Since its own inception, man has always been engaged in tussle, between himself and the environment around him. Due to his over sustained efforts he could now control his environment and calamities with the aid of emerging new science and technology. This has resulted in the improvement of quality of life and its expectancy. However, with the ever increasing trend in the world population more so in developing countries, problems of food, health and hygiene are widening day by day, thus putting pressure on man to increase agricultural production.

Soil is a thin layer of earth's crust, which serves as a natural medium for the growth of plants. It is a complex mixture of solids, liquids and gases that provide life support system for roots of growing plants and microorganisms. The important components of soils are mineral matter, organic matter, water and air. The soil is a primary recipient, intended or otherwise of all waste products and chemicals. Furthermore, once these materials enter the soil they become the part of cycle that affect all forms of life. At least a general understanding of the pollutants themselves, their reactions in soils, and available means of managing, destroying, or inactivating them is essential.

In modern agriculture, the role of pesticides cannot be over emphasised. The wide spread use of these chemicals played an important role in the success of Green Revolution and solving problem of adequate grain production in our country. Most of the pesticides are applied to soil to combat soil borne diseases and pests or they become systemic to provide tolerance to plants against air borne pests and diseases. Soil, water and air that support our agricultural system are under severe pressure.

Pesticides, used for increasing agricultural production are toxic chemicals, in broader sense and include a wide range of synthetically prepared organic compounds used to control insects, herbs, weeds, fungi, rodents, fishes, bacteria
and nematodes. These are respectively called insecticides, herbicides, weedicides, fungicides, rodenticides, piscicides, bactericides and nematicides. Pesticides stand out as one of the major developments of 20th century. During the past 20 years, however, concern has arisen about their presence in environment, which poses a threat to the wild life and environment. In our country only 155 pesticides belonging to different groups have been registered till the end of the year 2000.

The pesticides are, by and large, applied to plant foliage or incorporated on the soil surface in the form of emulsions, granules, and a suspension ultimately reaching the soil. Once a pesticide is introduced into the soil environment, whether through an application, a disposal or a spill, it is influenced by many processes, which determine the pesticide’s persistence and movement, if any, and its ultimate fate influence it. They may vaporise into atmosphere without chemical change; be adsorbed by the soil; move downward through the soil in the liquid or solution form and be lost from the soil by leaching; undergo chemical reactions within or on the surface of the soil; are broken down or degraded by soil micro organisms thereby influencing the soil properties and macro and micro nutrients status of the soil.

The indiscriminate use of pesticides affects the physico-chemical and biological properties of the soil, eliminate even beneficial insects and disturbs the ecological balance. The plants develop phytotoxicity symptoms when the concentrations reach at higher level often resulting in the destruction of useful plants. They may also enter the food chain, causing toxicity to the human beings, animals and other organisms. Quite a large amount of pesticides reaches the water resources causing toxicity to flora and fauna. These are equally toxic to man and other domestic animals who depend on plants for their daily needs. These chemicals also reach the water resources causing pollution. Thus, its use poses a great threat to the human health and the environment. At the same time, the intensive agricultural practice leads to the problem like land detoration,
water depletion, pest infestations, loss of genetic diversities of crops and deficiencies of trace elements and organic matter. Therefore, the challenge is to increase the productivity without damaging the environment. The greater the population the more is the impetus for food production and larger the danger to biosphere.

Adsorption is the attraction and repulsion phenomenon at the soil surface and exerts the most pronounced influence of the several processes operating in soil, on the fate of pesticides. United States Environmental Protection Agency (US EPA) has proposed guidelines for registration of pesticides requiring adsorption and movement studies in soils with certain uses because adsorption affects the pesticidal action, movement, persistence and degradation, leachability and translocation. The movement of pesticides in soils is of extreme importance owing to possible eventual contamination of underground water supplies. It is dependent on the amount of water moving through the soil and the degree of adsorption of the pesticides by soils.

Soil amendment with organic matter is a usual practice for crop improvement and control of diseases. The organic matter in soil is broken down to amino acids, phenols etc. The amino acids are important sources of nitrogen to the plants in its nutrition. The movement of amino acids in soil is influenced by several factors.

The phenols, which are also released during decomposition of organic matter, are reported to impart resistance and tolerance to plants against invasion by various microorganisms. It has been suggested that the roots absorb phenols released during decomposition of organic matter which might be imparting resistance/tolerance to plants. Some of the phenols may reduce plant growth probably by inhibiting nutrients uptake. They are responsible for inhibiting nitrification in soil. When they interact with different components of soil their mobility may be affected. The information, however, on this aspect is scanty.
The movement of trace elements/heavy metals in soils are of great importance because of the deleterious effects of the metals on biota specially when metals accumulate and reach toxic levels in soils to which sewage sludge’s are applied. Therefore, a thorough study of movement of trace elements as affected by different factors is of utmost importance.

Fly ash is one of the waste products when coal is burnt for electric power generation, for industrial use and production of liquid fuels etc. This fly ash falls on the soil and later becomes one of the components of soil. It has adsorption potential, which helps in removing the organic acids and other toxic ions from water. It has also been used satisfactorily in neutralizing the soil acidity and found to increase availability of certain nutrients in soil. Amendment of soil with fly ash has been reported to control nematode population.

Soil was recognised as natural ion exchanger in the middle of 19th century. Soon after it was established that aluminium silicates were responsible for ion exchange. Later on clays and zeolites were studied for their ion exchange behaviour. Thereafter, large number of inorganic ion exchangers were synthesised and used for separation and removal of pollutants from environmental samples.

In view of this an effort has been made here to highlight the advances made in the field of interaction of certain pesticides, amino acids, phenols and trace elements on soils, clays, fly ash and inorganic ion exchangers with a particular reference to adsorption, movement, thermodynamics of adsorption, thermodynamic of ion exchange equilibria and side effect of certain pesticides and fly ash on macro and micro nutrients status of the soils and growth of tomato plants in presence and absence of *Meloidogyne incognita*.

The present work is, therefore, an outcome of the series of studies in the form of recently published papers by the author and his co-workers to fill the lacunae in the knowledge of the above mentioned field. In all sixty eight papers have been selected out of total seventy-nine papers published to depict the
model system. Out of these six have been published as single author and fifty three as a senior author and nine as junior author.

The fields of study detailed herein can be classified as;

1. Adsorption of pesticides in soils
2. Adsorption thermodynamics of pesticides on soils, fly ash and inorganic ion exchangers.
3. Effect of different factors on the movement of pesticides in soils.
4. Effect of different factors on the movement of amino acids and phenols in soils.
5. Effect of different factors on the movement of trace elements in soils.
7. Thermodynamics of exchange equilibria of inorganic ions in soils, clays and synthetic inorganic ion exchangers.
8. Effect of pesticides on macro and micronutrients status of the soils and growth of tomato plants in presence of Meloidogyne incognita.
9. Effect of fly ash on nematode control and nutrients availability.

This is the outcome of an original research work carried out at the Department of Chemistry, (Faculty of Science), Department of Applied chemistry, (Faculty of Engineering and Technology) and Soil Science Laboratory, Department of Botany, (Faculty of Life Sciences), Aligarh Muslim University, Aligarh (India).
The entire work of this thesis has been divided into the following five chapters:

1. Adsorption and adsorption thermodynamics of pesticides on soils, fly ash and inorganic ion exchangers.
3. Physico-chemical and thermodynamic studies of nicotine on clays.
4. Thermodynamics of exchange equilibria of inorganic ions on soils, clays and ion exchangers.
5. Effect of pesticides and fly ash on macro and micronutrients of the soil and growth of plants in presence and absence of *Meloidogyne incognita.*