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Ozone pollution reduces tomato fruit yield and viability

Ozone harms pollen viability of tomatoes, leading to reduced fruit weight, size and quality, a recent study has revealed. The researchers suggest the effect of ozone on pollen could be a useful way to rapidly test for pollution-induced stress on crop plants in risk assessments.

Ground-level ozone damages plants as well as posing a risk to human health. It negatively affects crop yields and causes global annual losses of between $11 and $26 (€9.82 and €23.22) billion in the agricultural sector.

Some horticultural crops, including tomatoes, are especially sensitive to ozone. As the reproductive development (i.e. flower and fruit development) of a plant is a critical part of its life cycle, anything which adversely affects this can impair the yield and quality of the crop.

This study investigated how ozone affects the reproductive development of the tomato plant (*Lycopersicon esculentum* Mill.). The researchers grew tomatoes in controlled environment chambers, either with clean air or ozone-enriched air, (corresponding to ozone pollution) circulating through them. They then carried out a series of tests to see how these levels of ozone affected tomato pollination, fertilisation and seed development.

The researchers sowed pollen from tomato flowers grown in both environments in nutrient-filled Petri dishes, and incubated half the dishes in either clean or ozone-enriched air. Using a microscope, the researchers observed germination of the pollen and measured the length of the pollen tube, which grows during germination. The growth of the pollen tube is a key characteristic of the possibility for the pollen to fertilise the ovule of the flower, thus allowing seed formation.

Pollen from plants grown in the ozone environment and incubated in ozone-enriched air were significantly slower to germinate, and had reduced pollen tube lengths compared with pollen incubated in clean air, and taken from plants raised in clean air (the control). Pollen taken from plants grown in clean air, but germinated in ozone-enriched air, was also negatively affected.

In the second set of tests, the researchers used pollen from one plant to pollinate the flowers of another. After 48 hours, they examined the recipient flowers to see how much pollen had germinated. They found fertilisation rates were reduced by 25% when both pollen and plant had been grown in ozone-enriched environments, compared to the control.

For the third set of tests, the researchers again cross-pollinated tomato plants and allowed the tomatoes to grow for 3–4 weeks. They examined the seeds and found that the proportion of viable seeds was reduced by 26% in plants grown in ozone and fertilised by pollen from ozone environments. Similar rates were found in all cases where either the pollen or flower had been exposed to ozone. This indicated that ozone negatively impacts both the pollen and the reproductive development of tomato plants.

Finally, the researchers exposed growing tomatoes to either clean or ozone-enriched air. Ripe fruit that had been directly exposed to ozone was smaller, weighed less, and contained fewer seeds compared with fruit from clean air. Other tests revealed that ozone also negatively affected the quality of the fruits by hastening ripening, which reduced levels of vitamin C by 15% in the fruit, and also reduced starch levels.

These results highlight the harm that ozone pollution has on the reproductive development of tomatoes, ultimately reducing fruit yield. The researchers suggest the effect of ozone, and possibly other pollutants, on pollen could be used as a rapid indicator of pollution-induced stress on crop plants in risk assessments. Ozone impacts on pollen could also be used in crop breeding programmes to screen for ozone tolerant varieties of plants.