Chapter 1

Introduction

Since man cannot live from bread alone, almost three quarters of the earth's land surface is used for grain production. Human populations have grown at a vast rate in the last fifty years. According to census done (www.bbc.co.uk/.../geography/population, Retrieved in August, 2007) the world's population exceeded the six billion mark in 1999-2000. The top plant product consumed by people are cereals, where 2 064 178 metric tons are produced per year. Second to cereals are roots and tubers with a production of 649 994 metric tons per year. This indicates that cereals are used as the primary food source for man and domestic animals. Approximately 120 000 to 130 000 metric tons of barley are produced per year with 50 000 hectares devoted worldwide. The main use of this barley crop is for the production of beer (Simpson and Ogorzaly, 2001).

Grains are defined as seed-like fruit from the grass family *Poaceae*, where the seed coat is fused with the layers of the pericarp. There are approximately 9 000 grass species in the world, but only 35 species are used for the production of cereal. The word cereal is derived from the Roman goddess of agriculture, Ceres; and the cereal barley (*Hordeum vulgare*) belongs to the family *Poaceae* (Simpson and Ogorzaly, 2001). The origin of barley is understood to be in the south-western regions of Asia. Due to the mobility of populations between countries such as Egypt, Ethiopia and Asia, a variety of barley cultivars developed (Arnon, 1972).

There are three main uses for barley. Firstly, barley can be used for livestock feed. This includes all the lower quality yield barley that is produced. Although the barley seeds are not fit for other uses it still contains a high nutritional value (Arnon, 1972). According to Kent-Jones and Amos (1967), the dry weight protein and starch content of barley is higher than in wheat (*Triticum aestivum*). The second use of barley is for the production of beer where the high quality grain is used for malting. The third use of barley is for food products such as malt syrup, coffee and some breakfast cereals. Because of certain quality requirements for malting, such as the colour, size consistency, well-matured grain, decreased protein content, and low to no seed damage, most of the barley seeds are used for food purposes (Arnon, 1972).

Crop losses for barley occur due to seasonal changes, early sowing, close crop rotation,

pathogens and several other abiotic and biotic factors. Several pathogens that result in crop losses occur on barley. One of the most significant is *Fusarium graminearum* and it causes yield and quality losses across the world. It reduces the grain feed value and usage for malting. Furthermore, infected grain contains levels of mycotoxins and zearalenone, which causes hazardous effects in humans and animals (McMullen *et al*., 1997).

Pathogens can be divided into two groups. Necrotrophs are pathogens that kill the host and use the content of the host's dead cells as food. Biotrophs are pathogens that need the host to stay alive in order to complete their life cycles. *F. graminearum* tend to be biotrophic, switching to a necrotrophic life cycle (Goswami and Kistler, 2004). It infects cereals such as wheat, barley and rice, causing discolouration of kernels (KD) (Capettini *et al*., 2003). Viable conditions for *F. graminearum* infection occur between 24℃ - 26℃ and at 100% humidity (Booth, 1971).

Primary infection comes from mycelia over-wintering on plant debris. Mycelium and chlamydospores over-winter on the cereal, releasing conidia or ascospores when conditions are favourable (Parry *et al*., 1995). Infection usually occurs on the exposed spike after emergence from the sheath (Prom *et al*., 1999). The first signs of infection become visible as water-soaked brown spots. Infected kernels appear to have a brown tan colour (Goswami and Kistler, 2004). Later during the infection, pink-red fungal growth can be seen on the edge of the glumes (Booth, 1971).

The aim of this project was to study the interaction between *Hordeum vulgare* (barley) and *F. graminearum* (the causal agent of head blight / scab). This was done under two objectives:

- To isolate differentially expressed genes in barley by constructing an enriched library.
- Afterwards, transcripts were further studied through time trials to ascertain the induction levels of identified gene transcripts over time after *F. graminearum* infection.