Variable O3 episodes’ influence on yield and physiology in old and new wheat varieties under a climate change regime with elevated temperature and CO2 levels

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Variable O₃ episodes’ influence on yield and physiology in old and new wheat varieties under a climate change regime with elevated temperature and CO₂ levels.

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Background
The impact of O₃ on crop yield is a concern at present climatic conditions and effects of climate change will aggravate this impact (Ainsworth, 2017; Tian et al., 2016). Responses to changes in climatic factors are results of interactions and within plant regulation following the changes in one or more of these factors but also depends on genetic predispositions (Albert et al., 2011; Clausen et al., 2011; Ingvorsen et al., 2015; Shaw et al., 2002).

The focus of this experiment was to investigate the growth and yield of three wheat varieties grown under different climatic and O₃-exposures conditions.

RERAFF Facility
The plant growth facility, RERAFF, includes six 75 m³ airtight chambers providing precision control of various climatic factors and air pollutants to mimic the impact of potential future climates and pollutant levels on plant growth.

Materials and methods
Of three spring wheat varieties five pots with 12 seeds were grown under conditions shown in Table X; two modern varieties: Lennox and KWS Bittern, and a landrace variety, Lantvete.

Pots were watered based on chamber temperature; pots at ambient started at 5200 g and ended at 7000 g over their growth cycle, while pots in warmer conditions received 200 g more water throughout the cycle. Water limited KWS Bittern in treatments A.O₃ and CT.O₃ were at all times watered to a total weight of 5400 g and 5600 g respectively.

O₃ exposure and uptake expressed as ‘AOT₄₀’ for treatments (lines) and ‘POD₆’ for varieties in treatments based on measured conductances, plant development, and O₃ concentrations. The treatment-induced need for stomatal opening is clearly reflected in uptake as well as in variety differences.

Water Use Efficiency at day 56 or 58 after sowing. The varieties display differences in the treatments, that may be anticipated from the temperature settings: warmer treatment leads to lower WUE. The addition of ozone disturbs the varieties differently depending on the climate treatment.

Dry matter yield / water consumption (right); the ratio of dry matter in the pots (g) to water consumed in the pots as evapotranspiration (g). In several of the treatments varieties show no differences, although the landrace variety seem to outperform the modern varieties in those where a difference is seen.

Yield: All varieties yielded best in the ambient (A) treatments. O₃ exposure impacted differently depending on variety and O₃ regime. In A-treatments, O₃-exposure resulted in yield reduction in modern as well as landrace varieties. In the warmer CT-treatments yields are reduced by the climate treatment and O₃-impact depends on O₃-regime and variety.

Summary: Spring wheat variety and O₃-regime interact with the climate treatments to determine yield under ambient and warmer climates; modern varieties display strong reduction of yield under ambient conditions where the landrace variety yield is equally reduced under episodic as well as chronic O₃-exposure. At the warmer treatments O₃-impact is less distinctly exhibited by variety and O₃-regime.