INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most cereal crop widely grown in the world (www.FAO.org). In Egypt, wheat has been considered the first strategic food crop. Therefore, increasing wheat production becomes an important national goal to reduce wheat imports, save foreign currency, and provide enough food to meet increasing domestic demand. It was anticipated that high and stable wheat yield could be achieved if wheat improvement emphasis is directed to solve the problems of non availability of appropriate varieties possessing high resistance and / or tolerance to rust, salinity, drought and heat.

In wheat breeding programs, the choice of parents is the most important step in the development of adapted varieties to biotic and abiotic stresses. In Egypt, wheat rust diseases are still the main factor for eliminating and decreasing the longevity of Egyptian wheat cultivars. Out of the three rust diseases of wheat, the most common one is called leaf or brown rust caused by *Puccinia recondita* f. sp. *tritici*. Epidemics of this disease can lead to severe losses of grain yield and decreased nutritional quality. Some studies in Egypt have estimated crop losses due to leaf rust infection to be up to 50% (Abdel Hak *et al*., 1980).The use of resistance genes is an effective, economical and ecological method to control epidemics of leaf rust disease. More than 45 different resistance genes derived from wheat and related species to wheat have been described (Knott 1989; McIntosh *et al*. 1995) and used in wheat breeding (Johanson and Lupton, 1987).

There are two main breeding strategies to improve leaf rust resistance: pyramidization of the major resistance genes (*Lr* genes) conferring complete resistance and/or the accumulation of minor resistance genes conferring quantitative resistance. For some of the leaf rust resistance (*Lr*) genes, molecular markers have been developed for marker-assisted selection in breeding (Feuillet and Keller 1998).

In recent years dense genetic linkage maps have been constructed for many crop-plant species by means of molecular markers that identify heritable polymorphisms at the DNA level. Such maps may be used for localizing and manipulating important genes and Quantitative Trait Loci conferring agronomically useful traits, for examining ancestral rearrangements relevant to adaptation, and for phylogenetic investigations into crop origins. Maps presently exist for several species, but the map in bread wheat has not reached the same level of advancement owing to the large size and low level of polymorphism of the wheat genome.

One of the important applications of DNA markers is the prediction of heterosis in hybrids. Evaluation of hybrids for heterosis or combining ability in the field is expensive and time-consuming. For this reason, other parameters such as pedigree information, qualitative and quantitative traits and biochemical data (Leonardi *et al.,* 1991 and Wang *et al.,* 1992) are being used to study heterosis. DNA markers have also been extensively used to correlate genetic diversity and heterosis in several crops such as maize (Parentoni *et al.,* 2001), rice (Zhao *et al.,* 1999), oat (Moser and Lee 1994), barley (Melchinger *et al.,* 1990) and chickpea

(Sant *et al.*, 1999).

Microsatellite loci, also referred to simple sequence repeats (SSRs) have proved to be a valuable source of highly polymorphic DNA markers. SSR polymorphisms are based on differences in the length of simple sequence repeats at loci defined by locus-specific PCR primers flanking the microsatellite. The latest version of wheat genetic/physical map containing over 1400 total loci and primers (probes) details is available with GrainGenes Web site (http://wheat.pw.usda.gov).

Bulked segregant analysis (BSA) is a method to identify molecular markers linked to a gene of interest without having to construct a map of the genome (Michelmore *et al.*, 1991), which is considered the first goal in marker-assisted selection. BSA has been used successfully to develop RAPD markers for wheat resistance to yellow rust (Chen *et al.*, 1998).

In this investigation, some wheat genotypes were tested for their yielding ability and leaf rust reaction under Nubaria conditions (Nubaria is considered as a hot spot for leaf rust). Crosses among these genotypes were conducted using diallel technique by Griffing (1956). The main objectives of the research work presented in this thesis were :

1- Evaluation of parental genotypes for their yielding ability and leaf rust reaction under local conditions.

2- Studying the heterosis, general and specific combining ability and correlation for yield and yield components.

3- Detecting genetic polymorphism among the studied genotypes.

4- Assessment of the usefulness of microsatellite markers as predictors of the amount of specific combining ability and heterosis.

5- Tagging and mapping of the important leaf rust resistance gene (*Lr26*) with SSR markers using F_2 population.