops.

There are almost 50,000 species of plant pathogen which cause 13% damage to the crops and 13% damage is caused by the weeds. Cooper *et al.*, 2004, 2007 investigated that pesticides are usually used in many sectors of the agriculture production and it reduces the pests and thus improve yield as well as quality of the production. Soil containment, Water containment, Effects on organisms, Effects of pesticides and farming practises on biodiversity are environmental effects of pesticides.

Pesticides are used in controlling crop pests to reduce loss of agricultural products and to control the insect vectors. Food shortages have resulted in increased use of insecticides in agriculture. In India, almost 30% of agricultural output is lost because of pest infestation and pesticide utilization for protecting crops (Bhadbhade, 2002). Not even the pesticides instead their residues are also found to be harmful for human health & environment. There are reports showing that worldwide overexposure to pesticides resulted in  $43 \times 10^6$  cases of pesticide poisoning annually, unnecessary pesticide use has also created global problems like pest resistance, resurgence and pesticide residues in crops and soil (Qiao, 2003).

### **Pesticides related disease in the country**

According to WHO reports, Pesticide is also known today in 21st century for ruining the health of mankind very badly like asthma, autism and learning disabilities, birth defects and reproductive dysfunction, diabetes, Parkinson's and Alzheimer's diseases, and several types of cancer. In order to reduce chemical risk, a lot of people are associated with this very strong relationship, despite minimizing end-to-end personal risk. Pesticides are used to eliminate chemical compounds, as well as insects, rodents, fungi, and plants. And in public health, it is also used to kill mosquito, to kill insects of crops in agriculture. It is a poison for humans as well as creatures. Because of which there is a particular danger to the children, they all have to do it in very large amounts due to painful fatalities in many parts of the whole world. Despite all this, India is number one in the world of pesticides. According to the research and market report, India's pesticides market was 79 billion rupees in 2014, which will go up to 316 billion rupees by 2027 from 2019 to 2024.

### **Biopesticides and their effects**

Biopesticides are certain types of pesticides derived from natural materials as animals, plants, bacteria, and certain minerals. It is mainly made up by Plant Extracts that are imparting no harmful effects to our environment and not also harmful for human and animals. Bio pesticides are basically used against insects, pests, and variety of weeds. Biochemical pesticides can also be used, it is based upon the mechanism of plant resistance, inhibiting of growth, feeding, developments or reproduction.

Biopesticides are substances which are quite natural and control pests without the use of non-toxic mechanisms. They are important for the human beings as well as environment as they include chemical pesticides as part of bio-intensive integrated pest management. The pesticides which are mostly used are bio-fungicides (*Trichoderma*), bio-herbicides (*Phytophthora*) and bio-insecticides (*Bacillus thuringiensis*), (Salma, *et al.*, 2011). As with the regular use of chemical insecticides / pesticides pests has developed resistance against

various pesticides. & also they have negative impact on human & environment. In this context, Biopesticides are safe. Biopesticides are of three types:-

1. Microbial pesticides
2. Plant-Incorporated- Protectants (PIPs)
3. Biochemical pesticides

Microbial pesticides are the microorganism which can control many kinds of pests for e.g. there are certain fungi that control certain weeds not only this rather many microbial pesticides kill certain insect. Insect in cabbage, potato and in other vegetables can be controlled by the use of this fungi *Bacillus thuringiensis*. They are highly specific for their target pests. These pesticides are required to be analyzed continuously to make sure that they should not harm non target organisms like human being & animals.

Plant-Incorporated- Protectants (PIPs) are the substance that is produced from genetic material (GM) which is added to the plants. For e.g. they can take the gene for the *Bt*pesticidal protein, and introduce the gene into the plant genetic material. Then the plant, can synthesize the substance that destroys the pests or sometimes acts like a repellent.

Biochemical pesticides are the substances which are natural & are derived from plants or fatty acids. These pesticides control pest by non-toxic mechanisms. On the other hand there are some conventional pesticides that kill the pests.

So far, many scientists and authors have worked in the field of bio-pesticides. Some of the important biopesticides includes such as *Bacillus thuringiensis*, *Agrobacterium radiobactor strain K84*, *Bacillus spp.*, *coniothyriumminitans*, *paecilomycesfumosoroseus*etc. Thakore in 2006 is one of them who stated that bio pesticides represent 2.89% of pesticides market and 2.3% annual growth in coming years is expected. Kalra and Khanuja in 2007 studied *Bacillus thuringiensis*, *Trichogramma*, *Beauveria* and found that it was helpful for:-

- *Bacillus thuringiensis* was helpful in controlling diamond back moth.
- *Beauveria* was helpful in controlling mango hoppers, mealy bugs and coffee pod.
- *Bacillus thuringiensis* efficiently control *Helicoverpa* on cotton & pigeon pea.

Gupta *et al.*, 2010 stated that Use of Biopesticides and Bio-fertilizers can play a major role in easy way. Biopesticides has advantage over the chemical pesticides as:

- They are less harmful and puts lesser environmental load,
- Designed to affect only one specific pest or, in some cases, a few target organisms.

Mishra *et al.*, 2012 there are many productions of bio-pesticides from viruses such as; *Baculoviruses*, *Granuloviruses*, *Nucleopolyhedroviruses* and *Cypoviruses* etc. *Baculoviruses* are non-pathogenic as well as non-target organisms. In this virus, low toxic residual and pest resistances conventional pesticides are found there are various enemies of the Tomato Hornworm. They are tightly attached in Tomato leaves. They feed on blossoms, leaves & fruits. Joseph *et al.*, 2010 studied Botanical pesticides which are made of neem which is widely used in many formulations because it is the active component *Azadirachtin* available

in market. Reddy *et al.*, 2012 studied that many plant such as tomato fruit worm used same as bio pesticides.

Entomopathogenic fungi as Biopesticides against the *Helicoverpa armigera*. Hornworms can be controlled with Carbaryl, permethrin, spinosad insecticides. Organic pesticides and Tomato hornworm go together and destroy that the pest produces on Tomato plants. They do not attack only tomato plants, even also potatoes, eggplants, pepper and tobacco. There are so many Biopesticides which is used in our crops such as *Trichoderma*, *Gliocladium*, *Paecilomyces*, *Pseudomonas*, *Trichogramma*, NPV and Bacillus to use them against many insect pests and diseases.

Every year rise in global population is putting more burdens on agriculture sector for food production. This productivity lowers by the attack of various pests and insects. Availability of chemical pesticides is helping to resolve this problem but simultaneously adding up to environment and health problems. Various groups all over the world, working for various bio-pesticides of plant origin, being more eco-friendly plant based pesticides can resolve many problems. Lea and mix 2012, evaluated insecticides characteristics of *Melia azedarach* against *spodoptera exigna* and observed it to be effective, Solangiet *al.*, 2014, studied Neem, tobacco and tooth for control of tomato insects pests, Citronella ( Zaridah, *et al.*, 2003), *sapium grabamii*, *strophanthushispidus*, *jatrophacurcas*, *saturainoxia* ( Okunlotaet *al.*, 2008; Georges *et al.*, 2008) have been studied for their pesticidal properties. Many researches throughout the nation are involved in working with bio-pesticides of plant origin. Arora *et al.*, 2014 formulated bio-pesticides from various plants against tomato crop pests. *Ocimum santum*, *Aegle Marmelos*, *Lippia aba* also has been studied by Tripathi 2003 for bioactivity. In 2013 Dewan studied aphicidal activity of some indigenous plant extracts Sharma *et al.*, 2001 studied insecticidal activity of medicinal plants.

### **Chemical pesticides and their effects**

Syed, (1992) stated that pesticides had prevalent control method for many years not only this but biocontrol agents which also have a long history. A pesticides is a mixture of substances which is used for preventing, destroying, repelling many insects and pests attacking various plants and crops. Zhang *et al.*, (2001) studied the three phases which started before 1870s, in first phase natural pesticides were used to control pests, the second phase which was from 1870-1945, was the time of inorganic synthetic pesticides and during this period, natural materials and inorganic compounds mainly used and since 1945 was third phase which is an is the example of organic synthetic pesticides. These are man-made organic pesticides e.g.: DDT, 2-4-D and later HCH, dieldrin.

Liu *et al.*, (2002) found that these pesticides are obligatory in agricultural production. As it has been observed that one third of agricultural products are produced by using pesticides. Richter, (2002) found that the use of chemicals in agriculture crop fields simultaneously increased productivity. Not only this but it also increased the concentration of pesticides in food and in our environment and had imparted negative effects on human health. Nagarajuet *al.*, (2002) found that in south India, the application of pesticides was

beyond 50 sprays per Tomato crops. According to Zhang *et al.*, (2006), Zhang, (2008), the population is increasing and crops yields are limited, due to which the use of pesticides has become inevitable.

Cai, (2008) observed that without using pesticides application on fruits, vegetables, legumes and cereals damage from pests would reach 32% 54% & 78% respectively. Pimentel, (2009) found that there are thousands of species of insects and mites which cause 14% damage to the crops. There are almost 50,000 species of plant pathogen which cause 13% damage to the crops and 13% damage is caused by the weeds. Ellenhorn, Schonwald *et al.*, (1997) stated that these pesticides are used to kill pests and they consist compounds like insecticides (e.g. organophosphates, organochlorines, carbamates), rodenticides (e.g. anticoagulants), herbicides (e.g. paraquat, diquat, 2, 4-dichlorophenoxyacetic acid (2, 4-D), fungicides (e.g. dithiocarbamates), and fumigants (e.g. ethylene dibromide, methyl bromide). Abdollahi M, Jafari, Pajoumand *et al.*, (1996-1997) found that the common use of pesticides in human health and agriculture programmes has caused rigorous environment pollution and health problems as well as many acute and chronic human poisoning. Gultekin and Gupta (2000-2001) stated that several studies of DDT and methoxychlor stimulate oxidative stress and lipid pre-oxidation. Oerke, Dehne & Cooper *et al.*, (2004, 2007) investigated that pesticides are usually used in many sectors of the agriculture production and it reduces the pests and thus improve yield as well as quality of the production.

### **Plant Phytochemicals**

In 2000 Clifford, M. N. & Scalbert investigated that Along with being bioactive non-compound, photochemical is also the responsible food ingredient in which nutritious ingredients are found. So due to these entire compound, it helps to reduce the risk of chronic disease of people. Wise in 2001 found that More than 2 lakh 20 thousand phytochemicals are present, out of which 100 different fruits and vegetables and more than 50 thousand species are present which are known as phytochemicals. A dictator 2500 years old said that "Let food is your medicine and medicine becomes your food." Cowan, M.M. in 1999 investigated that Phytochemicals possessing many ecological and physiological roles are broadly distributed as plant constituents. According to an estimate, around 28% of all new chemical entries launched to the market have their origination from terrestrial plants, microbes, marine organisms etc. A claim was made regarding the existence of 250 to 500 thousands plant species present species present on the planet and out of this, there are only 1 and 10 % of these species being used as food by Humans and other animals.

### **Classification of Plant Phytochemicals**

Singh *et al* in 2016 founded that Mankind is developing from a complete diet. The selection of food depends on a large scale, such as the availability of consumption resources, climate ecology and socioeconomic needs. . Ezekiel *et al* in 2013 and Singh *et al* in 2017 founded that Food not only gives calories to our body, but it also prevents many diseases along with the sources of bioactive compound. Fruit and vegetables make our body full of carbohydrates, minerals, vitamins and proteins. Depending upon their function in plant metabolism phytochemicals are classified as primary constituents that include; amino acids,



common sugars, proteins, pyrimidine and purines and secondary constituents that comprise of plant chemicals like terpenes, alkaloids, flavonoids, plant steroids, lignans, saponins, phenolic, flavonoids, glycosides and quinine. Some of the major secondary metabolites produced by plants and considered as an end product of the primary metabolism, are described ahead.(45)

### **Flavonoids**

Flavonoids are defined as secondary metabolites with small molecular weights, manufactured by plants, and unlike primary metabolites, these are illustrated as non-essential for the survival of plants. There is information of more than 10,000 structural alternates of flavonoid that are able to show on interaction by means of diverse targets in sub cellular positions to a variety of event in microorganisms, plants and animals. More than 4,000 ubiquitous polyphenolic compound called flavonoids have been identified in nature and majority of them found in vegetables, fruits and different drinks like coffee, tea and fruit drink.(46)

### **Tannins**

Tannins are defined as a class of heterogenous heavy molecular weights compounds, polyphenolic in nature possessing the capability to generate reversible as well as irreversible complexes in the company of proteins, polysaccharides, alkaloids, nucleic acid and minerals etc. the ability to precipitate proteins and rendering them resistant to enzymatic attack, imparts the astringent nature to tannins. Tannins are thought to encourage healing when applied on a wound, as it forms is done a protective coating in order to prevent external irritation.(49)

### **Alkaloids**

Alkaloids derived their name from the word alkaline and are natural chemical compounds having a basic Nitrogen (N) atom. These are synthesized by many organisms that include bacteria, fungus, plants and a wide range of animal cells. They offer a lot of pharmacological benefits as well as find an immense use as a therapeutic agent along with being a recreational drug.(52-53) in the beginnings of 19<sup>th</sup> century, these nitrogen bearing bases were found to be the one producing different salts with acids and alkaloids. It has been huge variety of molecular structural organization.(54)

### **Phenolic Compounds**

Phenols containing compounds are one of the most common plant secondary metabolites that exist in form of glycosides, amides of esters. (55) the two parent structures that make up the phenolic compound are hydroxybenzoicderivatized compound constitute of vanillic, syringic, gallic acid and protocatechuic acids. Whereas, hydroxycinnamic acid derivatives comprise of caffeic, ferulic, sinapic acids and p-coumaric acid. (56) These compounds play an important function during various stages in growth of plants by offering protection alongside various kinds of infections, wounds as well as UV Radiations. (57)

### **Sapponin**

Saponins are secondary metabolites synthesized by many different plant species. The name resulted from Latin word “sapo” meaning soap, it is due to their surfactant properties which

allows the formation of foam on shaking in aqueous environment.(58)their medicinal uses include microbial, anti-tumor, anti-insect and anti-inflammatory activities. In addition, saponins are used in preparation of soaps, detergents, fire extinguishers, shampoo, beer and cosmetics. Several steroidal saponin drugs have been successfully used for treating various diseases. (59 )

## REFERENCES

- [1]. Varadarjan, T.M.C., Indian economic environment, the Indian institute of Bankes, Macmillian Publications (2003).
- [2]. Debarati, P.; Gunjan, P.; Janmejay, P.; Rakesh,V.J.K. (2005). Accessing Microbial Diversity for Bioremediation and Environmental Restoration, Trends in Biotechnology, 23 (3), pp.135-142.
- [3]. Jain, R.K.; Kapur, M.; Labana, S.; Lal, B.; Sarma, P.M.; Bhattacharya, D.; Thakur, I.S. (2005). Microbial Diversity: Application of Microorganisms for the Biodegradation of Xenobiotics, Current Science, 89 (1), pp.101-112.
- [4]. Suman Gupta, (2010). Biopesticides: An eco-friendly approach for pest control, Journal of Biopesticides 3(1 Special Issue), pp: 186 – 188.
- [5]. Srinivasan G. 1997. Panel for reduced use of chemical pesticides. Hindu Business Line, November 5, 1997.
- [6]. Jayaraj S. 1989. Advances in biological means of pest control. The Hindu Survey of Indian Agriculture. Hindu Newspaper Group, India.
- [7]. Jumanah, F. 1994. Pesticide Policies in Developing Countries: Do they encourage excessive use? World Bank Discussion Papers 238, The World Bank, Washington DC.
- [8]. Ames, B. N., Gold, L. S., and Willett, W. C. (1995). The causes and prevention of cancer. Proc. Natl. Acad. Sci. U.S.A. 92, 5258–5265.
- [9]. Ramanathan, M.P. and D. Lalithakumari, 1999. Complete mineralization of Methyl parathion by pseudomonas sp. A3. Appl. Biochem. Biotechnol.,80 1-12.
- [10]. Tayade, S., Patel, Z.P., D. S. Mutkule, D.S., Kakde, A. M. 2013. Pesticide contamination in food: A review. IOSR J. Agri. Vet. Sci., 6(1): 7 11.
- [11]. Rajendran S, (2002) Pesticide Spraying in Kerala – Human Cost and Environmental Loss, Economic and Political Weekly, 38(23)2206-7.
- [12]. Carson, R. 1962. The silent Spring. Houghton Mifflin, New York.
- [13]. Gavrilesco, M. (2005). Fate of Pesticides in the Environment and its Bioremediation, Engineer in Life Science, 5 (6), pp. 497-526.
- [14]. Patnaik, P. (2003). A Comprehensive Guide to the Hazardous Properties of Chemical
- [15]. Substances, John Wiley & Sons, New Jersey, USA.
- [16]. Salma Mazid, RatulRajkhowa, JogenKalita, (2011).article “A Review on use of Biopesticides in Insect Management”, International Journal of Science and Advanced Technology (ISSN 2221-8386) Volume (1) No 7 September
- [17]. Richter, E.D., (2002). Acute human poisonings. In encyclopedia of pest management. Dekker, New York, 3-6.
- [18]. Lai, D.W., 2008. Understand the role of chemical pesticides & prevent misuses of pesticides. Bulletin of agriculture science & technology, 1 pp: 36-38.
- [19]. Pimentel D., P. Rajinder and A. Dhawan, eds, (2009a). Pesticides & pest control. In:

- integrated pest management: innovation-development process, Springer, (1) pp: 83-87.
- [20]. Cooper, J., Dobson, H. (2007). The benefits of pesticides to mankind and the environment. *Crop Prot.*, 26, pp: 1337-1348.
- [21]. Bhadbhade, B.J., S.S. Sarnaik and P.P. Kanekar, 2002. Bioremediation of an Industrial effluent containing monocrotophos. *Current Microbiology*, 45: 346-349.
- [22]. Qiao, C.L., Y.C. Yan, H.Y. Shang, X.T. Zhou and Y. Zhang, 2003. Biodegradation of pesticides by immobilized recombinant *Escherichia coli*. *Bulletin of Environmental Contamination and Toxicology*, 71: 370-374.
- [23]. Kalra and S.P.S. Khanuja, (2007). Research and Development priorities for Biopesticides
- [24]. Andbiofertiliser products for sustainable agriculture in India, In. Business Potential for Agricultural Biotechnology, Asian Productivity Organization., pp.96-102.
- [25]. Suman Gupta, (2010). Biopesticides: An eco-friendly approach for pest control, *Journal of Biopesticides* 3(1 Special Issue), pp: 186 – 188.
- [26]. Mishra. D.J., Singh Rajvir, Mishra U.K., ShahiSudhir Kumar,(2012). Role of Bio-Fertilizer in Organic Agriculture: A Review. *J. Recent Sciences*. (2) pp: 39-41.
- [27]. Anis joseph, R.,Premila, K.S.,Nisha,V.G.,SooryaRajendran&SarikaMohan,S,(2010). Safety Of neem products to tetragnathid spiders in rice ecosystem, *Journal of Biopesticides*, 3(1), pp: 88-89.
- [28]. Reddy, R. Sunitha D. and Vishnu D. V. R. 2012. Evaluation of botanical and other extracts against plant hoppers in rice - A. *Venkat*, 5 (1): 57-61.
- [29]. Lee, M.T., Mix. K. (2012). Evaluation of *Melia azadirach* as a botanical pesticide against beet Army worm (*Spodoptera exigna*) *journal of agriculture and biological science* 7: 962-967.
- [30]. Solangi, B.K, Suthar,V., Sultana, R. Abassi, A.R., Nadeem, M.,Solangi, M.N. (2014). Screening of biopesticides against insect pests of tomato. *European Academic Research* 5: 6999-7018.
- [31]. Zaridah,M.Z.,Norazah,M.A., Abu said A,Mohd, Faridz,Z.p. (2003). Larvicidal properties of citrinellae and cymbogonnardus essential oils from two different localities. *Tropical biomedicine* 20:169-174.
- [32]. Okuntola, A.L., Ofuga, T.I.,Aladesanwa, R.D. (2008). Efficacy of plant extracts on major insects pests of selected leaf vegetables in southwestern Nigeria. *Agricultural journals*.3, 181-184.
- [33]. Georges,K.,Jayaprakaram, B.,Dalavoy, S.S., Nair, M.G. (2008). Pest manging activities of plants extracts and anthraquinones from *cassia nigricans* from Burkina faso. *Bio-resource technology* 99:2037-2045.
- [34]. Arora,S., Kanoja, A.K., Kumar, A., Mogha, N.Sahu, V. (2014). Biopesticides formulation to control tomato lepidopteran pest Menace. *Asian agri- History* 18 : 283-293.
- [35]. Tripathi, A.K. (2003). Phytochemicals in insects-pest management, in :sric=vastava,R.P.editor. *Biopesticide and bioagents in integrated pest management of agricultural crops*.international books publishing co.,Lucknow, India 220-267.
- [36]. Diwan, R.K. (2013). Insecticidal activity of *ailanthus excels* against *callosobruchus maculates*.*interaction journals of life science* 4:294-296.

- [37]. Shama, S.S., Gill, K., Maliok, M.S.,Malik,O.P.(2001). Insecticidal antifeedant and growth inhibitory activities of essential oils of some medicinal plants. In sushil,K.,Hasan,S.A.,Samresh,D.,Kukreja,A.K.,Ashok,S.,Sharma,A.K.editors.Proceedings of the national saminar on the frontiers of research and development in medicinal plants.CIMAP, Lucknow, 208-298.
- [38]. Syed, A. R. 1992. Insecticide Resistance in the Diamondback Moth in Malaysia, In: Management of Diamondback Moth and Other Crucifer Pests: Proceedings of the Second International Workshop, (Talekar, N. S. ed.), Shanhua, Taiwan: Asian Vegetable Research and Development Center, 437-442 PP
- [39]. Liu CJ, Men WJ, Liu YJ, et al. 2002. The pollution of pesticides in soils and its bioremediation. System Sciences and Comprehensive Studies in Agriculture, 18(4): 295-297
- [40]. Nagaraju, N., Venkatesh, H. M., Warburton, H., Muniyappa, V., Chancellor, T. C. B. and Colvin, J. 2002. Farmers' perceptions and practices for managing tomato leaf curl virus disease in southern India. International Journal of Pest Management, 48:333-338
- [41]. Zhang WJ. 2008. A forecast analysis on world population and urbanization process. Environment, Development and Sustainability, 10: 717-730
- [42]. Zhang WJ, Qi YH, Zhang ZG. 2006. A long-term forecast analysis on worldwide land uses. Environmental Monitoring and Assessment, 119: 609-620
- [43]. Cai DW. 2008. Understand the role of chemical pesticides and prevent misuses of pesticides. Bulletin of Agricultural Science and Technology, 1: 36-38
- [44]. Ellenhorn MJ, Schonwald S, Ordog G, Wasserberger J: Ellenhorn's Medical Toxicology: Diagnosis and Treatment of Human Poisoning, Williams & Wilkins, Maryland, 1997; 1614-63
- [45]. Abdollahi M, Jalali N, Sabzevari O et al: A retrospective study of poisoning in Tehran. J Toxicol Clin Toxicol, 1997; 35: 387-393
- [46]. Gultekin F: The effect of organophosphate insecticide chlorpyrifos-ethyl on lipid peroxidation and antioxidant enzymes (in vitro). Arch Toxicol, 2000; 74: 533-538
- [47]. Oerke, E.C., Dehne, H.W. (2004). Safeguarding production-losses in major crops and the role of crop protection. Crop Prot., 23, pp: 275-285.
- [48]. Cooper, J., Dobson, H. (2007). The benefits of pesticides to mankind and the environment. Crop Prot., 26, pp: 1337-1348
- [49]. Singh B, Singh JP, Kaur A, Singh N. Bioactive compounds in banana and their associated health benefits: a review. Food Chem. 2016;206:1-11. doi: 10.1016/j.foodchem.2016.03.033.
- [50]. Singh B, Singh JP, Shevkani K, Singh N, Kaur A. Bioactive constituents in pulses and their health benefits. J Food Sci Technol. 2017;54(4):858-870. doi: 10.1007/s13197-016-2391-9.
- [51]. Clifford, M. N. & Scalbert, A. (2000) Ellagitannins, occurrence in food, bioavailability and cancer prevention. J. Food Sci. Agric. 80: 1118-1125.
- [52]. Cowan, M.M. (1999). Plant Products as Antimicrobial Agents. Clinical Microbiology Reviews, 12(4):564-582.
- [53]. Hahn, N.I. (1998) Are phytoestrogens nature's cure for what ails us? A look at the research. American Diet. Ass. 98:974-976.

- [54]. Pridham, J.B., Baxer, H. (1960) Phenolic in plants in Health and Disease, pergamon press, New York: 34-35.
- [55]. Ferrell, K.E. and Thorington, R.W. (2006) Squirrels: the animals answer guide. Johns Hopkins University Press, Bltimore, p.91.
- [56]. Cordell, G.A. (2001) The Alkaloids: Chemistry and Biology. Academic Press, San Diego, Vol. 56 p.8.
- [57]. Dixon, R.A. (2004) Phytoesterogens. Annu.Rev. Plant Physiol. 55:225-261.
- [58]. Heim, K.E., Tagliaferro, A.R. and Bobilya, D.j. (2002) Flavonoid antioxidants: chemistry, metabolism and structure- activity relationship. J. Nutrit. Biochem. 13:572-584.
- [59]. Ribereau-Gayon, P. (1972) Plant phenolic; Hafner Publishing Company: New York, NY , USA.
- [60]. Arif, T., Bhosle, J.D., Kumar, N., Mandal, T.K., Bendre, R.S., Lavekar, G.S. and Dabur, R. (2009) Natural products- antifungal agents derived from plants. J. Asian Nat. Prod. Res. 11(7):621-638.
- [61]. Faizal, A. and Geelen, D.(2013) Saponins and their role in biological processes in plants. Phytochem. Rev. 12:877-893.