# Webinar: Ozone pollution in tropical agriculture

# 29th September 2021

# Q & A.

**Answers prepared by Felicity Hayes and Mike Perring**

## Session 1 (Asia and Africa)

**Q1: Is there is any simple equipment to measure ambient ozone:**

A1: Handheld ozone analysers can measure ambient ozone, but cannot be left outside for long-term recording, only give the current reading, and generally do not store data (some have data logging capability). Some do not have good accuracy and precision at low concentrations.

Continuous / regular monitoring of ozone requires the use of ozone analysers, which require a power source (although this could be a car battery in some cases). These analysers are generally based on UV absorbance. These analysers still need to be inside waterproof housing and are relatively expensive.

As outlined in the main webinar, it is also possible to use passive diffusion tubes. These give an integrated measure of ozone concentrations over the time period of their deployment, which is typically 4 weeks.

If you are interested in finding out more about these different options, or where they can be accessed, please contact Mike Perring (mikper 'at' ceh.ac.uk).

As also noted in the main webinar, and if e.g. your main focus is on effects of ozone rather than its direct measurement, you can assess the likely presence of ozone indirectly e.g. through the use of sensitive species or ozone gardens

**Q2: Are water-soaked areas on the leaf characteristics symptoms of ozone pollution?**

A2: This symptom is more often associated with bacterial infection. However, ozone causes damage to the cell structure within leaves, potentially causing cell death but also water leakage. In experiments at Bangor, we have not observed water soaking symptoms in crops at different ozone levels. The LearnWorlds course on Ozone and Tropical Agriculture, launching soon, will provide more details and examples of typical ozone injury symptoms: Ozone and Tropical Agriculture | UK Centre for Ecology & Hydrology (ceh.ac.uk)

**Q3: How to differentiate injury caused by ozone or by pathogen?**

A3: This is difficult to answer without knowing what pathogen is being referred to. We give some general points below.

In general, ozone damage and fungal damage can be differentiated. Fungi tend to leave multiple spots of similar size. There will be a strong border region to the spot. You may also have fruiting bodies within the spot, and/or rings or haloes – concentric circles around the spot. **None of these features are characteristic of ozone injury.**

Viruses can change leaf vein colour. **This would not be observed with ozone damage.**

Moulds on leaves can also be easily differentiated from ozone damage. **Ozone damage can not be rubbed off or washed off.**

The LearnWorlds "Ozone in Tropical Agriculture" course, soon to be released, will have a module jointly developed by UKCEH and CABI comparing and contrasting ozone damage symptoms with those left by other crop plant stressors. There is another module concentrating on how ozone affects crop plants, including the visual damage: Ozone and Tropical Agriculture | UK Centre for Ecology & Hydrology (ceh.ac.uk)

**Q4: Can Stomatal sluggishness cause both/either reduction and increase in stomatal conductance?**

A4: Yes, because if there is a drought, the stomata can stay open for too long and stomatal conductance will be higher than it should be. But also the stomata can stay closed for too long when daylight starts, or when the temperature goes from cold to warm, and in this case the stomata will be more closed than they should be based on the environmental conditions at the time.

**Q5: Native Plants/tree species are also sensitive to ozone.**

A5: Yes, it is important that native plants are not forgotten when considering ozone pollution. Some native plants can be important for agriculture. Native plants can also be important for landscape restoration. Since ozone affects plants by being taken in through the stomata, native plants are vulnerable to its effects. Just like crop plants, there is variation in the susceptibility of native plants. Although we have some data on this for e.g. temperate tree and grassland species, we lack data on many natives of tropical regions. Ensuring the success of agriculture and/or landscape restoration requires consideration of ozone pollution.

**Q6: Is there is any chemical to combat against ozone other then EDU (ethylenediurea)**

A6: Yes, there have been a few related to plant hormones that can protect plants by spraying on the leaves, but not on a large scale. There is also a soil drench that can be used which blocks response to a range of stresses. Again, this cannot be used on a large scale at the moment.

**Q7: Can we breed for resistance to ozone?**

A7: Yes, there are some genes for some crops that are known to make the plants sensitive or resistant. There are other plant traits that can make plants more resistant. It is important to consider trade-offs between different stresses. An important consideration is to make sure that by giving resistance to one stress you do not make more sensitive to another. There are some good possibilities for being resistant to ozone and high temperature at the same time.

**Q8: Are there anti-ozone compounds that could be used?**

A8: Please see answer to Question 6 (on EDU).

**Q9: Which agrochemicals lead to ozone pollution?**

A9: This can be answered in two parts:

**1)** Agrochemical manufacture: Any manufacturing process for any chemical that includes the release of NOx and/or VOCs will contribute to ground level ozone pollution. Given the manufacture of the chemicals will likely involve electricity, that will indirectly lead to ozone pollution too: Electricity generation is an important source of ozone precursors.
**2)** Agrochemical use: Any agrochemical that releases precursor chemicals at the time of its use will contribute to ozone pollution. Also, if agrochemicals lead to e.g. increased emissions of volatile compounds from plants, ground level ozone pollution could increase.

**Q10: How we decide the elevated ozone concentration in OTC treatment**

A10: Various approaches can be used to decide on an elevated ozone concentration in Open-top chamber studies.

We would recommend consulting future projections for your area under different future scenarios e.g. different levels of climate change, socio-economic development pathways. If possible, it can be useful to include multiple levels of ozone along a gradient as this can give more confidence in any results observed and you would be able to do e.g. a ‘worst-case’ scenario compared to a ‘likely’ scenario.

You also need to consider whether to use charcoal filtered air as a control, or whether to use either ambient air, or charcoal-filtered air to which a low amount of ozone has been added. There are advantages and disadvantages to all options!

This link provides information on model performance for current ground level ozone levels: Tropospheric Ozone Assessment Report: Assessment of global-scale model performance for global and regional ozone distributions, variability, and trends | Elementa: Science of the Anthropocene | University of California Press (ucpress.edu). For ozone concentrations in the future, there are many options according to different models and different scenarios.

**Q11: Symptoms are quite visible on leguminous plants, but quite difficult on other crops?**

A11: Some other crops also have distinctive symptoms; squash, millet, tomato are examples.

**Q12: May you explain the best way to irrigate in order to mitigate ozone damage to a crop.**

A12: Irrigating during sunlight hours when the plants are photosynthesising can increase ozone damage. By irrigating in the early morning and evening damage can be reduced as the ozone concentrations are likely to be lower, therefore, less ozone is likely to enter the plant when the stomata open following irrigation.

## Session 2 (Africa and South America)

**Q1: Does ozone pollution affect all plants or are some more susceptible than others?**

A1: There is a wide range of sensitivity, but many crops are sensitive. Legumes are well-known for being sensitive. Some slow growing plants with tough leaves are more resistant.

**Q2: Are you aware of any breeding efforts for ozone tolerance in wheat?**

A2: There has been some work on the genetics of ozone tolerance and resistance in wheat. There are also some plant characteristics that can confer tolerance. It is important to consider tolerance to several stresses at once, in case selecting for tolerance to one stress is at the expense of sensitivity to another.

**Q3: Ozone pollution and its effect on the crop is a complex concept for smallholders to understand. Are there any handheld tools that farmers can use to measure ozone pollution for them to take corrective measure and at what scale is recommended to measure ozone pollution?**

A3: There are only a few options for detecting ozone well. There is a possibility to use 'diffusion tubes' which get sent away for analysis, but this is more appropriate for a local academic effort than by a smallholder farmer due to the cost of analysis. Actually, the most effective cheap method is to use a few ozone sensitive plants, such as the most sensitive bean plants. If you see ozone injury on these, then you can know there is a problem. Generally, ozone concentrations are similar over a moderately large area (50-100 km) if the landscape, altitude etc are similar. For further details on ozone measuring equipment see the answer to Q1 of the first session.

**Q4: How does a passive diffusion ozone detector work?**

A4: There is a chemical inside the end of the tube to which the ozone is absorbed. It is over a comparatively slow timescale, which is why these are typically deployed for one month to give the average ozone concentration over the month. Further details can be obtained from Mike Perring (mikper ‘at’ ceh.ac.uk)