CHAPTER-I

INTRODUCTION

Wheat (*Triticum aestivum* L.) the versatile cereal food is also described as the stuff of life. It continues to retain this pride of place with its roots ramifying into the depths of human culture with evolutionary history parallel with the human civilization itself. Even today, it occupies primary position among all the cereal crops due to its feeding bowl to mankind. It is estimated that more than 35 per cent of the world population depends on wheat (Bourlaug, 1968 and Johnson *et. al.*, 1978) as it supplies more nutrients particularly essential amino acids than any other single crop (Ranum *et. al.*, 1990). Wheat is cultivated over a wide range of climatic conditions and therefore understanding of genetics is of great value for genetics and plant breeding purposes.

Globally, India is the second largest producer next to China with maximum area under wheat. However, in terms of productivity, it ranked thirteenth and marginally less relative to world average. Analysis on year-to-year growth indicated that the overall production in the country has increased by 2.57 per cent. Though acreage increase is the major reason for the historic production, yield in traditional and large wheat growing states like Punjab, Haryana and Madhya Pradesh have shown a rise which is a good sign for the central grain pool. State wise analysis indicated that Uttar Pradesh has registered the highest production (30.24 million tonnes), followed by Punjab (17.04 million tonnes), Madhya Pradesh (13.93 million tonnes) and Haryana (11.80 million tonnes). These top six states together contributed around 91 per cent of the total wheat production in the country. Among states, Madhya Pradesh alone produced additional 7.94 lakh tonnes (6.05 %) wheat in 2013-14 followed by Gujarat and Haryana. Despite increased acreage, production in Uttar Pradesh witnessed a fall by 0.6 lakh tonnes which is mainly due to the decline in yield. State wise analysis on acreage indicated that Uttar Pradesh holds the prime position (9.96 million hectares), followed by Madhya Pradesh (5.79 million hectares), Punjab (3.51 million hectares), Rajasthan (2.81 million hectares), Haryana (2.50 million hectares) and Bihar (2.26 million hectares). All these states together cover about 86 per cent of the total area in the country under wheat (Wheat Scenario, 2014).
During 2013-14 and 2014-15, the world production increased by 1 per cent (from 714 million MT to 720 million MT) and world trade decreased by 1.28 per cent, (from 156 million MT to 153 million MT), respectively (Commodity Profile for Wheat, 2016). India’s share in global exports was around 1.8 per cent in the year 2014-15.

Physical availability and economic accessibility of food are the most important criteria of food security. Induced mutations have played a great role in increasing world food security, since new food crop varieties embedded with various induced mutations have contributed to the significant increase of crop production at locations people could directly access. Some highlights are: rice in China, Thailand, Vietnam, and the USA; barley in European countries and Peru, durum wheat in Bulgaria and Italy, wheat in China, soybean in China and Vietnam, as well as other food legumes in India and Pakistan.

Induced mutations have been extensively used in crop plants both for basic and applied research. In the past, these mutations were utilized for crop improvement leading to the release of more than 3200 mutant varieties (http://mvgs.iaea.org/), which included 274 varieties of wheat (*Triticum aestivum* L.). There are many other reports of interesting and useful induced mutations in wheat (Plant mutation report, 2013). The wheat cultivar ‘Sharbati Sonora’, a mutant of ‘Sonora 64’, released in 1967, had better acceptance for grain colour by the consumer in the early years of the ‘Green Revolution’ in India (Ahloowalia *et. al.*, 2004).

Plant breeding requires genetic variation of useful traits for crop improvement. Often, however, desired variation is lacking. Mutagenic agents, such as radiation and certain chemicals, then can be used to induce mutations and generate genetic variations from which desired mutants may be selected. Mutation induction has become a proven way of creating variation within a crop variety. Treatment with mutagens alters genes or breaks chromosomes. Gene mutations occur naturally as errors in deoxyribonucleic acid (DNA) replication. Most of these errors are repaired, but some may pass the next cell division to become established in the plant offspring as spontaneous mutations.

It offers the possibility of inducing desired attributes that either cannot be found in nature or have been lost during evolution. Breeding for improved plant cultivars is
based on two principles: genetic variation and selection. Induced mutagenesis has been practiced with great success in crop breeding programmes in developing countries since the 1930s. In plant improvement, the irradiation of seeds may cause genetic, variability that enable plant breeders to select new genotypes with improved characteristics such as precocity, salinity tolerance, grain yield and quality (Ashraf, 2009).

Mutation breeding is relatively a quicker method for improvement of crops (Hirjana et. al. 2007). Hundreds of useful mutants have been induced for various plants characters in variety of crop including wheat through treatment with physical and chemical mutagens (Din et al. 2003 and Morten et. al. 2006). The use of the ionizing radiation technology may be considered as a revolution in agronomic research, especially in plant breeding and crop production (El-Bazza Zaiab et. al. 2000 and Khan et. al. 2003). Gamma rays in particular, are well known with their effects on the plant growth and development by inducing cytological, physiological and morphological changes in cell and tissues (Thapa, 2004).

Gamma rays belongs to ionizing radiation and are the most effective electromagnetic radiation, having the energy level from around 10 kilo electron volts (keV) to several hundred keV (Kovacs and Keresztes, 2002). Therefore, they are more penetrating than other types of radiation such as alpha and beta rays. There are several usages of nuclear techniques in agriculture. In plant improvement, the irradiation of seeds may cause genetic, variability that enable plant breeders to select new genotypes with improved characteristics such as precocity, salinity tolerance, grain yield and quality. Ionizing radiations are also used to sterilize some agricultural products in order to increase their conservation time or to reduce pathogen propagation when trading these products within the same country or from country to country. The most distinct advantage of gamma radiation source for prolonged treatments is that it can be placed in a greenhouse or field so that plants can be exposed as they develop over long periods of time. Cobalt-60 and Cesium -137 are the main sources of gamma rays used in mutation breeding. They are stored in lead containers when not in use and operated by remote control mechanisms to irradiate plant material.

Gastafason (1940), Gaul (1961) and Swaminathan (1963) classified induced mutation into two broad categories i.e., (i) “Macro mutation” have large effect and
affecting quantitative characters and, (ii) “Micro mutation” having small effect and affecting qualitative traits. During the last five decades, there have been large numbers of report on induction of macro-mutation in different crop plants. Induced mutation provides a powerful means of creating new and useful variability in crop plant both in qualitative and quantitative characters.

A number of physical and chemical mutagens have been used to induce genetic variations in crop plants. The mutagens are primarily grouped into two broad categories; i) physical mutagens like α, β, γ and x-rays, thermal neutrons and UV radiations, which act on DNA by breaking hydrogen bonds and sugar-phosphate moiety and ii) chemical mutagens which are sub grouped into alkylating agents like Ethyl Methane Sulphonate (EMS), acridine dyes, base analogues, hydroxylamine and nitrous acid. The nature of alteration of genetic makeup (deletions, insertions, rearrangements and point mutations) depends on the specific mode of action of a particular mutagen. They usually generate mispairing, base pair substitutions and small deletions and insertions in genomes. Larger deletions, insertions and rearrangements of DNA fragments may also occur based on dose level and treatment time that can result in the loss-of-functional alleles. The point mutations can create series of effects, which may be hypomorphic (decreased gene function), hypermorphic (increased gene function) and neomorphic (novel gene function) effects. These sorts of point mutations are desirable in functional genomics experiments to characterize genes.

In general, the main goal for all plant breeding programs is achieving high amounts of yield (Ehdaie and Waines, 1989) and in order to this point, having genetic diversity for the trait under selection with a higher heritability is essential (Falconer et al., 1996). Our understanding about nature of traits and influences of genetic and environmental factors on desire traits also have important effects on breeding programs (Mohammadi et al., 2010).

Grain yield is a complex character, which depends on it main components, viz., number of spikes per plant, spike length and number of grains per spike. These components are further dependent for the expression or reveal morphological and developmental traits, which are interrelated with each other and therefore the parents selected or the breeding program, aimed at increased seed yield should possess wide
range of genetic variation for the above said morphological and developmental character. Besides, it would be interest to know the magnitude of variation due to heritable component, which in turn would be a guide post in selection for the improvement of a population. In other word, for the improvement of any crop species, the knowledge of genetic variability for characters of economic importance and their heritability and genetic advance is of utmost importance in further breeding programmes.

Quality of wheat seeds is normally governed by inter play genetically, edaphic, environmental and biotic factors and it has to be preserved for longer period in storage by checking insect pests effectively without impairment of viability and vigour. Quality of seed is influenced by kind of crop management practices, storage conditions apart from physical, biochemical and physiological factors of seeds (Doijoide, 1988). Among these factors, storage condition plays a major role as it is associated with attack of storage pests and diseases under variable influences of temperature, relative humidity and seed moisture. Prevalence of fluctuating storage conditions not only cause significant deterioration in seeds but also make them useless for sowing in subsequent seasons. Time and again, attempts were made by several workers in different field crops to maintain viability, vigour and quality of seeds in storage for longer period by controlling insect pests at both pre- and post-harvest periods (Merwade, 2000 and Singh, 2003). Very little attention has paid in India regarding the storability of wheat seeds under ambient storage conditions.

The storage of food grain is practiced from the era of the beginning of civilization. It is an important problem because the production of grain crops is seasonal and location specific (Sawant, 1994); however, consumption of food grain is throughout the year and is not location specific. Storage of food grain is necessary in order to ensure constant supply for the year and also to provide to distant areas. Primary aim of storage is simply to prevent deterioration of the quality of grain. This is done indirectly through the control of moisture and air movements, and through preventing attack of microorganisms, insects and rodents. Farmers throughout the world, in every country at hot or cold climate store grain. They may store in traditional storages like earthen pots, in pits or in a granary, or modern storages either in bulk or in reasonably sophisticated storages. They store some large quantity of grain.
Seed being hygroscopic in nature, is bound to deteriorate fast in storage due to fluctuations in atmospheric conditions. This deterioration can be arrested effectively by storing seeds in suitable storage containers under ambient conditions. The seeds stored in moisture proof containers like polythene bag, aluminum foils *etc.* are found to retain viability and vigour for longer period compared to those stored in moisture pervious containers like cloth bag, gunny bag, *etc.* (Singh and Singh 1992, and Singh *et. al.*, 1988).

Seed deterioration occurs during storage, leading to reduction of vigor, germination per cent, and decreasing seedling growth rate. Temperature and moisture content are the important factors, which influence the viability of seeds during storage (Roberts, 1972). Seed viability and vigor decreased with prolonging storage period. Electrical conductance of seed leachates also increased with storage under unfavorable conditions. Packaging container and storage duration significantly affected viability and seedling vigor (Rao *et. al.*, 2006).

In view of foregoing points, appropriate technology for successful improving variety with desirable seed quality parameters and storability of wheat seeds need to be developed. Investigations were therefore conducted to Genetic Studies on Seed Quality Parameters and Yield Attributing Traits in Induced Population of Wheat (*Triticum aestivum* L.) with the following objectives.

1. To estimate the magnitude of genetic variability in the population generated through mutation for different characters
2. To determine of LD$_{50}$ dose of induced population of wheat
3. Determination of efficiency and effectiveness of mutagens used in the present study
4. To estimate the direct and indirect effects of various characters on yield in induced populations and
5. Effect of packing material on seed quality parameters (seed viability and vigour) of gamma rays induced wheat mutant seeds after storage at different time intervals.