

# Science for Environment Policy

## CO<sub>2</sub> and ozone affect wheat's nutritional quality

**Predicting the effects** of changing levels of atmospheric gases on agricultural crops is vital to ensuring food security under global environmental change. As well as yield, impacts on the nutritional value of crops must be considered. A new study has now shown that increased ozone decreases yields and increases the proportion of protein in the grain. Conversely, elevated levels of CO<sub>2</sub> boosts wheat yields, but it also reduces protein proportion in two different ways.

**Concentrations of both CO<sub>2</sub> and ground-level ozone**, a toxic pollutant, are predicted to rise in the coming decades, and their impact on [agriculture](#) and food supply is of increasing concern. While we may be able to adapt to an increase in CO<sub>2</sub> (through plant breeding), adapting to increased ozone is not possible. However, ozone levels can be controlled to some extent, for example, by phasing out ozone depleting substances. Although past research has demonstrated that CO<sub>2</sub> increases wheat yields but ozone reduces them, the impacts on the nutritional value of the crop are not well understood.

In this study, researchers assessed the exposure of wheat to different levels of CO<sub>2</sub> and ozone, based on evidence from 57 existing studies. The studies covered 24 different varieties of wheat across 11 countries, and considered the effects of both reduced and increased CO<sub>2</sub> and ozone concentrations.

CO<sub>2</sub> is known to increase yield, however, the researchers also assessed its effects on the proportion of the yield that was made up of nitrogen-rich protein, an important nutrient. They found that, although elevated CO<sub>2</sub> did increase overall yields, there was a 'growth dilution' effect. This effect means that although the overall amount of wheat increases, the proportion of protein in grains is reduced, because, under these conditions, the plant does not increase its nitrogen uptake at the same rate as its growth.

When examining the effects of ozone on wheat, the researchers found that the opposite was true. Under increased ozone concentrations, overall yield falls but the proportion of protein in the wheat grains increases. CO<sub>2</sub> and ozone affect yield via different routes; elevated CO<sub>2</sub> leads to an increase in the number of grains, but has no effect on size, while elevated ozone reduces yield as a result of smaller grains, but does not affect the number of grains.

The researchers were also able to go beyond these results to make the novel discovery that CO<sub>2</sub> reduces nutritional value, not just via growth dilution, but also through another process. When they compared the response of yield of grain with the response of protein proportion of that yield, they could see that the growth dilution effect alone could not explain the total protein reduction under elevated CO<sub>2</sub> as protein content was reduced also in the absence of growth enhancement.

The exact cause behind this added effect of CO<sub>2</sub> on protein content is not yet clear; however, some studies have suggested that plants become less efficient in taking up nitrogen from the soil and converting it to protein under elevated CO<sub>2</sub>. The researchers therefore note that more studies are needed to assess the interactive effects of changing levels of CO<sub>2</sub> and ozone on crops.



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