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AIR POLLUTION REDUCE PRODUCTION AND LEAVE AREA OF RED RADISH (Rapahanus sativus cv. Red Chime) AND CHINESE VEGETABLE (Brassica campestris var. rosularis cv. ATU171)

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Abstract

The present study was aimed to investigate the effect of ozone on Red Radish (Rapahanus sativus cv. Red Chime) and Chinese Vegetable (Brassica campestris var. rosularis cv. ATU171). The experiment was carried out in HoChiMinh (Vietnam) using open-top chamber (OTC) technique. The crops were exposed to different levels of O_3 by using charcoal-filtered air (CF) and non-filtered air. Parameters determined were concentration of SO_2, ozone, NO_x, temperature, leaf number, leaf area, dry masses of leaf and tuber, and total dry biomass. It was observed for both plants that ozone increased leaf number, but decreased leaf area, dry masses of leafs and hypocotyle, and total dry biomass.

Keywords: ozone, open-top chamber, OTC, charcoal-filter, Rapahanus sativus, Brassica campestris.

1. Introduction

Naturally ozone in the troposphere is low, only few ppb. Ozone itself is not emitted by human activities – rather it is formed in the atmosphere through chemical interactions amongst *precursor gases* that are produced by human activities (e.g. combustion products such as oxides of nitrogen, NO_x, and volatile organic compounds, VOCs). Thus human activities increase tropospheric O_3 levels by producing these precursor gases. Motor vehicle exhaust and industrial emissions, gasoline vapors, and chemical solvents as well as natural sources emit NOx and VOC that help form ozone. Sunlight and hot weather cause ground-level ozone to form in harmful concentrations in the air. As a result, it is known as a summertime air pollutant. Many urban areas tend to have high levels of "bad" ozone, but even rural areas are also subject to increased ozone levels because wind carries ozone and pollutants that form it hundreds of miles away from their original sources. Ozone (O_3) is a major phytotoxic air pollutant with the potential to cause injury of leafs and severe yield losses in many crops. SO_2 was found to be harmful on many crops also. In short air pollutants can have an adverse effect on crops, trees and can change diversity of the ecosystem. The effect of pollutants on human-being health, material and ecosystem should be considered when setting standard of air pollutants. A good standard of any pollutant is a level of this pollutant that is not cause considerable bad effect. It was found that current standard of air pollutants is not save level for many crops. Therefore in the last decade a lot of studies on effect of air pollutants on crops were reported. The present study was aimed to investigate the effect of air pollutants on Red Radish (Rapahanus sativus cv. Red Chime, sensitive to ozone) and Chinese vegetable (Brassica campestris var. rosularis cv. ATU171, Sensitive to sulfur dioxide) were chosen for the experiment. The experiment was carried out in HoChiMinh (Vietnam) using open-top chamber (OTC) technique.

2. Experimental

The experiment was conducted on the ground of the Institute of Tropical Technology and Environmental Protection in HoChiMinh City (N 10°49', E106°40'). There were no pollution sources of importance close to the experimental site. The soil was sent from England. The OTCs used in the experiment were 0.6m x 0.6m and 1.2m tall. Top of chamber was covered with insect-protecting net. Fans continuously ventilated the chambers. Two O_3 treatments, charcoal-filtered air (CF), non-filtered air (NF) were set up in turn over six OTCs. Passive samplers were used to measure O_3, NO_2, NO and SO_2 level inside each OTC and in the ambient air outside OTC. Meteorological parameters such as air temperature and relative humidity inside OTC and in the ambient air outside OTC were recorded continuously automatically. Each OTC had 16 pots divided into two halves planted with the Red Radish and Chinese vegetable. About 10 seeds of the each species were sown per pot. After sowing and watering, the pots were kept under natural light outside OTCs. The irrigation of plant was carried out twice a day from seeding to the end of the exposure experiment. Before starting the experiment the plants were thinned to a plant per pot and 2 plants per pot for Red Radish and for Chinese vegetable, respectively. At 9th day after seeding, the pots were transferred to the OTCs. The plants were harvested two weeks after starting the experiments. Fig. 1 gives pictures of the experiment field. Each treatment was replicated two twice in January and April 2005.

Biotic measurements: At each experiment 48 plants of Red Radish and 96 plants of Chinese vegetable were treated. Just at the harvest the visible injuries (purple, brown or distinct black spots) were observe for comparing the plants between CF and NF. The symptoms if recognized were recorded and photo. Leaf color, appearances of whole plant and incidences of symptoms were checked. The number of green and yellow leaves and the number of plants with visible O3 injury of leaves (purple, brown or black distinct spots) was recorded and leaf area was measured. Plants were cut and separate leaf (including petioles) apart from tuber, and dried to constant mass at 70^{O}C to measured dry mass (DM).

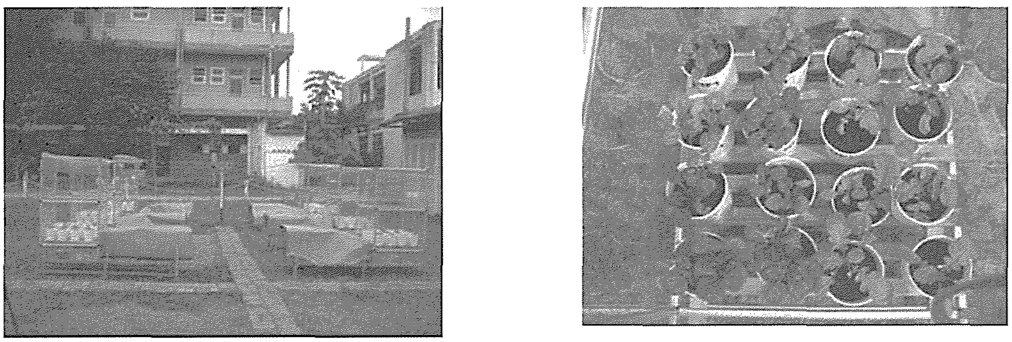


Fig. 1. Experiment field and plants before harvest.

3. Results

Climatic factors of the exposure period are given in Table 1. Temperature at the first treatment was about 3°C lower than that at the second treatment. However relative humidity at the first treatment was a little higher than at the second one. Both treatments were in the dry season with no rain.

Table 1. Climatic factors of the exposure period

		Temperature			Relative humidity		
		Max	Min	Aver	Max	Min	Aver
First Treatment	Ambient air	39.9	22.5	28.0	88	21	62
	OTCs	51.0	22.1	29.6	92	14	60
Second Treatment	Ambient air	41.2	23.3	29.9	90	19	58.3
	OTCs	51.1	22.9	32.7	91	16	56.7

Fig. 2 gives leaf injury observed both for NF and CF treatment. The most common leaf injury observed is acute injury seen as ivory necrotic patches between veins (Fig. 3). This was seen for both Red Radish and Chinese Vegetable under both NF and CF treatment. This kind of injury was much more presented for Chinese vegetable than for Red Radish. However the percentage of leaves injured under NF treatment was comparable or higher than that for CF treatment.

The other kind of injury was seen only for Chinese vegetable (Fig. 3). The symptoms were yellow flecks. Only 1 plant under CF treatment and 2 plants under NF treatment had this kind of injury.

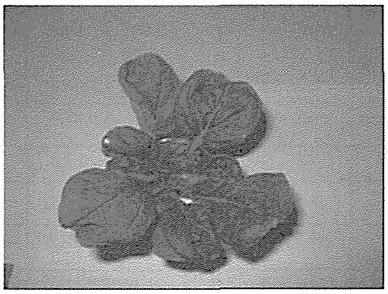
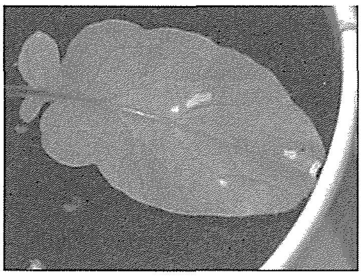


Fig. 2. Yellow flecks on leaves.



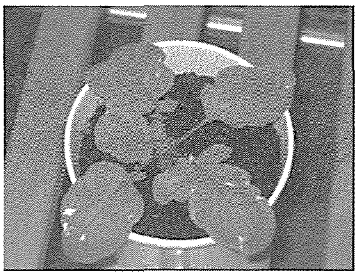


Fig. 2. Ivory necrotic patches on leaves (continued). **Fig. 3.** Yellow flecks on leaves

Tables 2 and 3 report the average concentrations of SO_2, O_3, NO_2 and NO, as well as the average number of buds and leaves, number of yellow leaves leaf area and dry mass of leaf and tuber. Charcoal fitter remarkable reduced air pollution. Concentration of ozone was highest and was reduced 8 – 10 ppb. The other pollutants were at lower level than ozone.

Table 2. Average bud number, leaf number, number of yellow leaves leaf area and dry mass of leaf and tuber for Red Radish.

Treatment	Test	Plant									Environment			
		Num of plants	Aver. Bud Num. /plant	Aver. Leaf Num /plant	Aver. Leaf Bud Num. /plant	Aver. Num of Yellow Leaf /plant	Leaf Area cm²/leaf	Leaf DM g/plant	Tuber DM g/plant	Tuber DM : Leaf DM	SO_2 ppb	O_3 ppb	NO_2 ppb	NO ppb
1	CF	48	1.2	5.4	6.6	0.71		0.53	0.87	1.40	1.6	3.8	3.5	0.2
	NF	48	1.2	5.7	6.9	0.25		0.51	0.84	1.34	4.5	14.3	6.6	0.9
	NF/ CF		**1.00**	**1.06**	**1.05**	**0.35**		**0.96**	**0.97**	**0.96**				
2	CF		2.1	9.8	11.9	0.08	10.0	0.32	0.47	1.46	1.5	4.1	2.9	0.1
	NF	48	2.0	9.3	11.3	0.04	9.8	0.29	0.35	1.22	3.5	12.0	5.3	0.9
	NF/ CF	48	**0.95**	**0.95**	**0.95**	**0.50**	**0.98**	**0.91**	**0.74**	**0.84**				

Table 3. Average bud number, leaf number, number of yellow leaves leaf area and dry mass of leaf and tuber for Chinese vegetable.

Treatment	Test	Plant							Environment			
		Num of plants	Aver. Bud Num. /plant	Aver. Leaf Num /plant	Aver. Leaf Bud Num. /plant	Aver. yellow-Leaf Num. /plant	Leaf Area cm²/leaf	Leaf DM g/plant	SO_2 ppb	O_3 ppb	NO_2 ppb	NO ppb
1	CF	45	2.3	9.2	11.4	0.7		0.685	1.6	3.8	3.5	0.2
	NF	48	2.6	9.7	12.3	0.7		0.618	4.5	14.3	6.6	0.9
	NF/CF		**1.13**	**1.05**	**1.08**	**1.00**		**0.90**				
2	CF	4.7	2.1	9.8	11.9	0.8	6.8	0.434	1.5	4.1	2.9	0.1
	NF	48	2.0	9.3	11.3	0.6	5.5	0.362	3.5	12.0	5.3	0.9
	NF/CF		**0.95**	**0.95**	**0.95**	**0.8**	**0.93**	**0.83**				

No trend on the leaf number was found for CF and NF treatment. However it was seen that pollutants clearly reduce the leaf area and production of the both species.

For Red Radish the leaf area under NF treatment reduced 2 %, leaf DM reduced 4 – 9%, tuber DM reduced 3 – 26% in comparison with under CF treatment. The ratio tuber DM/ leaf DM reduced also under NF treatment.

For Chinese vegetable leaf area under NF treatment reduced 7%, and reduced 10 – 17%.

4. Conclusion

Ozone at concentration lower 15 ppb did not cause visible ozone injury on Rapahanus sativus cv. Red Chime and Brassica campestris var. rosularis cv. ATU171. However, air pollutants like reduced leaf area and production of these species even at low pollution level.