Chapter-1

Introduction
INTRODUCTION

The most important group of food plants are the cereals and pulses. The terms cereals was coined by the Romans in honour of their Goddess of grain 'ceres', to whom they offered, offering of wheat and barely called Cerealia munera or gifts of ceres, during sowing and harvest festivals. Hence, these and associated plants came to be known as cereals.

Triticeae included wheat, barely, rye, their wild relatives, and a number of important wild grasses. The Fertile Crescent, at the core of Western Asia and Northern Africa, is the center of origin and early diversification of this clan (Paul.C; 1953).

Through centuries of seed selection and modern wheat breeding, Wheat can be grown in every temperate climate in the world. World wheat production is perennial, that is, wheat is being harvested in some part of the world in every month of the year.

Wheat is seeded anywhere from sea-level to elevations of ten thousand feet. A ninety day growing season is needed for wheat growth, and a period of dry, sunny weather is preferred for the ripening period.

Rainfall between ten and thirty inches annually is required, and soils that range from sandy loam to clay are used to grow wheat. The plant averages between two to three feet in height, and some varieties reach five to six feet. (Davis, S; 1997).

Wheat (Triticum aestivum L; Hindi-Gehu or Gehoon) is an important cereal crop of India belonging to family poaceae. It is cultivated in China, India, USA, Australia, Canada, France, Argentina and Germany. Wheat is grown in different conditions such as irrigated and rain fed, in temperate and warm
regions. A wide range of soil types can support wheat cultivation; however, the best yield of the crop may be obtained in heavy loams, such as silt and sandy loams. The seed of wheat is the best source of carbohydrate. Flour (the powdered or grounded grains) is chiefly used for making bread, which is the staple food all over the world (Pandey & Chaddha, 1996).

Wheat is grown on more land area than any other commercial crop and is the most important staple food for human. Globally, wheat is the leading source of vegetable protein in human food having higher protein content than either maize or rice, the other major cereals. (Cauvain, 2003).

In 2009, World production of wheat was 682 million tonnes making it the second most produced cereal after maize (817 million tonnes) and with rice as close third (679 million tonnes).

In 2010, World production of wheat was 651 million tonnes, making it the third most produced cereal after maize (844 million tonnes and rice (672 million tons). (http://faostat.fao.org)

Wheat is grown in India over an area of about 266.92 lakh hectares with a production of 721.40 Lakh tonnes. The normal National productivity is about 2703 kg/ha. The major wheat producing states are U.P., Punjab, Haryana, M.P., Rajasthan, Bihar, Maharashtra, Gujarat, Karnataka, West Bengal, Uttaranchal, Himachal Pradesh and Jammu & Kashmir. These states contribute about 99.5% of total wheat production in the country. Remaining states, namely, Jharkhand, Assam, Chhattisgarh, Delhi and Other North Eastern states contribute only about 0.5% of total wheat production in the country. (www.dacnet.net.nic.in). (Fig.-A)

The Production of wheat in India has shown a rising trend in the past 5 decades (Fig-B). However, there was a steep jump in production of wheat during 1960-70 to 1970-1980 by nearly 109%. (www.nmce.com).
The Green Revolution in the 1960's contributed to this phenomenal rise in wheat production in the country over the decade. However, following 1980's there has been a consistent declining trend in production of wheat in India. For instance, the production of wheat rose by just 61% from 1970-1980 to 1980-1990. In recent years, there has been a worsening trend with wheat production actually growing by just 7% from 2000-01 to 2001-02.

The population of India has increased with growth rate of 1.95% in 1911-2001. Presently Indian population is 16.7% of world population.

Introduction
In 2001 Indian population was 1,02,701,5247 and it is expected to be 1516.86 millions by the year 2051 (Sharma, 2003). Current population of India in 2012 is around 1,22,000,000 (1.22 billion) people. Currently, India is second largest country in the world after China in terms of population. By 2030, the population of India will be largest in world estimated to be around 1.53 billion. India population will be highest in the world by 2030 leaving behind China.

In spite of recent efforts to reduce the rate of population growth, the number of new humans added to world population each year and the additional demands for food, energy and other resources from our planet are frightening. Ministry of Agriculture, Govt. of India estimates that the demand of food is expected to 304.509645 million tones/year in 2051 for survival of dense human population in India. However that time India will produce 291.6426 million tones/year foods with deficit of 13.16704 million tones, (Pandey, 2003).

Paradoxically, the developing countries, in which from 50 to 80 percent of the population is engaged in agriculture, have the lowest agricultural output. Their people are living on substandard diet and they have the highest population growth rates (2.64%). Because of the current distribution and technical levels for food production, and of general world economics, it is estimated that even today some 2.0 billion people suffer from hunger or malnutrition or both. To feed these people and the additional million to come in the next few year, all possible methods of increasing the world food supply are currently being pursued, including (1) expansion of crop acreages, (2) improved methods of cultivation, (3) increased fertilization (4) use of improved varieties of crops, (5) increased irrigation and (6) improved crop protection.

According to Bunting (1972), "The storage pests, principally insects, fungi and small rodents require special mention, because they cause extensive, discouraging and unnecessary losses of plant and animal products. Their control is perhaps the most immediately rewarding aspect of pest regulation in developing countries."

Introduction
Severe invasion of post harvest commodities take place whenever environmental conditions become favorable for the proliferation of microorganisms. Moisture contents of the seeds or grain, its physical state, ambient temperature, length of storage and the interaction of stored products and different storage pests are the main factors that determine both the initiation and the extent of deterioration, such post harvest deteriorations have been of interest to those concerned with agricultural products because of economic losses due to obvious decay and adverse changes in the odour, taste, appearance and nutritive value. In case of severe infection the quality of the commodity gets deteriorated and some times, the seeds lose their viability (Chohan and Mehan, 1982]. Production of free fatty acids, decrease in non-reducing sugars, development of odours and yield have been reported by Christensen & Kaufmann (1965); Golumbic (1965); Bilgrami et.al. (1979).

Almost all insect pests of stored grains have a remarkably high rate of multiplication and within a few months they may destroy 10-15% of the grains and contaminate the rest with undesirable odours and flavours. Of the many stored grain insects, the most predominant and widely distributed pests are red flour beetle (*Tribolium castaneum H*), rice weevil (*Sitophilus oryzae L.*) and pulse beetle (*Callosobruchus maculatus F.*.) Azam et al., (1994).

It is a common observation that invasion of insects is almost always accompanied by fungi. Fungi represent one of the main causes of post harvest losses. In addition to causing rot, they can also contaminate food with highly toxic chemicals known as mycotoxins. It is estimated that each year 30-40% of the world wide food production is contaminated by mycotoxins (Richard et al., 1989) with consequent adverse effects on population, health and economy (Tzatzarakis et al., 2000).

The term 'mycotoxin' (myco from the Greek word 'mykes' meaning fungus or mould) refers to secondary metabolites produced by moulds as they grow on or in foods and feeds and capable of elating a toxic effect in humans and animals. The toxicity syndromes resulting from the intake of mycotoxin-contaminated material by animals and man, usually by ingestion, have been termed
Mycotoxicoses have been known since biblical times, although perhaps not by that name. Incidence of different mycotoxicoses in animal (Mehrotra & Khanna, 1973; Rajendran et al., 1975; Pier et al., 1980; Bars, 1983; Cao et al., 1986; Mary et al., 1987); and man (Enomoto, 1976; Bauers & Garries, 1987) have been reported from all over the world. These aflatoxins are well known for their carcinogenic, mutagenic and teratogenic effects to plants, man and to domestic animals. (Newberne, 1965, Newbeme et al. 1968; Wylli & Morehouse, 1978; Lancaster et al. 1961, Hayes, 1980; Natarajan, 1989; Sumbali 2001; Agrawal 2001).

Attempts to control post harvest disease have been carried out by different physical and chemical treatments. Physical treatments include heat therapy, mechanical refrigeration, controlled atmosphere, hypobaric storage, radiation and other sophisticated techniques are used in industrialized countries to extend storage life and minimize post harvest losses. These techniques are capital intensive and the requisite manpower is lacking or inadequate in most developing tropical countries. Moreover, physical treatment has been used with limitations. Firstly, some non-parasitic wide troubles such as red blotches, pitting, membranous stain, sprouting, injuries, cost etc. develop on the community (Desrosier & Dasrosier, 1977, Bonwart, 1981; Aworh et al. 1991); secondly some fruit rotting fungi develop well even at low temperatures (Eckert & Somner 1967). As regards radiation, most of the fruits and vegetables can tolerate the radiation dosages required for decay control. The irradiated food can also lead to adverse metabolic reactions in human and animal systems (Ray Chaudhari & Dharma Vir, 1977). Moreover some fruits and vegetables are injured by low temperature storage. When injured produce is returned to room temperature, the respiration rate rises, than declines rapidly due to the death of cells in the tissues (Desrosier & Desrosier, 1977).

Although hot water and air treatment of fruits and vegetables are being used to control post harvest decay but have exhibited possible side effects such as reduced storage life of Apple (Edney & Burchill, 1967); Stem rot on Mango (Spalding & Reeder, 1972); Poor degreening in oranges (Smoot & Melvin, 1965).
Induced injury to commodities and lack of residual protection are serious limitation of use of heat treatment (Golan & Phillips 1991).

Heat treatments can affect the host by altering ripening (Anthony, et al., 1989), fruit colour, electrolyte leakage, sugar metabolism, ethylene production, ethanol production and pectic enzyme activity (Phillips & Harris, 1979), thus the necessity for chemical control can be hardly denied.

A pesticide is any substance or mixture of substance intended for preventing, destroying, repelling or mitigating any pest. (US Environmental, 2007). A pesticide may be a chemical substances, biological agent, antimicrobial, disinfectant or device used against any pest. Pests include insects, plant pathogens, weeds, molluscs, birds, mammals, fish, nematodes, (round worms) and microbes that destroy property, spread disease or are a vector for disease or cause a nuisance. Although there are benefits to the use of pesticides, there are also drawbacks, such as potential toxicity to humans and other animals.

According to the Stockholm convention on persistent organic pollutants, 10 of the 12 most dangerous and persistent organic chemicals are pesticides, (Gilden et al., 2010).

Food and Agriculture Organization (FAO) has defined the term of pesticide as any substance used for preventing, destroying or controlling any pest, including vectors of human or animal disease, unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage, transport or marketing of food, agricultural commodities, wood and wood products or animal feeds tuffs or substances which may be administered to animals for the control of insects, arachnids or other pests in or on their bodies.

The term includes substances intended for use as a plant growth regulator, defoliant, desiccant or agent for thinning fruit or preventing the premature fall of fruit. Also used as substances applied to crops either before or after harvest to protect the commodity from deterioration during storage and transport. (FAO of the United Nations 2002).
Pesticides are used to control organisms considered harmful. For example, they are used to kill mosquitoes that can transmit potentially deadly diseases like west nile Virus, yellow fever, and Malaria. They can also kill bees, wasps or ants that can cause allergic reactions. Insecticides can protect animals from illnesses that can be caused by parasite such as fleas.

Pesticide can prevent sickness in human that could be caused by mouldy food or diseased produce. Herbicide can be used to clear roadside weeds, tree, and bush. They can also kill invasive weeds that may cause environmental damage.

Herbicides are commonly applied in ponds and lakes to control algae and plants such as water grasses that can interfere with activities like swimming and fishing and cause the water to look or smell unpleasant. (Helfrich et al., 1996; 2007), uncontrolled pests such as termites and moulds can damage structure such as houses. Pesticides are used in grocery stores and food storage facilities to manage rodents and insects that infest food such as grain; each use of a pesticide carries some associated risk. Proper pesticide use decreases these associated risks to a level deemed acceptable by pesticide regulatory agencies such as the United States Environmental protection Agency (EPA) and Pest Management Regulatory Agency (PMRA) of Canada.

Pesticides can save farmer’s money by preventing crop losses due to insects and other pests. In the U.S. farmers get an estimated four fold return on money they spend on pesticides, (Kellogg et al., 2000). One study found that not using pesticides reduced crop yields by about 10% (Kuniuki, 2001).

Another study, conducted in 1999, found that a ban on pesticide in the united States may result in a rise of food prices, loss of jobs, and an increase in world hunger. (Knutson, 1999).

DDT, sprayed on the walls of houses, is an organochloride that has been used to fight malaria since the 1950s. Recent policy statements by the World Health Organization have given stronger support to this approach.
Dr. Arata Kochi, WHO's malaria chief, said, "One of the best tools we have against malaria is indoor residual house spraying of the dozen insecticides WHO has approved as safe for house spraying, the most effective is DDT." However, since then, an October 2007 study has linked breast cancer from exposure to DDT prior to puberty. (www.sustainableproduction.org.) Poisoning may also occur due to use of DDT and other chlorinated hydrocarbons by entering the human food chain when animal tissues are affected. Symptoms include nervous excitement, tumours, convulsions or death.

Scientists estimate that DDT and other chemicals in the organophosphate class of pesticides have saved 7 million human lives since 1945 by preventing the transmission of diseases such as malaria, bubonic plague, sleeping sickness, and typhus. (Miller, 2004). However, DDT use is not always effective, as resistance to DDT was identified in Africa as early as 1955, and by 1972 nineteen species of mosquito worldwide were resistant to DDT.

A study for the world health organization in 2000 from Vietnam established that non-DDT malaria controls were significantly more effective than DDT use. The ecological effect of DDT on organisms is an example of bioaccumulation.

In 2002, 1.1 billion pounds of pesticides were used by 90% household in the United States, (Gilden et al., 2010).

There are more than 1, 055 active ingredients registered as pesticides, (U.S. Environmental Protection Agency) which are put together to produce over 16, 000 pesticide products that are being marketed in the United States. (www.cdc.gov/niosh/topics/pesticides).

Pesticide use raises a number of environmental concerns. Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species, including non-target species, air, water, soil. (Miller, 2004). Pesticide drift occurs when pesticides suspended in the air as particles are carried by wind to other areas, potentially contaminating them. Pesticides are
one of the causes of water pollution, and some pesticides are persistent organic pollutants and contribute to soil contamination.

In addition, pesticide use reduces biodiversity, reduces nitrogen fixation (Rockets, 2007) contributes to pollinator decline, (Hackenberg et al., 2007). Destroys habitat (especially for birds), and threatens endangered species. (Miller, 2004).

Pesticides may cause acute and delayed health effects in those who are exposed, (U.S. Environmental Protection- Agency, August 30, 2007). Pesticide exposure can cause a variety of adverse health effects. These effects can range from simple irritation of the skin and eyes to more severe effects such as affecting the nervous system, mimicking hormones, causing reproductive problems and also causing cancer. (www.epa.gov/pesticides/health).

A 2007 systematic review found that "most studies on non-Hodgkin lymphoma and leukemia showed positive associations with pesticide exposure" and thus concluded that cosmetic use of pesticides should be decreased. (Bassil et al., 2007). Strong evidence also exists for other negative outcomes from pesticide exposure including neurological, birth defects, fetal death, (Sanborn et al., 2007) and neuro developmental disorder. (Jurewicz and Hanke 2008).

The American medical Association recommends limiting exposure to pesticides and using safer alternatives. "Particular uncertainty exists regarding the long term effects of low dose pesticide exposures. Current surveillance systems are inadequate to characterize potential exposure problems related either to pesticide usage or pesticide-related illnesses. Considering these data gap's, it is prudent to limit pesticide exposure and to use the least toxic chemical pesticide or non-chemical alternative."

The WHO and the UNEP estimate that each year, 3 million workers in agriculture in the developing world experience severe poisoning form pesticides, about 18,000 of whom die. (Miller, 2004).
According to one study, as many as 25 million workers in developing countries may suffer mild pesticide poisoning yearly (Jeyaratnam, 1990).

One study found pesticide self-poisoning the method of choice in one third of suicides worldwide and recommended, among other things, more restrictions on the types of pesticides that are most harmful to humans. (Gunnell et al., 2007).

The Bhopal disaster occurred when a pesticide plant released 40 tens of methyl isocyanate (MIC) gas, a chemical intermediate in the synthesis of some carbamate pesticides. The disaster immediately killed nearly 2,259 people and ultimately caused at least 15,000 deaths.

In the 17th century, nicotine sulfate was extracted from tobacco leaves for use as an insecticide. The 19th century saw the introduction of two more natural pesticides, Pyrethrum, which is derived from Chrysanthemums, and rotenone, which is derived from the roots of tropical vegetables. (Millied, 2002). Until the 1950s, arsenic based pesticides were dominant. (Ritter, 2009). Paul miller discovered that DDT was a very effective insecticide. Organochlorines such as DDT were dominant, but they were replaced in the U.S. by Organophosphates and carbonates by 1975. Since them, Pyrethrin compounds have become the dominant insecticide. (Ritter, 2009).

Pesticide use has increased 50 fold since 1950 and 2.3 million tonnes of industrial pesticides are now used each year. (Miller, 2002). Seventy five percent of all pesticides in the world are used in developed countries, but use in developing countries is increasing (Miller, 2004). In 2001 the Environmental Protection Agency stopped reporting yearly pesticide use statistics. A study of USA pesticide use trends through 1997 was published in 2003 by the National Science Foundations Center for Integrated Pest Management. (Ritter, 2009). The agricultural use of DDT is now banned under the Stockholm convention on persistent organic pollutants, but it is still used in some developing nations to prevent malaria and other tropical diseases by spraying on interior walls to kill or repeat mosquitoes. (Lobe, 2006).
A pesticide poisoning occurs when chemicals intended to control a pest affect non-target organisms such as humans, plants, wildlife, or bees. Self-poisoning with agricultural pesticides represents a major hidden public health problem. It is one of the most common forms of self-injury in the Global south. The World Health Organization estimates that 300,000 people die from self-harm each year in the Asia-Pacific region alone. (Reeves & Schafer 2003).

Pesticide poisoning is an important occupational health issue because pesticide are used in a large number of industries, which puts many different categories of workers at risk. Extensive use puts agricultural workers in particular at increased risk for pesticide illness. (Calvert et al., 2008).

Acute pesticide poisoning is a large-scale problem, especially in developing countries. "Most estimates concerning the extent of acute pesticide poisoning have been based on data from hospital admissions which would include only the more serious cases. The latest estimate by a WHO task group indicates that there may be 1 million serious unintentional poisoning each year and in addition 2 million people hospitalized for suicide attempts with pesticides. This necessarily reflects only a fraction of the real problem. On the basis of a survey of self-reported minor poisoning carried out in the Asian region, it is estimated that there could be as many as 25 million agricultural workers in the developing world suffering an episode of poisoning each year." (Jeyaratnam, 1990) In Canada in 2007 more than 6000 cases of acute pesticide poisoning occurred. (www.davidsuzuki.org) Estimating the numbers of chronic poisoning worldwide is more difficult. Specific pesticides have special considerations with regard to respiratory support. In anticholinesterase poisoning, adequate tissue oxygenation is essential before administering atropine. In paraquat and diquat poisoning, however, oxygen is contraindicated. (Feldmon & Maiback 2007).

The common way to control these pests is the application of chemical pesticides. The use of pesticides to control different pests has been increasing steadily at an annual rate of about 14% since the mid 1950s. By 1977 approximately 2.3 billion Kg of pesticides including fungicides, insecticide, and herbicides were applied to crops and their products in storage throughout the...
world each year. The total pesticide consumption in the country in agricultural sector has been estimated to be 90,000 metric tonnes of which about 75,000 tonnes is manufactured in India, while the remaining is imported. Cotton and paddy account for about 70 per cent of the total consumption. The average consumption of pesticides in India is one of the lowest in the world (around 300-400g/ha) compared to 10 Kg/ha in Japan.

It is a fact that chemical control now dominates pest management including India. The environmental considerations in integrated pest management have posed new challenges to scientists, for developing environmentally benign pest control chemical which are effective against the target species but create minimal adverse effects on non-target species (Lim, 1998; Dhaliwal and Arora, 2001).

While chemical pesticides have played an important role in increasing the food production in India, their indiscriminate use has led to several environmental problems including development of resistance in insects to insecticides, resurgence of non-target pests, pesticide residues in food, fodder and feed, destruction of beneficial insects like honeybees, pollinators parasites and predators. Persistent residues of DDT and BHC have been detected in foodgrains, vegetables, fruits, oil, butter, fish, meat, milk and milk products and even in mother's breast milk. (Dhaliwal and Singh, 2000).

The pesticide consumption has gone beyond 100,000MT during the year 1997-98. Among the total pesticide use in India more than 60 percent of the pesticides are consumed in the agriculture sector.

The consumption of pesticides is highest in Andhra Pradesh (20%), followed by Punjab (10%), Tamilnadu (9%), Karnataka and Gujrat (6% each). Maximum utilization of these pesticide is against cotton, rice and vegetables. Of the total annual pesticide consumption about 56 percent is used for cotton alone, though cotton is grown in only 5 percent of the cropped area. On the other hand, the pesticide share is only 6-7% in the case of millets, oils seeds and pulses though they have a cropped area share of 58%.

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Farmers are unable to use even minimum quantity of pesticide due to their high cost. The use of pesticides is also heavy in vegetables, fruits and plantation crops but very moderate in sugarcane. The rice crop also consumes about 18% of the total quantity of pesticides used in the country.

Among the chemical pesticides, insecticides are used to the extent of about 80% in India followed by fungicides (10%), herbicides (7%) and other chemicals (3%). (Dhaliwal and Arora 2001). While in most of the Western countries herbicide use is the highest. The world average for herbicide use is about 45% followed by insecticides (36%), fungicides (17%) and other chemicals (2%). However, the encouraging aspect is the reduction in the use of conventional chemical pesticides in terms of g/ha. In 1990-91 it was 404g/ha and 1999-2000 it was 243g/ha.

In the last several years, the use of pesticides has begun to decline in the united states and in Europe, but the use of pesticides in developing countries continues to increase sharply. Majority of the pests are suppressed to significant extent by application of chemical pesticides, however, it is not the ideal way of controlling the pests because it contains different ill side effects such as carcinogenicity, teratogenicity, residual toxicity, contamination of food and human body, impact on non-target species, hazards to useful wild life and aquatics and upset the pest natural enemy equilibrium (Edward, 1973; Majumder, 1974; Bajaj & Gosh 1975; Sax, 1987; Arya, 1988; Kingk, 1991; Mani, 2002).

Besides phytotoxic and off-odour effects, these chemicals create pesticidal pollution and wholesale mortality of many animal and plant species due to their non biodegradable nature (Fawcett and Spencer, 1970; Koeman, 1978; Novoshilov, 1978).

According to Gupta (1983) such pesticides are known to effect adversely a number of biological functions such as nervous system in many organism, reproduction in birds and fish, hormonal balance in mice, temperature regulating mechanisms in fish as well as liver function in man etc. This has led to the total
ban of some of the synthetics in developed countries and put a warning to other
developing countries like India. Some of the synthetic chemicals are often found
to cause slow poisoning due to slight errors in their handling. In India, one such
chemical created havoc at Bhopal due to slight error in its handling. A large
number of diseases are reported based on pesticides in India. These are
blindness, cancer, deformities, liver diseases, nervous system diseases etc.
According to a report of WHO and UN the level of chlorinated pesticides intake is
higher among the people of India than the people in other countries. The
pesticides residues have been reported in food commodities wheat, rice, pulses,
ground nut, fishes, meat, butter, ghee, cheese, eggs, fruits etc. (See Dwivedi,
1993). It is estimated that the daily diet of an Indian contains about 0.27mg of
DDT and its level of accumulation in the body is highest in the world varying
between 12.8 µl/ml and 31.0 µl/ml (See Gupta, 1989; Gupta 2001).

This hazardous chemical is present in ground water sources, through
seepage into soil, due to which river, ponds and seas have become poisoned.
Recently toxic synthetic fungicides have been reported in cold and soft drinks in
India with high concentration. It is alarming for us to check the entry of such
synthetics in our ecosystem by evaluating new source (Anonymous, 2003). India
accounts for one third of pesticidal poisoning cases in the third world. Sulphas is
commonly used as a fumigant biocide to protect stored grains and consumption
of sulphas is fatal to human also. It is now utilized as suicidal agent and
producing a social abuse. The food poisoning tragedy (1990) in Basti district of
U.P. took 150 human lives, due to ingestion of highly contaminated wheat with
synthetic pesticides (Nigam, 2001).

Further due to development of new physiological races of pathogens
many of these synthetic chemicals are gradually becoming ineffective (Wellman,
1977; Wicks, 1997; Delp, 1980; Rosenberger & Meyer 1981; Spotts & Cervants
1986). The acquired resistance by *Penicillium italicum* to fungicides used on
citrus fruits to prevent decay and spoilage during post harvest storage and
marketing has become a matter of much concern in recent years (Houck, 1977).
Enthusiasm for benzimidazole fungicides was gloomed some what by the
comparative ease (Eckert, 1977). Thus use of these synthetics needs replacement by some harmless pesticides. Therefore, there is now urgent need to develop new and effective means for controlling post harvest diseases that pose less risk to human health and the environment (Surya Narayan, 1978; Wilson & Wisniewski 1989).

Plant and microbial origin antipathogenic substances need encouragement for safety of crop plants from diseases and for unpolluted environment. Plant face biotic and abiotic stresses due to which crop yield declines. The biotic stress is caused by several pathogens. Soil is an abode of an array of microbes and many of them cause disease of crop plants. Many non-pathogenic microbial forms can be used for biocontrol of the disease.

Although biological (microbial) control processes have promising ability to control crop diseases without side effects but this field is yet in seedling stage with own limitation.

India is blessed with incredible biological diversity. Not only is it counted among the 12-mega-gene centers of the world, two the Eastern Himalayyas and Western Ghats are located here. India is also placed 10th among the plant rich nations of the world and 4th among the Asian countries (Joshi, 2003) India contains 5% of the world's biodiversity on 2% of Earth's surface. It is estimated that 45000 wild species of plants occur in our country. In which about 2000 are being extensively utilized for treatment of various ailments (Dubey, 2000; Rambhuj, 2001).

India has a tremendous amount of ecosystem, species and genetic diversity. The diversity is also due to the fact that India has almost every major types of habitat and climatic condition from Alpine heights to coasts, and plains from areas of heaviest rainfall to dry deserts. Due to different types of habitat, plants produce varieties of chemicals which may be explored as antifungal agent, as indigenous, non-toxic and renewable source for plant disease control.

In recent years, study and use of chemicals from natural sources which are non toxic and specific in their action is gaining considerable attention for
exploitation as natural pesticides. Higher plants contain a wide spectrum of secondary substances viz. phenols, flavonoids, quinones, tannins, essential oils, alkaloids, saponins and steroids. These plant chemicals may be fruitfully exploited for their different biological properties (Wain, 1977; Kubo & Nakanishi, 1979; Mahadevan, 1982; Rice, 1984).

Recently in some laboratories plant chemists and biologists are trying to find out the potentiality of secondary metabolites of higher plants as alternatives source of chemicals in control of plant diseases caused by fungi, nematodes, bacteria and insects. Further, it is noteworthy that Pyrethrum obtained from Chrysanthemum cinerariaefolium holds a leading place amongst the insecticides and there is not a single material yet developed of such potency. The plant is still cultivated on large scale in Africa and South America (See Marini-Bettal, 1977). Several plant parts and their constituents have recently proved their fruitfulness in providing lesser phytotoxic, non animal toxic, more systemic, easily biodegradable and host metabolism stimulating pesticides (Fawcett and spencer, 1970; Jacoboson and Crosb, 1971; Beye, 1978; Dixit et al., 1978; Mahadevan, 1982; Yong &Tong, 1988; Mishra et al., 1992; Mishra & Dubey 1994; Dubey et al., 2000; Liu et al., 2001). Beye (1978) has emphasized that we must not overlook the fact that practically all natural pesticides are completely biodegradable within a short periods without leaving any residue and thus limit pesticidal pollution.

According to Wilson and Wisniewski (1989) "numerous opportunities are open for the development of biological control as an alternative to fungicides. Exploitation of natural plant products as fungicides should be expanded. Also a basic understanding of resistance and defense strategies in harvested commodities should reveal a multitude of new approaches for control of post harvest diseases." Of various types of fungicides used to combat storage diseases better control is expected with gaseous fungicides as they get more uniformly dispersed over a product than spray, wash, dip or dust treatment (Smith, 1962). Vapour emitting chemicals have been used with success against post harvest
diseases of fruits, vegetables and grains (Gaur and Ray Chaudhuri; 1970; Dang and Thakur, 1972; Prasad and Stadelbacher, 1973).

The volatility, ephemeral nature and biodegradability of flavor compounds of angiosperms will be especially advantageous if they are developed as pesticides (French, 1985). Further it has been noted that the volatiles do not leave any residue (Krishnaswami et al. 1974; Shethna and Rao 1981) and thus there may be least chance of residual toxicity by treatment of food commodities with volatile substance of higher plant origin. Recently volatiles obtained from higher plants (essential oils) have successfully been tested against a number of storage fungi (Chandra and Dikshit, 1981; Dikshit et al., 1983; Dubey et al. 1983a; Mishra and Dubey, 1994; Dubey et al. 2000).

Keeping these views in mind the present study has been undertaken to find out the potentiality of some volatile plant products (essential oils) as ecofriendly, natural pesticides against fungi (Aspergillus flavus and Aspergillus niger) and insects (Sitophilus oryzae and Tribolium castaneum) causing heavy deterioration of wheat during storage (Christensen, 1965; Mishra, 1992; Azam et al. 1994).

The study comprises:

- Survey of stored wheat sample for fungi and insects, responsible for their deterioration during their storage in different sets of conditions.
- Isolation of fungi and Insects from stored food commodities with the help of recognized technique and maintenance of their cultures.
- Isolation and screening of volatile Angiospermic plant products (essential oils) against dominant fungi and insects from stored samples and selection of active plant products.
- Standardization and Identification of active products (essential oils) by their physico-chemical properties, chromatographic studies and spectral data.
- Detailed in vitro fungitoxic and insecticidal investigations with active essential oils.
- Phytotoxicity of selected plant products

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• Animal toxic investigations with the active plant products, so as to find out effect of the constituents on different animal systems. This work would be carried out by feeding the treated feed of test animals for some periods so as to find out their chronic toxicity as well as investigation on acute mammalian toxicity of oils in form of LC_{50}.

• \textit{In vivo} studies with selected plant products.

• Fumigant activity of the oils in management of bio-deterioration of stored wheat caused by fungi and insects.