

## Response of Eight Cultivars of *Chrysanthemum* to Peroxyacetyl Nitrate

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### ABSTRACT

Eight cultivars of chrysanthemum were exposed to 20 and 60 pphm peroxyacetyl nitrate (PAN) for 4 h. Of 256 cuttings exposed, symptoms developed on one plant exposed to 60 pphm for 4 h. These results indicate that PAN-like symptoms observed on chrysanthemums in cities in the eastern USA are not due to PAN alone. They may be a result of PAN interacting with another pollutant or a response to other pollutants such as hydrogen chloride or aldehydes.

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Chrysanthemum is one of the most widely used herbaceous ornamental plants in the USA and represents a major source of cut flowers. During the mid-1950's, chrysanthemum was found to be generally resistant to ambient smog in the California area (4). However, several varieties of chrysanthemum have been reported to develop peroxyacetyl nitrate (PAN)-like symptoms in the eastern USA (1). The PAN-like symptoms observed on chrysanthemum consisted of an abaxial leaf surface glazing and bronzing.

Since PAN-like symptoms have been observed on this species and since the cause of these symptoms is unknown at the present time we decided to determine the relative sensitivity of eight commonly used cultivars of chrysanthemum to PAN. The results of this study are reported herein.

**MATERIALS AND METHODS.**—Rooted cuttings of chrysanthemum (*Chrysanthemum morifolium* Ramat.) cultivars 'Gaiety', 'Delight', 'Forty-niner', 'Golden Gate', 'Princess Anne', 'Streamer', 'Torch', and 'Tuneful' were provided by Yoder Brothers, Inc. of

Barberton, Ohio. Over 250 cuttings were used. The cuttings were maintained in a regularly fertilized peat-perlite mixture and grown in the greenhouse prior to and immediately following exposure to PAN. A full range of leaf ages from just-expanding to 8 wk was present on each cutting at the time of exposure.

PAN was generated as described by Stephens (6) and was stored in low-pressure oxygen tanks at 7.031 kg-force/cm<sup>2</sup> (100 psi). During exposures, PAN was released from the tank through a rotometer and into a manifold system within the exposure chamber. PAN concn during each exposure was monitored with a Panalyzer which is a gas chromatograph equipped with an electron capture detector and modifier to measure PAN as described by Darley et al. (3).

The cuttings were placed in a controlled environment chamber at 24 C, 75% relative humidity, 36,584 lx (3,400 ft-c) of light, and a 15-h photoperiod for a minimum of 24 h prior to exposure. Following this treatment, they were placed in the exposure chamber at the same environmental conditions and exposed to PAN for 4 h. PAN concn in the exposure chamber was established prior to introduction of test plants and PAN concn during exposures was checked at 15-30 min intervals by withdrawing a sample with a hypodermic syringe and injecting it into the Panalyzer.

Four cuttings of each cultivar were used in each exposure, and the eight varieties were subjected to eight different exposures. During the initial exposures, PAN dosages of 20 pphm for 4 h were used; dosages of 60 pphm for 4 h were used in the latter exposures.

Pinto bean (*Phaseolus vulgaris* L.) plants were included in two of the initial exposures as bio-indicators for PAN. Following exposure, cuttings were transferred to the greenhouse where they were examined daily for symptoms; final symptom evaluation was made 5 days following exposure.

**RESULTS.**—A total of 256 cuttings were exposed to dosages ranging from 20 pphm for 4 h to 60 pphm for 4 h. Symptoms were observed only on one plant which had been exposed to 60 pphm for 4 h. The symptoms consisted of a bifacial bronzing of the leaves and occurred on leaves at the third node down from the terminal bud. Severe lower leaf surface glazing and bronzing were observed on the pinto bean plants that had been included in two of the exposures. The symptoms on pinto bean were typical of those induced by PAN. In summary, eight cultivars of chrysanthemum exposed to relatively high dosages of PAN failed to develop symptoms.

**DISCUSSION.**—Failure of PAN-like symptoms to develop on eight varieties of chrysanthemum exposed to concns of 20 to 60 pphm PAN for a period of 4 h suggests that PAN-like symptoms observed on chrysanthemums in eastern USA are probably due to a cause other than PAN. There is relatively little information available on ambient concns of PAN in the atmosphere over various cities in the USA. However, information available indicates that the concns used in this study were well in excess of what one would expect to find in an ambient atmosphere. For example, Mayrsohn and Brooks (5) reported a maximum concn of PAN for the Los Angeles area of 21.0 pphm. Taylor (7) reported a maximum in Riverside, California of 5.8 pphm, and Tingey and Hill (9)

reported a maximum near Salt Lake City, Utah of 5.4 pphm. They also observed that PAN concns exceeded 1.0 pphm for 61% of the days from July through September and 2.0 pphm only 15% of the days from July to September. PAN concn in the atmosphere of eastern cities has not been monitored; its existence in such atmospheres has been implied from symptoms observed on various PAN-sensitive plants.

Data obtained by Taylor (7) at Riverside, California suggest that PAN injury to sensitive plants occurs at ambient concns which are lower than those required to cause injury in artificial exposures to PAN alone. These observations indicate that PAN injury in the field might be the result of interactions involving PAN and other pollutants. As a consequence, it is possible that the PAN-like symptoms observed on chrysanthemum in the northeastern USA are a result of PAN interacting with another pollutant and it is essential that such a possibility be investigated before PAN is ruled out as part of the causal complex for this disease.

Silvering and bronzing of lower leaf-surfaces, a symptom classically associated with PAN injury to several vegetable crops, can also be induced by other air pollutants. For example, glazing of the under leaf surface of tomato plants by hydrogen chloride gas was reported by Taylor (8). Other investigators have reported a similar response of vegetable crops to hydrogen chloride gas. Brennan et al. (2) suggested that aldehydes might induce a lower leaf surface glazing of the leaves of certain sensitive plants. Consequently, the PAN-like symptoms observed on chrysanthemums could be a result of another

single pollutant such as hydrogen chloride gas or an aldehyde.

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