Unit - 4

What are Pesticides?

Pesticides are chemical substances that are meant to kill pests. In general, a pesticide is a chemical or a biological agent such as a virus, bacterium, antimicrobial, or disinfectant that deters, incapacitates, kills, pests.

This use of pesticides is so common that the term pesticide is often treated as synonymous with plant protection products. It is commonly used to eliminate or control a variety of agricultural pests that can damage crops and livestock and reduce farm productivity. The most commonly applied pesticides are insecticides to kill insects, herbicides to kill weeds, rodenticides to kill rodents, and fungicides to control fungi, mould, and mildew.

Types of Pesticides

These are grouped according to the types of pests which they kill:

Grouped by Types of Pests They Kill

1.Insecticides – insects
2.Herbicides – plants
3.Rodenticides – rodents (rats & mice)
4.Bactericides – bacteria
5.Fungicides – fungi
6.Larvicides – larvae

Based on how biodegradable they are:

Pesticides can also be considered as:

•**Biodegradable:**

•The biodegradable kind is those which can be broken down by microbes and other living beings into harmless compounds.

•**Persistent:**

•While the persistent ones are those which may take months or years to break down.

Chemically-related pesticides:

•Organophosphate:

•Carbamate:

•Organochlorine insecticides:

•Pyrethroid:

•Sulfonylurea herbicides:

•Biopesticides:

Examples of pesticides

Examples of pesticides are fungicides, herbicides, and insecticides. Examples of specific synthetic chemical pesticides are glyphosate, Acephate, Deet, Propoxur, Metaldehyde, Boric Acid, Diazinon, Dursban, DDT, Malathion, etc.

Benefits of Pesticides

The major advantage of pesticides is that they can save farmers. By protecting crops from insects and other pests. However, below are some other primary benefits of it.

- Controlling pests and plant disease vectors.
- Controlling human/livestock disease vectors and nuisance organisms.
- Controlling organisms that harm other human activities and structures

Effects of Pesticides

- The toxic chemicals in these are designed to deliberately released into the environment. Though each pesticide is meant to kill a certain pest, a very large percentage of pesticides reach a destination other than their target. Instead, they enter the air, water, sediments, and even end up in our food.
- Pesticides have been linked with human health hazards, from short-term impacts such as headaches and nausea to chronic impacts like cancer, reproductive harm.
- The use of these also decreases the general biodiversity in the soil. If there are no chemicals in the soil there is higher soil quality, and this allows for higher water retention, which is necessary for plants to grow.

What are insecticides?

Substances which are used to kill insects are called insecticides. Insecticides have a wide application in the field of medicine, agriculture, and industry. They have the potential to alter ecosystem components majorly and are toxic to animals as well as humans. Some insecticides become concentrated as they spread in the food chain.

Classification of insecticide

•Based on chemical composition, it is classified as organic and inorganic.

•Based on the mode of entry in the insects, it is classified as contact poisons, fumigants poisons, stomach poisons, and systemic poisons.

•Based on the mode of action, it is classified as physical poisons, nerve poisons, respiratory poisons, protoplasmic poisons, general poisons, and chitin inhibitors.

•Based on toxicity, it is classified into four types:

- Extremely toxic – Colour: red, symbol: skull and poison, oral LD50: 1-50
- Moderately toxic – Colour: blue, symbol: danger, oral LD50: 501 – 5000
- Highly toxic – Colour: yellow, symbol: poison, oral LD50: 51 – 500
- Less toxic – Colour: green, symbol: caution, oral LD50: >5000

•Based on the stage of specificity, it is classified as ovicides, pupicides, larvicides, and adulticides.

Types of insecticides

There are three different types of insecticides. They are

1. Systemic – This type of insecticide is introduced into the soil for it to get absorbed by the plant roots. Once the insecticide enters the roots, it moves to external areas such as leaves, fruits, twigs, and branches. It forms a layer on the plant surface area and acts as a poison to any insect that comes to chew the plant.
2. Ingested – Some examples of ingested pesticides are rat and roach.
3. Contact – These type of insecticides act like bullets that aim only at a particular target to kill insects by its application. Usually, household insect spray works like contact insecticides as it must directly hit the insect.

Disadvantages of insecticides

1. Non-target organisms – Insecticides can kill more than intended organisms and are risky to humans. Also, when insecticides mix with water sources through leaching, drift, or run off, they harm aquatic wildlife. When birds drink such contaminated water and eat affected insects, they die. Some examples of insecticides, like DDT, were banned in the US as it affects the reproductive abilities of predatory birds.
2. Resistance – Insects when repeatedly exposed to insecticides build up resistance until finally, they have little or no effect at all. The reproduction in insects is so quick that they produce a new generation every three to four weeks. Therefore, the resistance builds up rapidly.

Herbicide

A herbicide is a chemical used to kill or otherwise manage certain species of plants considered to be pests. Plant pests, or weeds, compete with desired crop plants for light, water, nutrients, and space. This ecological interaction may decrease the productivity and yield of crop plants, thereby resulting in economic damage.

Application

Modern weed killers are put in two categories: selective (affecting specific plant species) and nonselective (affecting plants generally). These, in turn, are classified as foliage-applied and soil herbicides. Contact herbicides (e.g., sulfuric acid, diquat, paraquat) kill only the plant organs with which they are in contact. Translocated herbicides (e.g., amitrole, picloram, and 2,4-D) are effective against roots or other organs to which they are transported from aboveground treated surfaces (i.e., soil). With respect to planting time, herbicides are also classified as preplant, preemergence, or postemergence weed killers. Preplant herbicides may be applied to the soil or to weeds before crop planting.

What are the advantages of chemical herbicides over mechanical herbicides?

•A great advantage of chemical herbicides over mechanical weed control is the ease of application, which often saves on the cost of labour. Most herbicides are considered nontoxic to animals and humans, but they can cause substantial mortality of nontarget plants and the insects that depend on them, especially when applied aerially

What is selective and non selective herbicides?

•Selectivity (all plants or specific plants) Selective herbicides control or suppress certain plants without affecting the growth of other plants species. Non-selective herbicides are not specific in acting against certain plant species and control all plant material with which they come into contact.

Are herbicides toxic to humans?

•Most herbicides are considered nontoxic to animals and humans, but they can cause substantial mortality of non-target plants and the insects that depend on them, especially when applied aerially. Herbicides are chemicals used to kill plants. Their potential to produce toxicity in humans is rather low.

What are Food Additives?

Many chemicals are added to food for their preservation and to enhance their appeal. These are called food additives.

Types of Food Additives

The different types of food additives used in food are:

1. Flavors and sweeteners
2. Antioxidants
3. Preservatives
4. Food colors (dyes)
5. Fat emulsifiers and stabilizing agent
6. Flour improvers antistaling agents and bleaches.
7. Nutritional supplements such as vitamins, minerals, and amino acids.

What are Artificial Sweetening Agents?

The chemical compound which gives a sweetening taste to the food and enhances its order and flavour is called an artificial sweetening agent. Sweetness is commonly associated with sugars. The monosaccharides and disaccharides are sweet.

Cane syrup, honey, lactose (milk sugar) are the most common natural sweetening agents. Some important artificial sweeteners are saccharin, dulcin, cyclamate, nectarine, sucralose, aspartame.

Saccharin (ortho-sulphobenzimide)

It is the first most popular artificial sweating agent. It has been used as a sweetening agent for many food items since 1879. It is 1,2-benzisothiazolin-3-one-1,1-dioxide and occurs as a white crystalline powder. It has a very sweet taste and is about 550 times sweeter than sucrose. It is excreted from the body in the urine unchanged. Its use is of great value to a diabetic person and people who need to control the intake of calories.

Dulcin

Dulcin was the second artificial sweetener discovered in 1884. It didn’t get market acceptability and was banned in 1951.

Aspartame

Aspartame is one of the most widely used artificial sweeteners. It is the methyl ester of dipeptide derived from aspartic acid and phenylalanine. It is about 100 times sweeter than sucrose. Aspartame is unstable at cooking temperature, and therefore, it is used as a sugar substitute for cold foods and soft drinks.

Alitame

Alitame is a high potency sweetness and is more stable than aspartame during cooking, but it is difficult to control the sweetness of the food to which they are added.

Sucralose

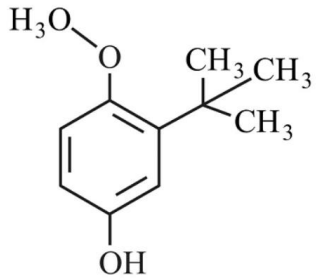
Sucralose is a colourless, trichloro derivative of sucrose. Its appearance and taste are similar to sugar and are

What are Antioxidants?

Antioxidants are substances that prevent or return the oxidative deterioration of food. Antioxidants act as radical inhibitors. These retard the action of oxygen on fatty or oily food and help in the preservation of food material. Vitamin EE is a naturally occurring preservative found in vegetable oil.

Antioxidants minimize the damage to some amino acids and the loss of some vitamins due to rancidity. During the oxidation of food, free radicals are generated. The antioxidants react with these free radicals and stop the chain reaction of the oxidation of the food. Thus, antioxidants decrease the rate of involvement of free radicals in the ageing process.

The most common antioxidants are butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA). Ascorbic acid (vitamin CC) and tocopherols (vitamin EE) have also been used as antioxidants.



What is Food Preservation?

The process in which the perishable food materials are given a suitable chemical or physical treatment to prevent their spoilage and to retain their nutritive value for a longer period is called food preservation.

There are two basic methods of food preservation. They are,

1. Bactericidal methods: In this method, the microorganism responsible for the spoilage of food material is eliminated.

2. Bacteriostatic methods: In this method, the condition is created to return the growth and action of the food spoiling microorganisms such as bacteria and enzymes.

The presence of a high concentration of salt squeezes out water from the food material through osmosis. This prevents the spoilage of food by inhibiting bacterial growth.

Sugar syrup containing more than 68% sugar also inhibits bacterial growth as there is very little free water.

What are Chemical Food Preservatives?

A chemical substance that prevents the spoilage of food material by destroying the food spoiling microorganism in it is called a food preservative.

Some examples of chemical food preservatives are,

1. **Sodium Benzoate:** It is used to preserve fruit juices and squash as sodium benzoate is soluble in water. It kills the food spoiling microorganism. It is metabolized by the conversion of hippuric acid (C6H5CONHCH2COOH)(C6H5CONHCH2COOH) that is ultimately excreted out in the urine.

2. Sodium or Potassium Metabisulphite: it is used for preserving colourless fruits like apple, litchi, mango chutney and lemon squashes, etc. These react with the acids of fruits are juices and produce sulfur dioxide, which kills the microorganisms.

Salts of propanoic acid and sorbic acid are used as preservatives for controlling the growth of yeast and moulds in food items such as cheese, pickles, baked food, certain meat, and fish products.

Is Food Colour a Food Additive?

Food colours (dyes) are used to increase the appearance of the food. Acidic and basic dyes are widely used synthetic dyes. Some examples of food colours are carmoisine, erythrosine, sunset yellow, indigo, etc.

What are the Advantages of Food Additives?

1.Food additives improve the quality, texture, consistency, appearance, and other technical requirements of the food material.
2.Food additives are added to increase the shelf-life of the stored food or for cosmetic purposes.
3.Antioxidants, preservatives, fat emulsifiers, and stabilizing agents as well as flavor improvers, are used to increase the shelf-life of the stored food. Dyes, flavors, and sweetening agents help to improve their cosmetic value.
4.Food additives like nutritional supplements such as vitamins, minerals, and amino acids have unique health benefits.
5.With the help of food preservatives, seasonal crops and fruits are available throughout the year.
6.Food additives are used to lower the calories.

What are the Disadvantages of Food Additives?

1.Several additives can cause allergic reactions, gastric irritation, diarrhoea, rashes, asthma, nausea, respiratory irritation, risk of cancer, etc.
2.It may lead to hyperactivity and affect the nervous system.
3.Food additives sometimes destroy vitamins in the food, replacing real ingredients.
4.During food preservation, there may be a loss of nutritive value of the food.

What are the most toxic heavy metals?

The heavy metals most commonly associated with poisoning of humans are **lead, mercury, arsenic and cadmium**. Heavy metal poisoning may occur as a result of industrial exposure, air or water pollution, foods, medicines, improperly coated food containers, or the ingestion of lead-based paints.

What are the side effects of toxic metals?

Symptoms

•Abdominal pain, nausea, vomiting, and diarrhea (the hallmark symptoms with most cases of acute metal ingestion)
•Dehydration.
•Heart abnormalities such as cardiomyopathy or abnormal heart beat (dysrhythmia)
•Nervous system symptoms (e.g. numbness, tingling of hands and feet, and weakness)

Dye

dye, substance used to impart colour to textiles, paper, leather, and other materials such that the colouring is not readily altered by washing, heat, light, or other factors to which the material is likely to be exposed. Dyes differ from pigments, which are finely ground solids dispersed in a liquid, such as paint or ink, or blended with other materials. Most dyes are organic compounds (i.e., they contain carbon), whereas pigments may be inorganic compounds (i.e., they do not contain carbon) or organic compounds. Pigments generally give brighter colours and may be dyes that are insoluble in the medium employed.

- Two natural dyes, alizarin and indigo, have major significance. Alizarin is a red dye extracted from the roots of the madder plant, *Rubia tinctorium*. Two other red dyes were obtained from scale insects. These include kermes, obtained from *Coccus ilicis* (or *Kermes ilicis*), which infects the Kermes oak, and cochineal, obtained from *Dactylopius coccus*, which lives on prickly pear cactus in Mexico. One kilogram (2.2 pounds) of cochineal dye can be obtained from an estimated 200,000 insects. The principal coloured components in these dyes are kermesic and carminic acids, respectively, whose similarity was established by 1920.

- With a process developed by the Phoenicians, a derivative of indigo, Tyrian purple, was extracted in very small amounts from the glands of a snail, *Murex brandaris*, indigenous to the Mediterranean Sea.
- Natural yellow dyes include louting, from the leaves of weld, *Reseda luteola*, and quercetin, from the bark of the North American oak tree, *Quercus tinctoria*. These are in the flavonoid family, a group of compounds occurring almost exclusively in higher plants and producing the colours of many flowers.
- Logwood is the only natural dye used today. Heartwood extracts of the logwood tree, *Haematoxylon campechianum*, yield hematoxylin, which oxidizes to hematein during isolation.

The synthetic dyes, can be named according to the chemical structure of their particular chromophoric group. For example, diphenylmethane derivatives, triphenylmethane compounds oxazine compounds, xanthene compounds, Azo dyes are one of the most popular varieties of synthetic dyes. Today it is being used up to 90% in the dyeing units, as they are versatile and simple to synthesize. Most of the synthetic dyes with a few exception are aromatic organic compounds which can be divided into groups like non-ionic (oil soluble), cationic, and anionic. A typical example of Cationic dye is Methyl violet, while Azo dyes are anionic dyes.

Types of Synthetic Dyes

- Acid Dyes
- Azoic (or Naphthol) Dyes
- Basic Dyes
- Chrome (or Mordant) Dyes
- Developed (or Diazo) Dyes
- Direct Dyes
- Disperse (or Acetate) Dyes
- Reactive (or Fiber-reactive) Dyes
- Sulphur Dyes
- Vat Dyes

Examples of Synthetic Dyes

- Fast green.
- Picric acid.
- Orange G.
- Oil red O.
- Eosin Y.
- Light green SF.
- Basic fuchsin.
- Acid fuchsin.

Parameters in choosing Synthetic Dyes

•**The following parameters can serve as a guideline for synthetic dyes:-**Boiling

•Perspiration

•Fading

•Machine wash ability

•Gas fume fading (from oil heaters)

•Fastness assessments

•Dry cleaning

•Hot pressing

•Steam pressing

•Salt water

Applications of the Synthetic Dyes

Earlier, synthetic dyes are used in textile industries only but now a days these dyes serve many industries such as: Medicine, chemistry, plastics, paint, printing ink, rubber, cosmetics etc.

Detergents

A detergent is a surfactant or mixture of surfactants that has cleaning properties in dilute solution with water. A detergent is similar to soap, but with a general structure $R\text{-}SO_4^-$, Na^+, where R is a long-chain alkyl group. Like soaps, detergents are amphiphilic, meaning they have both hydrophobic and hydrophilic regions. Most detergents are akylbenzenefulfonates. Detergents tend to be more soluble in hard water than soap because the sulfonate of detergent doesn't bind calcium and other ions in hard water as easily as the carboxylate in soap does.

Types of Detergents

Detergents are classified according to their electrical charge:

- **Anionic detergents**: Anionic detergents have a net negative electrical charge. The liver produces bile acids, which are anionic detergents the body uses to digest and absorb fats. Commercial anionic detergents are usually alkylbenezesulfonates. The alkylbenzene is lipophilic and hydrophobic, so it can interact with fats and oils. The sulfonate is hydrophilic, so it can wash away soiling in water. Both linear and branched alkyl groups may be used, but detergents made with linear alkyl groups are more likely to be biodegradable.
- **Cationic detergents**: Cationic detergents have a net positive electrical charge. The chemical structures of cationic detergents are similar to those of anionic detergents, but the sulfonate group is replaced by quaternary ammonium.
- **Non-ionic detergents**: Non-ionic detergents contain an uncharged hydrophilic group. Usually, these compounds are based on a glycoside (sugar alcohol) or polyoxyethylene. Examples of non-ionic detergents include Triton, Tween, Brij, octyl thioglucoside, and maltoside.
- **Zwitterionic detergents**: Zwitterionic detergents have equal numbers of +1 and -1 charges, so their net charge is 0. An example is CHAPS, which is 3-[(3-**ch**olamidopropyl)dimethyl**a**mmonio]-1-**p**ropane**s**ulfonate.

Detergent Uses

The largest application of detergents is for cleaning. Dishwashing detergent and laundry detergent are the most common formulations. However, detergents are also used as fuel additives and biological reagents. Detergents prevent fouling of fuel injectors and carburetors. In biology, detergents are used to isolate integral membrane proteins of cells.

Bleaching Powder

- Bleaching powder is a pale yellowish powder existing with a strong smell of chlorine.
- It is soluble in water but due to the presence of impurities, we never observe a clear solution.
- Its chemical formula is $Ca(OCl_2)$
- with its chemical name as **Calcium hypochlorite**.

1. Preparation of Bleaching Powder

Bleaching powder is synthesized by the action of chlorine gas (produced from the chlor-alkali process) on dry slaked lime

$$Ca(OH)_2 + Cl_2 \rightarrow Ca(OCl_2) + H_2O$$

2. Uses of Bleaching Powder

- It is used for bleaching dirty clothes in the laundry, as a bleaching agent for cotton and linen in the textile industry.
- It is a strong oxidizing agent, hence used as an oxidizer in many industries.
- It is used as a disinfectant which is used for disinfecting water to make potable water.

- Bleaching powder is basic in character. It gives calcium chloride, chlorine and water when bleaching powder reacts with hydrochloric acid.
- Bleach usually contains 5% sodium hypochlorite, which gives the skin a pH of about 11 and makes it mildly irritating.

Sodium Hydroxide

•Sodium hydroxide is a whitish solid, available in flakes, pellets and granules.
•It is popularly known as caustic soda.
•It is soluble in a polar solvent such as water but insoluble in non-polar solvents such as ether.

1**. Preparation of Sodium Hydroxide**

•Sodium hydroxide is synthesized through the **chloralkali process**. In this process, electricity is passed through an aqueous solution of sodium chloride (commonly called brine), and the decomposition of brine takes place.
•Chlorine gas is deposited at the anode while hydrogen at the cathode. The final solution of sodium hydroxide is formed at the cathode.
•As NaOH (an alkali) and chlorine gas are present in the final product, this process is known as the chloralkali process.

$$2NaCl\,(aq) + 2H_2O\,(l) \rightarrow 2NaOH\,(aq) + Cl_2\,(g) + H_2\,(g)$$

2. Uses of Sodium Hydroxide

•It is used for the manufacturing of paper, soaps, and detergents.
•It is used for degreasing metals.
•It is used to remove sulphurous impurities from poor quality crude oil by a process called caustic washing.