CHAPTER I

GENERAL INTRODUCTION
Man is cultivating plants from prehistoric times and since then he has been thinking about the improvement of crop production. The present day agriculture is the result of various improvements incorporated in the past agricultural practices. Now a days many of the developed and developing countries are self sufficient in their agriculture production but suffering with the non availability of the required quantity of food due to certain problems of post harvest management of their own agricultural produce. Besides these many countries are still suffering with the lack of required crop production and hence are looking towards agriculturally developed countries to meet out their annual food requirements.

The world's total agricultural production seems to be sufficient to fulfil the world's food requirements but a large portion of this produce becomes unsafe or lost during storages. According to the Food and Agricultural Organisation (F.A.O.) about 5 percent of the total grain, harvested throughout the world, is lost. In developing and under developed countries such losses can reach upto 15-20 percent or even more (Jain et al., 1994). According to Neergaard (1977) "The people need food not production statistics and a crop is not food until it is eaten". The
statement suggests the proper management of the agricultural produce is required during storage, transport/transit and marketing so that it reaches in good condition to the consumers or to the industries which process such produce to manufacture food by using raw food grains.

A lot of improvements have been done in agricultural practices for the safe and enhanced production of the food crops. However, this has became possible only after a sincere research by the scientists engaged in programme relating to the crop improvement, field management, pest control and production and use of better quality of agrochemicals. And to some extent we are now self sufficient in our agricultural production but due to unscientific storage, rodents, insects and microorganisms, about 10 percent of food grains is lost in India. The quantity so wasted is enough to feed at least 50 million people (Pingale, 1976). Christensen and Kaufmann (1969) stated that a programme to reduce storage losses may result in 10-20 percent increase in available food in some developing countries, and can assure that if any increase occur in production in future would be used for the nourishment of people not for feeding pastes.

Insects, rodents and microorganisms are the chief destroyers of the stored cereal grains. Insect and rodents consume grains and seeds and contaminate them with feces, webbing, body parts and microorganisms. Beetles and moths
are the most ruinous of the grain insects and many of them are capable of destroying the stored grains completely. Besides these, microorganisms are considered most undesirable because of their danger to public health and they destroy and contaminate a variety of foods, making them unacceptable for man's use (Sinha, 1974; 1975).

Amongst microorganisms, 'storage fungi' can be a sole cause of grain spoilage and substantially decrease the quality, grade and price of cereal grains and their products (Jain et al., 1994). The grains or seeds may also get deteriorated or becomes sick under field conditions by certain group of fungi and hence the grain invading fungi have been classified into two distinct groups, field fungi and storage fungi depending on whether they invade mainly before or after harvest. According to Christensen and Kaufmann (1965, 1969) field fungi are those that invade grain on the developing plants in the fields before harvest or after the crop is cut and swathed but before it is threshed. Common field fungi are *Alterneneria tenuis*, *Cladosporium herbarum*, *Curvularia* spp., *Fusarium* spp., *Verticillium* etc. Field fungi require at least 0.85 a_w for growth (Lacey et al., 1991). The field fungi may survive for years in dry grains (Christensen, 1963), but die rapidly in grains having moisture contents in equilibrium with relative humidity of 70 to 75 percent (Lutey and Christensen, 1963). By contrast storage fungi have
the ability to grow in materials whose moisture content are in equilibrium with 70 to 90 percent relative humidity at which no free water is present. The storage fungi comprise about 10 to 15 group species of *Aspergillus*, of which only five or six are most common that are involved in the deterioration of seeds, and several species of *Penicillium*. Some species of *Penicillium* are field fungi, others are storage fungi (Mislivec and Tuite, 1970). Storage fungi usually do not invade grain kernel before harvest in temperature regions but often do so in the tropics (Jain et al., 1994).

The storage fungi differ greatly in their temperature and water requirements. The predominant groups of storage fungi are as follows:

1. **Aspergillus restrictus** - This invades corn and wheat at moisture contents between 13.5-14.5 percent and can kill and discolour the germ or embryo. Grain spoilage caused by this group species is not accompanied by a temperature rise (because it grows too slowly) or with production of toxic metabolites.

2. **A. glaucus** - It discolours and kills seed embryo slowly. It grows well at 14.0-14.5 percent moisture content in corn and wheat and at 14.5-15.0 percent in sorghum. This causes an appreciable rise in temperature. Some isolates of this group are producing toxic metabolites in pure culture in laboratory but no ill effects in
rats and chicks are reported when fed ration contaminated with this fungus.

(3) **A. candidus** - The lower limit of moisture for the growth of this group of fungi is 15.0-15.5 percent for wheat and corn. As with *A. glaucus*, most isolates produce no ill effects on rats and chicks when fed with *A. candidus* infested grains.

(4) **A. ochraceus** - The limit of moisture content required in grains for its invasion is similar to *A. candidus*. It kills and discolours germ. Some isolates produce ochratoxin(s) which possess toxicity similar to aflatoxins.

(5) **A. flavus** - The lower limit of moisture for growth is 18.0-18.5 percent for wheat and corn. 17.0-17.5 percent for soybeans. It kills and discolours germ and decays whole kernel. It can cause heating up to 50°-55°C. Some isolates of this group produce aflatoxin(s).

(6) **Penicillium spp.** - Species of *Penicillium* discolour germ and the whole kernel. It can also kill the germ. These may cause mustiness and caking in grains. They require low temperature and moisture content more than 18 percent in corn and wheat for growth. Some species of *Penicillium* are well known toxin producers.
Christensen (1978) classified damage to grain caused by storage fungi into seven categories, (1) decrease germinability, (2) discolouration, (3) heating, (4) production of mycotoxins, (5) mustiness, (6) caking and (7) total decay. However, the extent of damage depends much on the types of fungi and availability of suitable growth conditions for them. A number of microorganisms such as species of field fungi, storage fungi including mesophilic, xerophilic or xerotolerant, thermotolerant and thermophilic fungi, bacteria and actinomycetes are found associated with almost all types of agricultural products and hence, in the deterioration process involvement of all or atleast some different types of microorganisms is quite possible. While studying microflora of grain storages and the possible role of associated microorganisms, Clarke et al. (1967, 1969) identified five phases in the developing microflora in stored grains. According to them field fungi predominates the first phase, these decrease during second phase and are replaced in the third by yeast, and in the fourth phase typical storage fungi occur and by spontaneous heating of the grain the growth of the thermotolerant and thermophilic organisms of the fifth phase are promoted (Clarke et al., 1967; 1969; Mulinge and Chesters, 1970; Lacey, 1971). The studies by above workers and those carried out by many workers on the ecology of grains storages in India (Hasiza, 1963; Gupta et al., 1970; Basu, 1974; Mehrotra, 1974; Shukla, 1990; Jain, 1992) suggest the
involvement of a variety of fungi in the deterioration of stored grains.

The wheat grains are the rich source of nutrients and that they are consumed by people in almost all parts of the world. Any change in the composition of these grains i.e. in the carbohydrates, proteins, oil, vitamins or minerals may affect the quality of the products prepared. Wheat quality is a relative concept and is usually judged by its suitability for a particular end use. Wheat grains are milled to obtain flour which is baked to obtain products like bread, biscuits and chapatties. The primary function of the food is to provide various nutrients required by the body and hence, the nutritive value of food refers to its potential ability to supply nutrients to the body. Any change in the quality of the grain, for which it has been cultivated, may fail to fulfil our basic need. And for this reason some supplementary foods are required to enrich food prepared using low grade or deteriorated grains.

The quality of wheat is generally described in terms of milling, baking and nutritional properties. The milling quality is related to the hardness of the grain. High flour yield and low ash content are two important parameters by which the milling quality of wheat is judged. Insects and microorganisms cause reduction in the extraction of high grades of flour in proportion to the degree of infestation (Liscombe, 1962; Loegering et al., 1967; Mehdi
et al., 1973; Verma et al., 1981; Chavan and Kadam, 1985). The discolouration of seeds and germ are common damages by storage fungi (Christensen and Kaufmann, 1974) which may change the colour of the flour. Heating and caking of grains any affect milling quality very badly.

Dietary fibre in cereal grains is receiving much attention as an essential nutrient in recent years. The dietary fibre has beneficial effect on hypercholesterolemia and various intestinal disorders (Burkitt et al., 1974; Scala, 1976). Infestation of insects and moulds are affecting the yield and proportion of dietary fibres in wheat grains and also its quality. The non starchy carbohydrates are relatively unchanged by cooking and they are not readily digested by human digestive system (Scala, 1976). Hence these are called "unavailable carbohydrates" made up of crude fibre (cellulose and lignin), hemicellulose and pectic substances. These are often referred to as 'dietary fibre' and hence these are not the same as crude fibre content.

The baking quality of wheat depends upon a number of factors including genetic, processing and environmental. Baking quality of flour is adversely affected due to storage (Salunkhe and Adsule, 1985). Insect pest infestation encourages fungus growth in grains by increasing moisture content and thus lowers bread making quality (Pingale, 1953; Subramanyam et al., 1954) perhaps due to change in the
gluten content of the grains (El-Dessouki and El-Kifl, 1976).

The literature indicates that more emphasis has been given to prevent quantitative losses in food grains (U.S. Department of Agriculture, 1965; Sinha and Wallace, 1966; Wilbur, 1971; Mphuru, 1976; Bulla and Niernberger, 1977; Simwat and Chahal, 1982), to study the ecology of grain deteriorating microorganisms (Sinha, 1973; 1979; Wallace, 1973; Christensen and Kaufmann, 1974; Neergaard, 1977; Christensen, 1978; Lacey et al., 1980; Hill and Lacey, 1983; Meronuck, 1987; Shukla, 1990) and on the mycotoxicology (Shotwell et al., 1970; 1973; 1976; Scott et al., 1972; Hesseltime, 1974; Davis et al., 1975; Wyllie and Morehouse, 1977; 1978; Bilgrami, 1983). The importance of preserving nutritional quality of grain is not always realised. Many beetles and moth larvae feed principally on germ portion of grain (Salunkhe and Adsule, 1985). Similarly field and storage fungi are invading the germ of wheat and most cereal grains (Christensen, 1955; Fields and King, 1962; Christensen and Kaufmann, 1967; Chrispeel and Varner, 1967), however, these fungi differ in their time of invasion in grains. The germ is the main centre of biological activities during germination and seedling growth, besides this property, the germ is also considered as a major part of human food and nutrition (Mac Masters, 1962). It also enriched food by being rich in vitamins, proteins, fat and minerals (Fraser and Holmes, 1959;
D'Appolonia et al., 1971; Aykroyd and Doughty, 1970). The exploitation of germ as a source of nutrition and medicine have also been successfully achieved in some cereals like rice, wheat and maize (Mac Masters, 1962; Shurpalekar and Haridash Rao, 1977; Orthoefer and Sinram, 1987; Pillaiyar, 1988). It is used in the preparation of bread, biscuits, and cakes and for extraction of oil (Shurpalekar and Haridash Rao, 1977).

The protein content and its quality in wheat is important from its nutritional point of view. The protein content of wheat is affecting its milling and baking quality because it is responsible for dough making. The protein content of wheat ranges from 6-21 percent in different varieties (Mattern et al., 1970). The proteins are distributed in all the major parts of wheat kernel i.e., pericarp, germ and endosperm. In all, four different types of proteins i.e. albumin, globulin, gliadin and glutenin determine the quality of wheat. Amongst these, glutenin and gliadin are necessary for gluten formation. The covalent bonds are said to be responsible for maintaining gluten structure (Khan and Bushuk, 1978). The structure and the colloidal property of gluten determines the baking property of wheat flour. Glutenin gives solidity to gluten while gliadin is responsible for binding (Adsule, 1985). Bietz and Wall (1981) reported the involvement of at least 6 major types of wheat proteins in gluten formation. Besides proteins, essential amino acids are also important
constituents of the wheat grains.

Lipids of wheat kernel amounts about 20 percent of the weight of the wheat flour and they determine the dough properties, baking behaviour and retardation of bread staling (Mac Ritchie, 1981). Any change in the proportion of polar and non-polar lipid fractions of wheat flour can cause substantial change in bread loaf volume. The lipid content is found more in germ than any other region of the wheat kernel. Wheat lipids have a high proportion of unsaturated and nutritionally important essential fatty acids (Davis et al., 1980).

Nutritional quality of wheat is affected greatly in the growing crop by certain crop diseases (Chavan and Kadam, 1985), and by growth regulators (Desai and Sangle, 1985). Infestation of grains by insects and microorganisms during storage are also known to damage cereal grains (Christensen and Kaufmann, 1974; Neergaard, 1977). However, much attention has not been paid to the loss caused by different fungi to the different constituents of grains at various level of fungal growth on them. Any change in the chemical composition of the grains by storage fungi during storage may lead the problems of malnutrition in human population. The change in nutritional quality need not necessarily be occur with the visible moulding on grains and hence it becomes difficult to assess the quality of such deteriorated seeds or grains during marketing. The
present study is an attempt to assess the fungal contaminants of different wheat varieties and the effect of fungal contaminants on the chemical composition of grains at different water content.

Treatment of grains prior to storage can minimise the loss of quality in them. To achieve this the treatment of the grains prior or during the storage should be in such a way so that it can minimise the chance of early deterioration of the product concerned and that it should not change the property of the product itself. Keeping this in view a pilot experiment has been conducted to investigate the effect of UV radiation on the naturally occurring microflora of the wheat grains and to see whether these radiation can be of any use for the safe storability of cereal grains.