CHAPTER I

INTRODUCTION

Wheat is one of the most important cereal crops in terms of acreage, production and as staple food for over one third of the world population. It is being grown in a wide range of climates. Wheat is being cultivated over 215.27 million ha in the world with an annual production of 583.62 million tons and productivity of 2711 kg/ha. In terms of both area and production, India ranks second among the wheat growing countries in the world, covering an area of 27.45 million ha and total production of 73.14 million tons with 2583 kg/ha productivity.

Wheat is the first important cereal crop of rabi season in Uttar Pradesh. It occupies 9.39 million ha area in U.P. with total production of 25.97 million tons and its total productivity 2764 kg/ha (Anonymous, 2001).

The breeding of wheat by traditional methods has been practiced for centuries and numerous varieties are produced every year around the world. Conventionally, plant breeders recombine the desired genes from donor genotypes and related species by sexual hybridization and develop new cultivars with the desirable traits such as high yield and resistance to biotic and abiotic stresses. They are now faced with an even greater challenge to sustain food production for
the ever-growing human population. Now there is stagnation in the production potential of present improved varieties. It is largely due to recycling of selected genotypes. Since the success of a crop improvement programme depends on the extent of genetic variability in base population, various innovative approaches are being contemplated to bring forth novel variation and exploit it in breeding high yielding and resistant cultivars. Thus, there is an urgent need to employ unconventional methods for supplementing these efforts to sustain the progress in genetic amelioration.

*In vitro* technology undoubtedly complements the conventional method of wheat breeding in generating genetic variability. The adoption of new technology such as plant tissue culture may help in achieving some of the goals to increase food production. There is a great potential of cell and tissue culture techniques in plant improvements, provided plants can be readily regenerated in large numbers. Tissue culture induces variation in regenerated plants which is called somaclonal variation (Larkin and Scowcroft, 1981). It can result in a range of genetically stable variation, useful in crop improvement. In crop species where the creation of genetic variability through sexual reproduction is difficult, somaclonal variation along with mutagenesis is the most likely way to generate variability for crop improvements. The tissue culture techniques employed for induction of somaclonal variation are relatively easier than recombinant DNA technology.
Crop improvement with conventional and non-conventional breeding methods has proved very difficult and expensive.

Somaclonal variation appears to be proper technology for genetic manipulation of some crops. The application of somatic tissue culture methods in cereal improvements involves development of regenerative tissue cultures. Superior plant regeneration depends on the production of embryogenic callus. In wheat several explants like immature inflorescences (Caswell et al., 2000), immature embryo (Shrivastava et al., 2000), mature embryo (Ozgen et al., 1998), immature leaves (Rajyalaxmi et al., 1991), anthers (Sehrawat et al., 2002) and shoot tips (Viertel and Hess, 1996) have been tested for callus initiation.

The most frequently and successfully used explant for the initiation of embryogenic cultures are immature embryos. The success of callusing and plant regeneration is variable and the differences are attributed to the origin of explants, to genotype and age of callus. Besides these, the composition of nutrient medium and culture conditions may be relevant regarding the origin of somaclonal variations. Exposure of cells to high levels of exogenously supplied phytohormones, like 2,4-D, BAP and NAA etc. and other chemicals in the culture medium are major factors involved in the induction of somaclonal variations.

Wheat, being an annual plant, immature embryos are available only within a brief period of two months. The callus derived has to be maintained and
differentiation should be induced only at a time when transplanting to soil can be done with reasonable success. Hence, callus should be maintained from April to October when differentiated plant could be transferred in appropriate season.

Somaclonal variation is recognized as a novel technique and valuable source of variability. It assumes greater significance in crops as changes can occur at a high frequency in important agronomical and physiological traits such as plant height, tillers per plant, days to maturity, length of spike, 100-grain weight, grain yield, biological yield, harvest index, leaf area index and photosynthetic rate. The occurrence of somaclonal variation also depends on the number of subcultures. Tissue culture system itself act as a mutagenic system because cells experience traumatic experiences from isolation and may reprogramme during plant regeneration which are different than under natural conditions and creates a wide range of variation in newly regenerated plants. In some cases explants have been also treated with γ-irradiation or with EMS before culturing. Plant tissue culture allows the plant cells to grow in an unorganized manner. This removal of organizational coherence results in a genomic instability which leads to chromosomal aberrations (Karp and Maddock, 1984; Chen et al., 1981), mutations (Evans and Sharp, 1983), activation of transposable elements and gene amplification. Larkin (1985) speculates that in higher plant genomes, a portion of the stored genetic information is not expressed. He suggested the genomes of crop
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species may be manipulated in order to express previously untapped genetic information and that such a process may be in operation in somaclonal variation.

Somaclonal variation has a vast potential for inducing genetic variation. Somaclonal variation results in the production of new genotypes, with a limited change in the original genomes and within short time. This type of variation may be transmitted to the next generation. Therefore, it may be necessary to study the transmission of variation to sexual progeny (R₁) to facilitate the estimation of its utility for improvement of crop. Potential application of somaclonal variations have been proposed as a supplementary tool to obtain well established breeding approaches for crop improvement, since earlier studies showed that somaclonal variation could take place frequently and might stabilize within a few generation (Larkin et al., 1983; Evans, 1984). A comprehensive survey (Ahloowalia, 1986) indicated that the frequency and type of somaclonal variation in cereal crops were low and undesirable. On the other hand, success in improving wheat plants by inducing somaclonal variation has been reported by Lazar et al. (1988), Veilleux and Johnson (1998). Recently a somaclonal variant wheat variety HEZU8 has been officially released for commercial production (Gao et al., 1991). Keeping the above considerations in view, the present study was planned with the following objectives: