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Ethylene Diurea (EDU) Protection Against Ozone Injury in Tomato Plants at Delhi

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Air pollution has become an increasingly serious problem in developing countries. Ozone is the most phytotoxic gaseous air pollutant. Ground level ozone measurements carried out at Delhi during 1990 -1992 show that the ambient concentration of ozone varies between 20 to 273 µg m^{-3}, and the one hour WHO ozone standard of 110.74 µg m^{-3}, was violated on many occasions (Varshney and Aggarwal, 1992). Heck *et al.*, 1982 have shown that out of total crop loss caused by air pollution in USA, about 90% of the crop loss is attributed to ozone. Ethylene diurea (EDU) has been shown to be specific in protecting plants against ozone injury because it is an strong anti-oxidant (Carnahan *et al.*, 1978). Exploratory studies have been carried out to evaluate the protective role of EDU against ozone damage in cereals, legumes and vegetables (Astorino et *al.*, 1995; Brennan *et al.*, 1990; Brunschon-Harti, 1995; Clarke *et al.*, 1990; Hofstra *et al.*, 1978; Kostaka-Rick and Manning, 1992, 1993; Tonneijck and Vandijk, 1997). In India Bambawale (1986) have shown that the leaf spot disease of potato reported from Punjab in 1978 was primarily due to ozone pollution and foliar spray of EDU was found to reduce about 25-30%leaf spot disease. Higher yield in EDU-treated plants in comparison to un-treated plants has been attributed to the specific protective effect of EDU against ozone damage (Clarke *et al.*, 1990; Saettler, 1981; Smith *et al.*, 1987).

Tomato, an important vegetable fruit crop grown widely in the country, has been shown to suffer adversely from ozone stress (Khan and Khan 1994). The present study was undertaken to evaluate the performance of tomato plants, with and without EDU treatment, exposed to ambient ozone levels at selected urban and peri-urban sites at Delhi.

MATERIALS AND METHODS

Monitoring of ambient ozone at the following sites was carried out in Delhi (Figure-1) at 15 day interval, during March-June, 1997.

Tilak Bridge is one of the busiest stretch on a main road connecting New Delhi with Old Delhi. The traffic at this site is very heavy. In addition, a thermal power plant in the vicinity makes it one of the most polluted sites in Delhi

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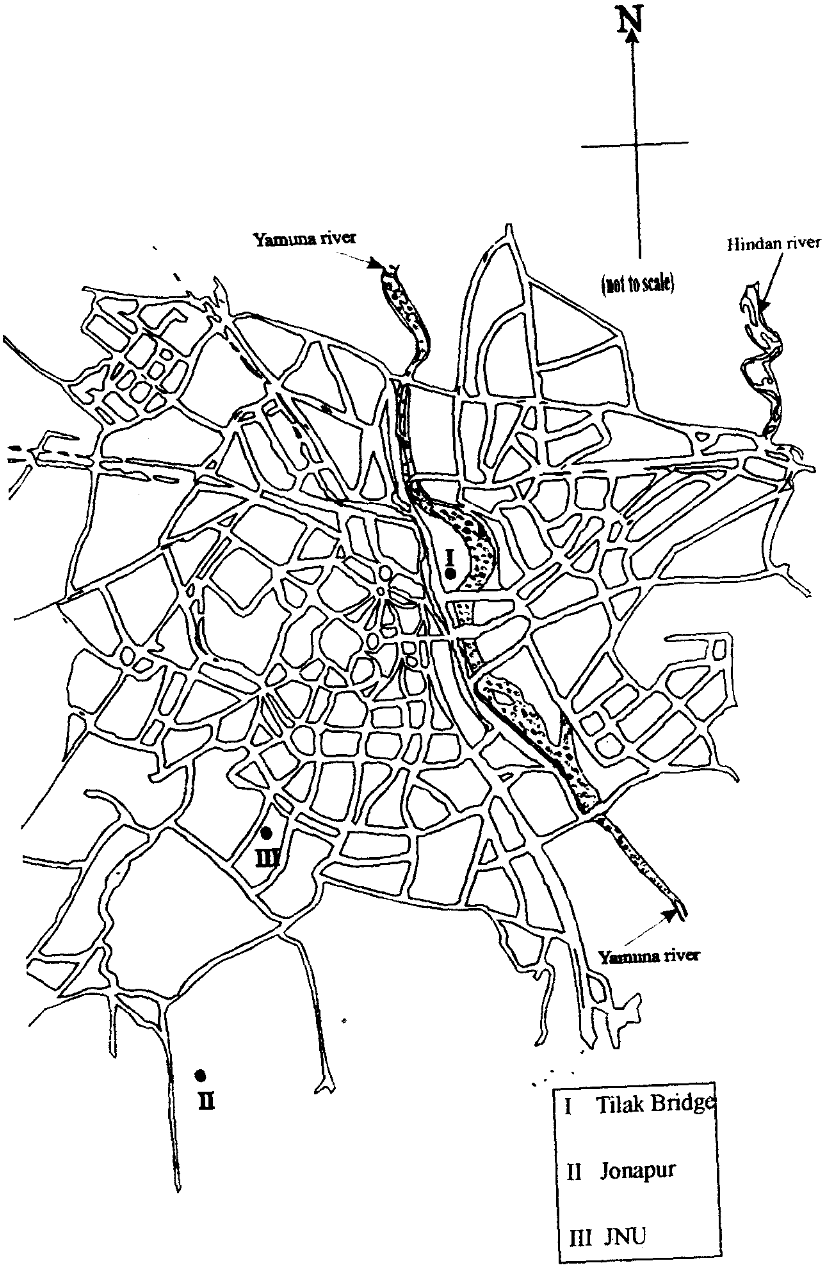

Fig 1. Map of Delhi showing field sites

Jonapur is located in peri-urban/rural location lying at the outskirts of Delhi, at approximately 12- 15km south of JNU and 15-20km away from traffic dense areas, close to Haryana border (2km).The traffic of Delhi go to Haryana and vice versa through this village. Agricultural activity is still going on around the locality. This area is totally residential but in recent years construction activity has picked up rapidly. This site is not completely free from air pollution.

JNU is located in side of a vast tract of natural vegetation in the southern part of Delhi, is a secluded area, relatively free from pollution, selected to serve as a control site. The natural vegetation of the area is dry deciduous forest which has suffered severely from urbanisation.

Air samples were drawn at hourly interval at a rate of 2 litre per minute using

KIMOTO handy sampler Model HS-7 for 5 hr (from 11.00-16.00 hr) and ozone estimation was carried out using Saltzman (1961) method, with modification suggested by Boyd et al., 1970, having a precision of ±5% from the mean.

Lycopersicon esculentum var. Pusa Ruby (Tomato) plants were raised from seeds in pots in the Ecological Garden, JNU ,during the last week of February 1997. In the third week of March, six pots (two plants in each pot) were transferred to Jonapur (peri-urban) and Tilak Bridge (urban), the field sites and a set of six pots was maintained in the JNU garden to serve as reference. From the last week of March three pots at each site, were given EDU treatment, at twelve day interval, by soil drenching with 400 ppm of aqueous solution of EDU. The remaining three pots at each site were maintained without EDU treatment for comparison and were drenched with water instead of EDU solution.

Plant growth was monitored and the degree of visible injury was recorded at bi-week intervals. The plant parameters studied were, leaf number, shoot length, root length, dry weight of shoot and dry weight of root. The tomato plants were harvested on maturity in Mid-Jun after 82 days of field exposure. To evaluate the effectiveness of EDU treatment on the growth and performance of tomato plants at Delhi, data from all the sites were pooled under two categories namely 1. EDU treated and 2. untreated plants for a better comparison.

RESULTS AND DISCUSSION

The results show that the ground level hourly peak ozone concentration in the ambient environment at three sites in Delhi varied between 113.42- 124.42 μg/m^3 and average hourly ozone concentration ranged between 88.41-89.98 μg/m^3. The hourly peak ozone value at the Tilak Bridge in the city centre was 113.42 μg/m^3, was relatively less as compared to the hourly peak ozone value of 124.42 μg/m^3 at the JNU which lies at the outskirts of the city resembling per-urban environment.

In general, at all the three sites the performance of EDU treated tomato plants was

In general, at all the three sites the performance of EDU treated tomato plants was better as compared to the untreated plants. However, variation in the performance of the tomato plants from one site to another was found to be related to the inter-site variation in the ambient ozone concentration (Table-1).

Shoot length root length, shoot biomass and root biomass were less in the plants which did not receive EDU treatment as compared to EDU treated plants. In EDU treated plants the leaf size was bigger as compared to the non-treated plants, however the number of leaves in untreated plants were about 15.70% more as compared to EDU treated plants (Table -2). Data on shoot length, root length, shoot biomass and root biomass given in Table 2-3 show that the performance of EDU treated plants was much better as compared to untreated plants at all the three sites. On an average the shoot length, root length, shoot biomass and root biomass in untreated plants were reduced by 19.10%, 14.50%, 25.60% and 17.96% respectively. It may be observed that the protection provided by EDU treatment was different for different organs in the same plant. In accordance with the degree of EDU protection the four plant organs fall in the following sequence:

Shoot biomass > shoot length > root biomass > root length.

It seems that EDU treatment is not equally effective in respect of different plant organs. In future studies related to EDU effect, it would be interesting to identify the causes and the significance of the variation in the response of different plant organs as observed in this study.

Table 1. Ground level ambient ozone concentration ($\mu g\ m^{-3}$) at different urban and peri-urban at Delhi

Sites	March		April		May		June		Average hourly concentration
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	
Tilak Bridge	87.27	62.14	98.54	78.14	113.42	83.14	97.83	82.15	88.41
Jonapur	97.23	83.42	106.73	91.32	118.47	36.56	98.72	76.46	89.53
JNU	93.12	61.99	113.12	81.47	124.43	80.32	112.82	89.87	89.98

Table 2.Effect of EDU treatment on number of leaves, shoot and root length in tomato plants exposed to ambient air pollution at Delhi

Site	Leaf number			Shoot length (cm)			Root length (cm)		
	EDU	Control	% increase	EDU	Control	% loss	EDU	Control	% loss
Tilak Bridge	72.90	83.50	14.54	63.37	52.07	17.83	19.91	15.30	23.15
Jonapur	48.93	58.22	15.92	62.44	50.23	19.55	16.08	14.43	10.26
JNU	48.37	58.00	16.60	63.25	50.65	19.92	16.28	14.64	10.07

Table 3. Effect of EDU treatment on shoot and root biomass in tomato plants exposed to ambient air pollution at Delhi

Site	Shoot biomass (g / plant)			Root biomass (g / plant)		
	EDU	Control	% loss	EDU	Control	% loss
Tilak Bridge	28.25	21.04	25.53	5.28	4.46	15.53
Jonapur	28.40	20.94	26.27	4.47	3.63	18.79
JNU	28.52	20.54	27.99	4.67	3.76	19.57

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