PROJECT TITLE

The influence of elevated atmospheric [CO2] on physiology and yield of wheat cultivars accounting for 60 years of northern-European breeding

CONSORTIUM

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SUMMARY OF THE REPORT

The increase in atmospheric carbon dioxide concentration [CO_2] is one of the most evident climatic changes of the past ninety years (Trend in Atmospheric Carbon Dioxide 2019). It has been well established that the steady rise in [CO_2] will significantly influence crop production worldwide. The primary effects on crops include stimulation of photosynthesis by the 'fertilization influence' particularly in C_3 crops such as wheat (Ainsworth and Long 2005). At the same time, elevated [CO_2] reduces stomatal conductance (g_s) and transpiration (due to reduced stomatal aperture and a reduction in stomatal density). It has been proposed that in many species the increases in leaf temperature due to changes in g_s may be detrimental to photosynthesis and could alter whole-plant water use efficiency (Osborne 2016; Gray et al. 2016). Wheat, a key food crop globally, is predicted to be greatly influenced by the rise in [CO_2] and several reports suggest positive benefits in both yield and physiological performance (Christy et al. 2018).

Several studies have demonstrated a strong correlation between $g_s$and grain yield in crops (Roche 2015, Faralli et al. 2019a) grown at present atmospheric [CO_2], including wheat Fischer et al. 1998). These studies have illustrated that both stomatal control of CO_2 uptake for photosynthesis, evaporative leaf cooling and canopy temperature can account for these correlations. At the same time, evidence suggests that the compromise of reducing transpiration to save water might impact on plant performance through increasing leaf temperature Fischer et al. 1998). Therefore, it has been speculated that partial stomatal closure triggered by elevated [CO_2] might negatively impact wheat production under specific environmental conditions (Osborne 2016; Gray et al. 2016). The detrimental effect of a potential increase in leaf temperature following elevated [CO_2] has not been extensively explored, although recent work suggests that even leaf temperatures of 25°C can inhibit photosynthesis in plants acclimated to cooler temperatures (Yamasaki et al. 2002) such as wheat.

Breeding for yield improvement in wheat and subsequent assessment of physiological traits have been predominantly conducted at current ambient [CO_2]. There is evidence to suggest a significant increase in $g_s$has been the inadvertent result of breeding efforts in the last 70 years, however, this has never been demonstrated specifically in European and/or northern-European cultivars (see Roche 2015).

Therefore, the aim of this study was to re-evaluate these key physiological traits under elevated [CO_2] using FACE technology. Winter bread wheat cultivars representing 60 years of breeding were grown under current ambient and elevated [CO_2]. We hypothesized that the physiological response of photosynthesis and g_s to increasing [CO_2] in north European wheat was dependent on the year of release.