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TOLERANCES OF SUNFLOWER (*Helianthus annuus*) CULTIVARS TO OZONE, A COMPONENT OF THE AIR POLLUTION COMPLEX

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During the summer of 1971, at Beltsville, Maryland, the foliage of several sunflower cultivars in field plots was severely injured (Fig. 1). Symptoms resembled those produced by oxidant air pollutants (Fig. 2), namely small, localized, necrotic flecks occurring predominantly on the upper leaf surfaces. On the basis of relative air pollution sensitivity observed in the field and the relative susceptibility to Verticillium wilt, 12 cultivars were selected to be exposed to ozone, an oxidant of the photochemical complex, in a controlled experiment. Ozone was generated by an electric arc discharge lamp. Ozone at 25 pphm v/v for 2 hr was introduced into a Controlled Environment PWG (1) growth chamber equipped to provide light, temperature, and relative humidity of 17.2 Klx, 26 C, and 85 %, respectively. After exposure, plants were removed from the chamber to the greenhouse, and the extent of injury was determined 48 hr later. Scoring was on a 0 to 9 basis, where 0 = no injury and 9 = most severe injury. Two separate experiments were run, and each cultivar was replicated 12 times in each experiment.

The relative ranking of cultivar sensitivity to ozone is presented in Table 1. In both experiments, Romania HS-53, CM-162, and HA-92 were least injured, and Romania HS-52 and CM-144 were most injured by ozone. The responses of cv. CM-162, Verticillium susceptible, and of cv. CM-144, Verticillium resistant, to ozone suggests that tolerance to ozone and Verticillium is influenced by a different mechanism. Perhaps phenols that are responsible for plant resistance to the fungus are readily oxidized by ozone and thus form substances that inhibit normal cell metabolism in CM-144, thus accounting for ozone sensitivity.

In greenhouse conditions, visual foliar injury caused by ozone and two-spotted mite, Tetranychus urticae, is very similar (Fig. 3). Leaves from cv. Greystripe--noninjured (Fig. 4), and ozone and mite injured-- were fixed in CRAF solution, sectioned, and stained with safranin, and counter-stained with fast green. Stained histological sections of ozone-injured leaves indicate that palisade cells are most affected (Fig. 5); whereas, in mite-injured leaves, cells adjacent to mite colonization are most affected (Fig. 6, 7, 8).

This study reveals the following :

1 - There is variation in sensitivity to oxidant air pollution among sunflower cultivars, and some cultivars are among the most sensitive agricultural crops to these phytotoxicants. Observations made in the field with respect to sensitivity agreed with observations from chamber fumigations.

2 - The response of cultivars to Verticillium wilt appears to be opposite to that of ozone.

3 - Although visual symptoms of mite and ozone injury are very similar, ozone destroys specific cells, whereas mites destroy cells adjacent to colonization.

(1) Mention of a trademark name or a proprietary product does not constitute a guarantee or warranty of the proprietary product by the USDA and does not imply its approval to the exclusion of other products that may also be suitable.

Table 1 - Relative sensitivity of several sunflower genotypes to ozone at 25 pphm for 2 hr. Scored on 0-9 scale, 0 = no injury.

Genotype	Scores of injury for 2 experiments	
	Dates of each experiment	
	2.29.72	5.15.72
Romania HS-53	*6.2 ***	5.6 a
CM-162	6.5 a	5.3 a
HA-92	6.7 a	6.8 a
Greystripe	6.7 a	6.7 ab
HA-95	7.0 a	6.7 ab
Peredovik	7.2 ab	7.2 abc
p-21MS x HA-60	7.2 ab	7.2 abc
HA-60	7.8 bc	7.6 bc
Krasnordorets	7.9 bc	7.8 bcd
p-21VR1	8.1 bc	8.2 cd
Romania HS-52	8.2 c	8.1 d
CM-144	9.0 c	9.0 d

* Average of 12 replications/fumigation date.

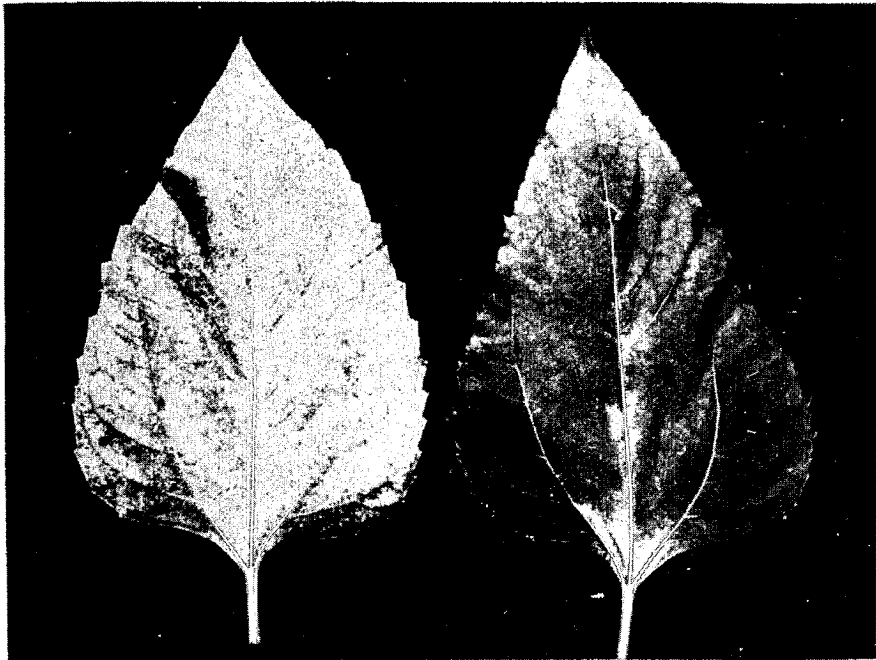
*** Values within columns followed by the same letter are not significantly different at the .01 level.

LEGENDS FOR FIGURES

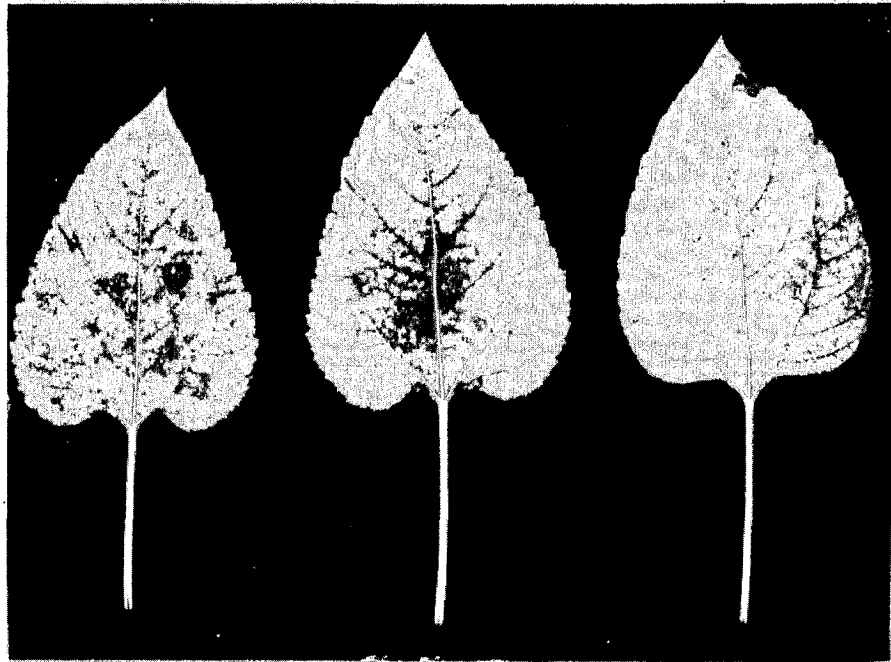
- 1 - Sunflower foliage with oxidant-type air pollution injury (field).
- 2 - ozone-injured and noninjured leaves.
- 3 - Mite injury on leaves.
- 4 - Cross section of noninjured sunflower leaf.
- 5 - Cross section of ozone-injured leaf. Injured cells are predominantly palisade.
- 6, 7, 8 - Cross sections of sunflower leaves showing different degrees of mite injury.



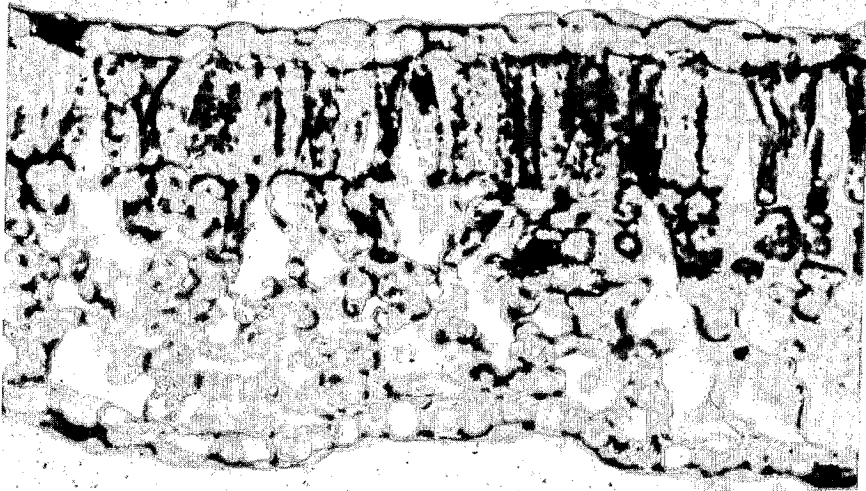
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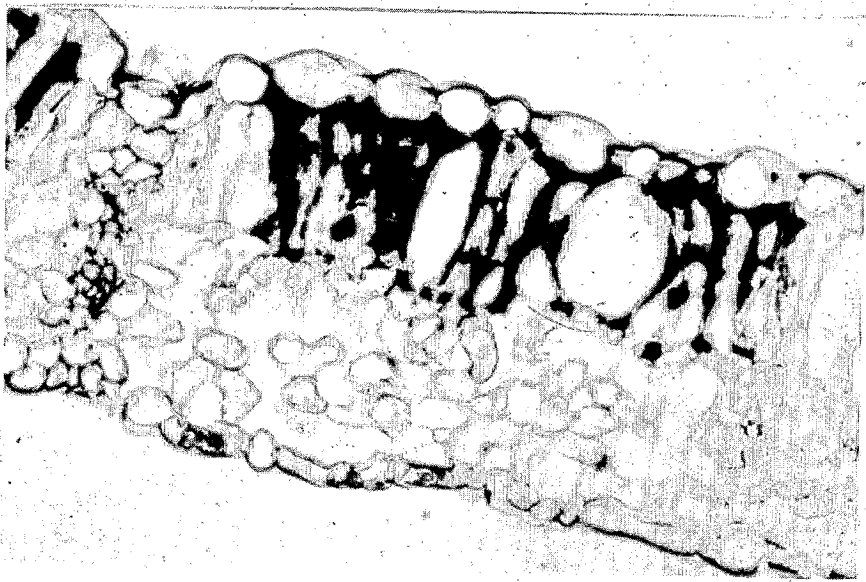
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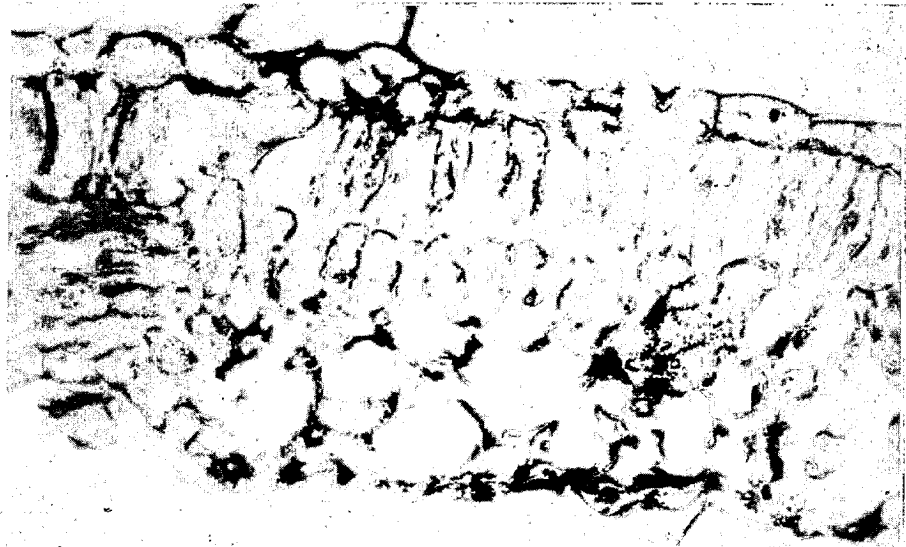
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