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DTU Chemical Engineering
Department of Chemical and Biochemical Engineering

Significant reductions in oil quality and lipid content of oilseed rape (*Brassica napus* L.) under climate change

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Despite of the potential importance to food and bioenergy purposes effects from climate change on plant oil quality have hardly been characterized. Worldwide *Brassica napus, r*apeseed or oilseed rape, is the second largest source of vegetable oil and the predominant oil crop in Europe. We found significant changes in oil quality and quantity of cultivars of oilseed rape grown in five future climate scenarios with elevated [CO_2], [O_3], temperature and combinations hereof (~RCP8.5, IPCC 2013).

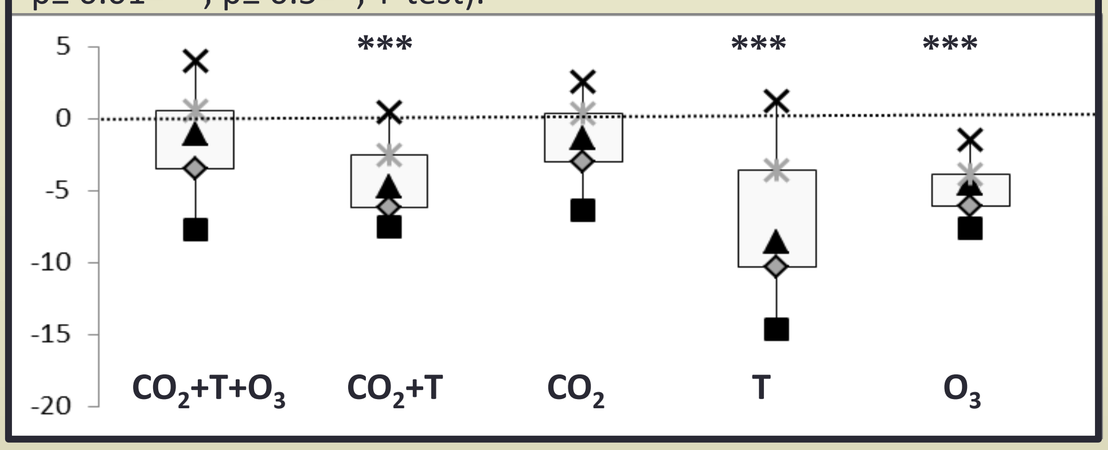
Populations of 4 oilseed rape cultivars were grown under ambient and 5 future climate change conditions in a climate-phytotron:

Treatment	CO_2	O_3	Temp.	Water
Multi	650 ppm	60/20 ppb	24/17 C	as ambient
Multi	650 ppm	20/20 ppb	24/17 C	as ambient
Single	650 ppm	20/20 ppb	19/12 C	as ambient
Single	385 ppm	20/20 ppb	24/17 C	as ambient
Single	385 ppm	60/20 ppb	19/12 C	as ambient
Ambient	385 ppm	20/20 ppb	19/12 C	ambient

The future climate decreased the content of lipid

The future climate scenarios decreased the content of total lipid in three of the treatments: When elevated [CO_2] and temperature were combined (10% decrease), and when elevated temperature (17% decrease) and ozone (11% decrease) were applied as single factors.

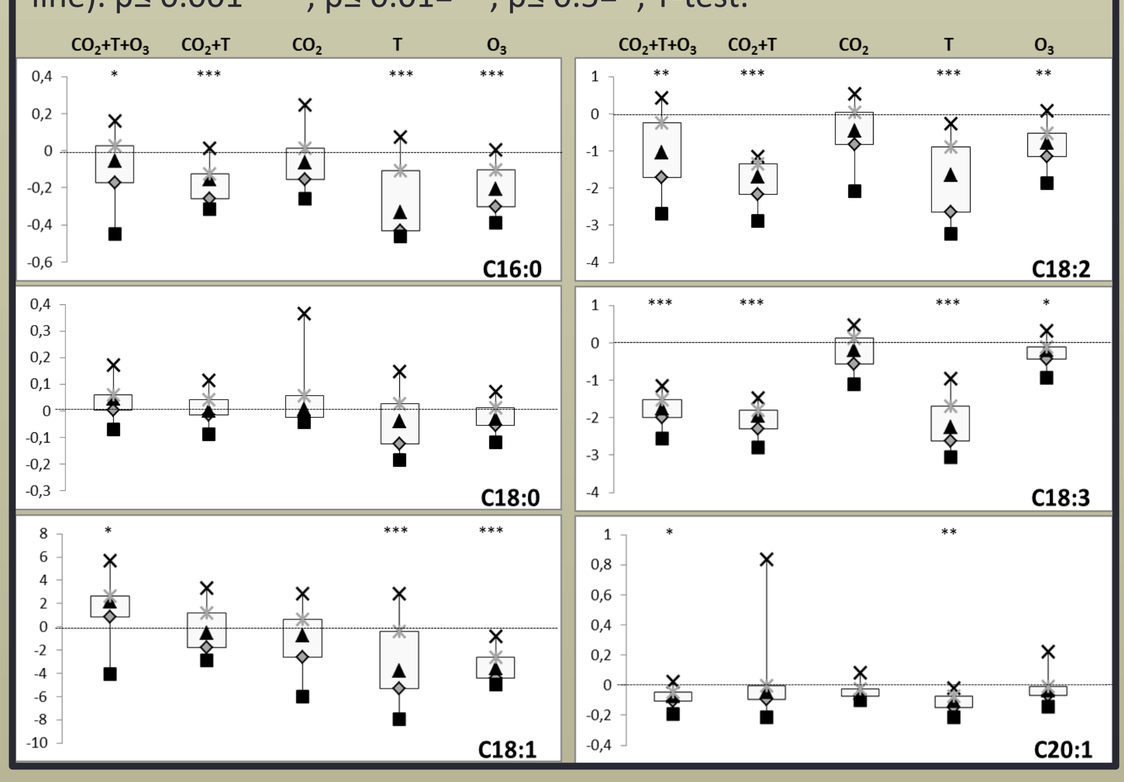
Effects of the future climate scenarios on total lipid in rapeseed (mg oil/100 mg seeds) given relative to ambient (0-line (p≤ 0.001 ***, p≤ 0.01=**, p≤ 0.5=*; T-test).



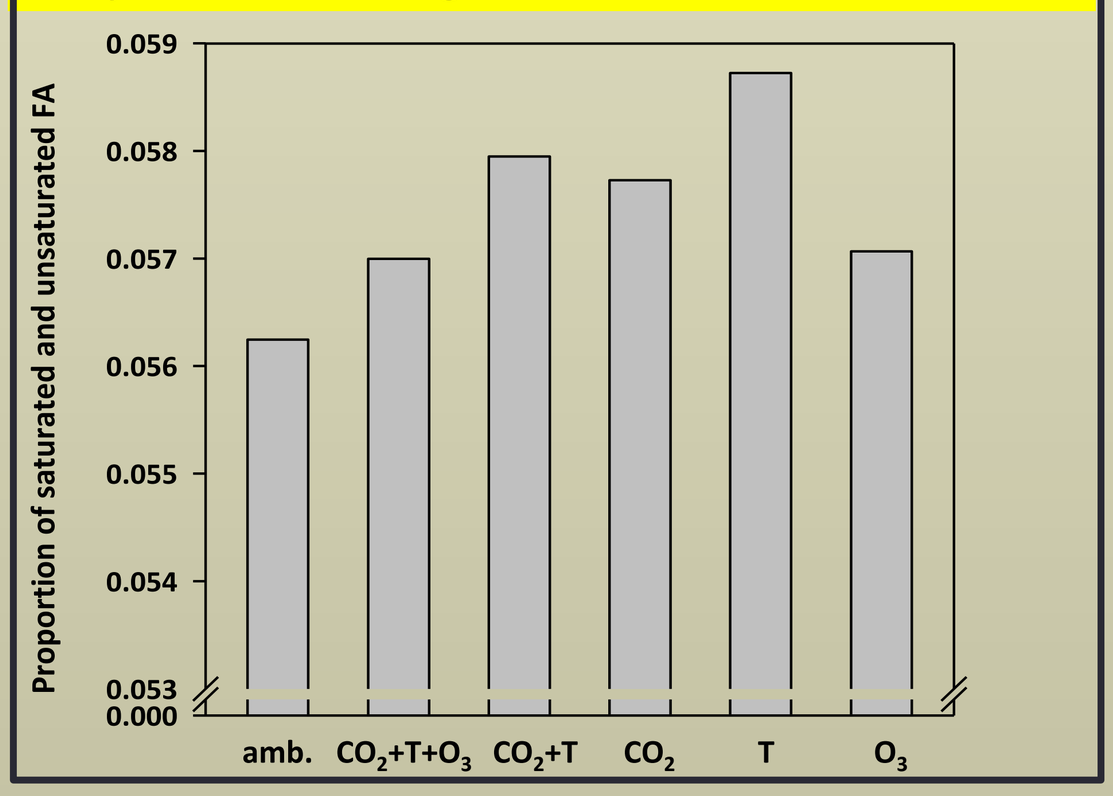
The oil quality was significantly reduced

- **Oil quality were significantly reduced except in the scenario with elevated [CO_2] alone.**
- **Of the six analyzed fatty acids five - oleic acid (C18:1), linoleic acid (C18:2), linolenic acid (C18:3, omega-3), palmitic (C16:0), eicosenoic acid (C20:1) - showed reductions, the only exception being stearic acid, C18:0.**
- **We found that in the two-factor treatment, where elevated [CO_2] and temperature were combined, the essential fatty acid omega-3, C18:3, decreased by 45%.**

Effects of the future climate scenarios on the fatty acid content of rapeseed oil (mg fatty acid/100 mg seeds) given relative to ambient (0-line). p≤ 0.001 ***, p≤ 0.01=**, p≤ 0.5=*; T-test.



The proportion between saturated and unsaturated fatty acids was changed



Total losses in fatty acid and oil yields would be even larger considering reported reductions in seed biomass in these future scenarios (Frenck, 2011, 2013): When [CO_2] and temperature are elevated simultaneously, the oil yield per ha will drop 58% and the production of omega-3 (C18:3) will be reduced by 77% per ha. Breeding for climate tolerant cultivars seems essential for oil yield and quality.

Frenck G, Linden LD, Mikkelsen TN, Brix H, Jørgensen RB (2011) Increased [CO_2] does not compensate for negative effects on yield caused by higher temperature and [O_3] in *Brassica napus* L. European Journal of Agronomy, **35,** 127– 134.
Frenck G, Linden L, Mikkelsen TN, Brix H, Jørgensen RB (2013) Response to multi-generational selection under elevated [CO_2] in two temperature regimes suggests enhanced carbon assimilation and increased reproductive output in *Brassica napus* L. Ecology and Evolution, **3,** 1163–1172.