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# *EFFECT OF SOME SOURCES OF POLLUTION ON TOMATO PLANTS*
## I-Growth analyses, yield and anatomy

**Ansary E. Moftah, Ahmed A. Gendy and Abd El-Halim M. Eid**
**Dept.** of Agricultural Botany, Faculty of Agric., Menoufia University, Shebin El-Kom, Egypt.

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## ABSTRACT

The effects of lead (0, 50, 100 and 200 ppm), dimethoate (0.0, 0.2, 0.4 and 0.8%) and sulfuric acid (0.0, 0.02, 0.04 and 0.08 N) on the growth, yield and anatomy of tomato plants were investigated.

Results showed that 200 ppm of lead decreased plant heights, root length, leaf area and the dry weights of plant organs. The high levels of lead decreased the leaf area index (LAI), the specific leaf weight (SLW) and the leaf area ratio (LAR) but the specific leaf area (SLA) was increased. Foliar spray method was more effective in causing harmful effects on the net (NAR), the relative growth rate (RGR), the relative leaf area growth rate (RLGR) and other growth parameters than soil application method. Lead treated-plants flowered earlier than untreated control, but fruit yield was decreased significantly even at 100 ppm. Lead caused a decrease in the area and thickness of xylem tissues in stems. The high levels of dimethoate caused nearly a complete cessation in plant growth. LAI and SLW were decreased, while LAR and SLA were increased with dimethoate treatments. In addition, NAR, RGR and RLGR were negatively affected. The medium and high levels of dimethoate prevented flowering and fruit production. Dimethoate reduced the area of the parenchyma tissues such as cortex and pith. Sulfuric acid caused a significant reduction in all growth parameters. The dry weights of leaves, stem and roots were reduced by all tested $H_2SO_4$ concentrations, at 75 days of transplanting. The effect on growth analyses was similar to that resulted from dimethoate. Soil treatment was more harmful to affect growth parameters than foliar spray. The soil application of $H_2SO_4$ caused an early flowering, while the foliar application delayed it. The fruit yield was decreased significantly by all acid concentrations. The high levels of $H_2SO_4$ ceased flowering and fruiting. A complete destruction in cortex and pith cells was observed under the high acid-levels.

## INTRODUCTION

The effects of pollution on plants is very important to be investigated not only because of economic loss from damaged crops, but also because plant injury provides an indication of how pollutant materials may eventually affect human life.

Foy (1970) postulated that plants could be injured by various environmental pollutants which reduced the quantity and/or the quality of plant products. In this concern, Naegele (1974) reported that pollution effects on plant system are a function of three factors: first: the type of toxicant or pollutant and the manner in which it is presented to the plant system; second: the concentration and exposure time of pollutant; third: the genetic response of the plant system as modified by environmental influences. Further studies by Thomas (1986) indicated that pollutants are directly taken up by injured plants.

Lead is the most widespread pollutant omitted from industry, stationary combustion plants and motor vehicles. The problem in Egypt is that most industrial areas are located adjacent to cultivated lands. Moreover, traffic roads and highways are carrying a vast number of motor vehicles running through the cultivated areas of Egypt. Consequently, there is a danger that lead uptake by plants enters human food chain. This can cause serious problems of lead toxicity to those who consume polluted food. Furthermore, with the widespread of industry and fuel combustion, lead may accumulate in the soil to the limit causing plant toxicity and vegetation damage (Kuboi et al., 1986 and Stiborova et al., 1986) and to reduce the yield of many species (Diehl et al., 1983 and Xian, 1989).

Agriculture, being the main stay of the economy in Egypt, invariably attracts the use of pesticides, which are widely used for crop protection in the region. Considerable amounts of these pesticides reach irrigation and drainage water systems by spray drift, areal spraying or run-off from agricultural land. These pesticides may produce stable residues that can persist or accumulate in the environment, and can also enter plants as a polluting chemicals in various ways. Moreover, if plant foliage sprayed with an organic pesticides, some of these compounds are absorbed into the leaves and may still be present when the crop is harvested for animal or human food. In addition, these chemicals may cause changes in fertility and hormone as well as enzyme action (Dix, 1981), and consequently, can alter the physiological processes in plants, thus affect the growth (McConnell et al., 1985 and Venkatesulu and Bhat, 1987) and yield (Hussein et al., 1975 and Sarma, 1979) of many crops.

Sulfuric acid is usually considered as a dangerous source of pollution. In this concern, $SO_2$ gas was referred to be an ubiquitous industrial by-product and causes a significant damage to the field crops. In addition dew and fogs may be mixed with $SO_2$ gas to produce a sulfuric acid that can be harmful to plant foliage and other organs (Jacobson et al., 1986 and Tomer and Kumer, 1987). Acids were found, also, to reduce productivity of several species

(Gupta and Ghouse, 1987 and Murray and Wilson, 1988)

The widespread of pollutants in the environment made it very important to test their effects on tomato plants as one of the most important vegetable crops grown in Egypt, in an attempt to test the effect of lead, as representative of heavy metals; dimethoate [O,O-dimethyl-S-(N-methyl-carbamoyl-methyl) dithiophosphate], as a representative of insecticides used for white-fly control; and sulfuric acid ($H_2SO_4$), as one of the widely found acids in the environment, on the growth, anatomy, and yield of tomato plants.

## MATERIALS AND METHODS

The present investigation was performed at the Agricultural Experimental Station of the Faculty of Agriculture, Menoufia University, during 1989 and 1990 summer seasons. Tomato (Lycopersicum esculentum Mill) seeds of Ace variety were used in this study. In both seasons, tomato seeds were sown on March 10th and then the 40 day old uniform-seedlings were transplanted in clay pots of 30 cm diameter. Every pot was filled with 7 Kg pure sand. The sand culture technique used in this investigation was similar to that described by Hewitt (1952). Two seedlings were transplanted in each pot.

A nutrient solution similar to that recommended by Hoagland and Arnon (1950) was used in this experiment. Each pot received 500 ml of the solution twice a week. Distilled water was used for irrigation whenever needed. Treatments were arranged in a complete randomized block design with 8 replications.

Pollutant treatments: Lead was used as lead chloride at the concentrations of 00, 50, 100 and 200 ppm. These concentrations were chosen to be near from those found in the agricultural soils (25-100 ppm) or in the extremely polluted areas (200 ppm) as reported by Ali (1982).

Dimethoate emulsion was introduced at the concentrations of 00, 0.2, 0.4 and 0.8%. These concentrations are close to those used in Egyptian environment for controlling many kinds of insect species (Soria, 1967).

Sulfuric acid solutions at the concentrations of 0.0, 0.02, 0.04 and 0.08 N were applied. The chosen concentrations are very close to those produce pH similar to that estimated in the acid rain and collected fogs around industrial areas (Haines, 1979).

Pollutants were applied at vegetative growth stage (30 days after transplanting) in two methods, soil application with irrigation water or foliar spray. Plants in each pot were supplied with a fixed volume of the pollutant solution (20 ml).

Three plant samples were successively taken at random from every treatment, throughout the whole course of development, starting 45 days after transplanting and then, every two week intervals (i.e. 60 and 75 days after transplanting). At each sampling time, five plants were taken out carefully from the pots using a stream of water to minimize loss of root system, and were then cleaned from any adherent dirts using wet muslin cloth.

In the laboratory, plants were separated into leaves, stems and roots; and the following growth parameters were determined:
Plant height (cm), root length (cm), dry matter (g) of plant organs (70°C using a hot-air oven). The data of dry weight and leaf area were used to determine the following growth analyses:

$$\text{Leaf Area Index (LAI)} = \frac{\text{Leaf Area (LA)}}{\text{Ground Area (GA)}}$$

$(cm^2/\text{ground } cm^2)$

$$\text{Leaf Area Ratio (LAR)} \; (cm^2/g \text{ d.wt}) = \frac{\text{Leaf Area (LA)}}{\text{Plant D.Wt.}}$$

$$\text{Specific Leaf Area (SLA)} \; (cm^2/g \text{ d.wt}) = \frac{\text{Leaf Area (LA)}}{\text{Total Leaf D.Wt.}}$$

$$\text{Specific Leaf Weight (SLW)} \; (mg \text{ d.wt}/cm^2) = \frac{\text{Total Leaf D.Wt.}}{\text{Leaf Area (LA)}}$$

The above analyses were determined according to Hunt (1978).

Net Assimilation Rate (NAR), Relative Growth Rate (RGR) and Relative Leaf Area Growth Rate (RLGR) were calculated according to the method of Buttery and Buzzell (1974) as follows:

$$\text{NAR } (g/m^2/day) = \frac{(W_2-W_1)(\log_e A_2-\log_e A_1)}{(A_2-A_1)(t_2-t_1)}$$

$$\text{RGR } (mg/g/day) = \frac{(\log_e W_2-\log_e W_1)}{(t_2-t_1)}$$

$$\text{RLGR } (cm^2/day) = \frac{(\log_e A_2-\log_e A_1)}{(t_2-t_1)}$$

where: $W_1$ and $W_2$ are the total dry weights in grams at $t_1$ and $t_2$ (date of sampling at the first and second sampling time, respectively); $A_1$ and $A_2$ are the leaf area per plant in $cm^2$ at $t_1$ and $t_2$, respectively; e is the base of the normal logarithm (2.71828). NAR, RGR and RLGR were calculated between samples 1 and 2 (t= 15 days) and between samples 2 and 3 (t= 15 days).

Anatomical methods: Stem structure was studied at the highest concentrations of each pollutant when was added as soil application only.

Stem samples were taken at the second sampling date, 60 days after transplanting. Segments (10 mm) from the middle part of stems were killed and fixed in formaldehyde-alcohol-acetic acid (FAA) solution. The segments were then washed with tap water and were dehydrated in ascending concentrations of ethyl alcohol. Samples were then passed into increasing concentrations of xylol, in absolute alcohol, and then followed by two changes of pure xylol. Infiltration began by adding some wax-shaving to the samples which were covered with xylol. After saturation, infiltration was completed in oven where pure melted wax was added. Segments were then embedded in a special wax to improve their cutting. Samples were microtomed at 15 microns. Sections were fixed to slides by means of albusol adhesive (Sass, 1951). Staining was done using sufranin light-green dye. Photomicrographs were taken by Pentacon Camera attached with a Carl Zeiss Jena Research Microscope.

All data were subjected to statistical analysis according to the procedures outlined by Snedecor and Cochran (1973). The analysis was done using a statistic computer-program (PC-STAT).

## RESULTS AND DISCUSSION

Vegetative Growth: Data present in Table (1) indicated clearly that plant height, root length and leaf area were all increased gradually throughout the growing season. It was obvious that foliar application of lead and sulfuric acid was more harmful for plant height than soil application method, while the reverse was true for dimethoate pollutant. The highest concentrations of all pollutants were highly serious in reducing plant height; with the

Table (1): Effect of lead, dimethoate and sulfuric acid on plant height, root length and leaf area of tomato plants at different stages of growth.

| Method of application | days after transplanting | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | plant height | | | root length | | | leaf area | | | plant height | | | root length | | | leaf area | | |
| | 45 | 60 | 75 | 45 | 60 | 75 | 45 | 60 | 75 | 45 | 60 | 75 | 45 | 60 | 75 | 45 | 60 | 75 |
| | (season 1989) | | | | | | | | | (season 1990) | | | | | | | | |
| Control* | 27.5 | 38.5 | 40.3 | 13.7 | 20.2 | 24.5 | 679 | 836 | 1150 | 24.7 | 32.6 | 36.8 | 14.8 | 19.8 | 24.8 | 744 | 757 | 812 |
| **Lead (ppm)** | | | | | | | | | | | | | | | | | | |
| soil | | | | | | | | | | | | | | | | | | |
| 50 | 26.3 | 36.5 | 40.2 | 12.5 | 19.3 | 23.7 | 671 | 825 | 1040 | 23.2 | 30.1 | 34.4 | 14.7 | 18.1 | 22.6 | 740 | 769 | 793 |
| 100 | 24.0 | 33.5 | 38.3 | 12.0 | 18.8 | 22.7 | 654 | 816 | 955 | 21.6 | 29.0 | 31.3 | 13.6 | 18.3 | 21.7 | 731 | 729 | 744 |
| 200 | 23.3 | 30.8 | 36.5 | 11.3 | 17.3 | 20.2 | 649 | 763 | 810 | 20.7 | 26.6 | 30.3 | 11.2 | 17.7 | 20.3 | 636 | 702 | 712 |
| foliar | | | | | | | | | | | | | | | | | | |
| 50 | 24.3 | 33.7 | 37.7 | 13.8 | 19.7 | 24.5 | 669 | 811 | 1014 | 22.9 | 28.3 | 30.2 | 14.1 | 19.0 | 23.2 | 733 | 742 | 767 |
| 100 | 22.3 | 31.3 | 35.8 | 13.2 | 19.2 | 23.3 | 664 | 797 | 892 | 20.1 | 27.7 | 30.2 | 13.1 | 18.7 | 22.1 | 707 | 721 | 734 |
| 200 | 21.3 | 29.7 | 32.7 | 12.3 | 18.2 | 22.7 | 613 | 749 | 788 | 19.7 | 24.1 | 27.4 | 12.1 | 17.8 | 21.1 | 612 | 647 | 653 |
| L.S.D. (5%) | 3.7 | 4.1 | 2.4 | 1.2 | 1.8 | 1.8 | 14 | 13 | 15 | 2.4 | 2.1 | 1.7 | 1.2 | 1.7 | 2.4 | 18 | 20 | 25 |
| **Dimethoate (%)** | | | | | | | | | | | | | | | | | | |
| soil | | | | | | | | | | | | | | | | | | |
| 0.2 | 26.2 | 30.9 | 34.8 | 12.5 | 18.3 | 19.8 | 671 | 800 | 1031 | 23.3 | 27.1 | 30.3 | 13.3 | 16.5 | 18.7 | 732 | 742 | 758 |
| 0.4 | 22.6 | 27.6 | 28.3 | 11.3 | 15.5 | 17.0 | 663 | 772 | 1006 | 20.2 | 22.6 | 22.7 | 12.2 | 13.3 | 14.8 | 711 | 647 | 537 |
| 0.8 | 19.9 | 21.9 | 24.4 | 10.7 | 12.2 | 12.3 | 639 | 732 | 873 | 16.6 | 16.8 | 16.9 | 11.5 | 12.0 | 12.8 | 673 | 521 | 362 |
| foliar | | | | | | | | | | | | | | | | | | |
| 0.2 | 26.9 | 37.7 | 37.6 | 14.3 | 21.0 | 23.8 | 680 | 839 | 1142 | 23.8 | 30.8 | 31.4 | 14.7 | 18.3 | 20.2 | 740 | 751 | 782 |
| 0.4 | 24.4 | 30.3 | 34.1 | 13.2 | 19.8 | 22.7 | 670 | 826 | 1108 | 21.1 | 26.3 | 27.1 | 13.8 | 15.2 | 18.6 | 726 | 743 | 508 |
| 0.8 | 21.1 | 23.4 | 26.7 | 12.8 | 18.7 | 21.2 | 660 | 787 | 1061 | 18.4 | 20.3 | 21.4 | 12.4 | 13.6 | 16.9 | 711 | 637 | 411 |
| L.S.D (5%) | 3.9 | 6.7 | 7.2 | 3.7 | 4.4 | 4.9 | 28 | 33 | 23 | 3.7 | 4.4 | 4.9 | 1.2 | 1.8 | 2.9 | 37 | 50 | 99 |
| **Sulfuric acid (N)** | | | | | | | | | | | | | | | | | | |
| soil | | | | | | | | | | | | | | | | | | |
| 0.02 | 29.2 | 40.7 | 41.3 | 13.8 | 21.3 | 24.3 | 669 | 811 | 1070 | 24.5 | 31.3 | 33.4 | 14.4 | 18.5 | 22.7 | 737 | 749 | 756 |
| 0.04 | 25.5 | 36.2 | 38.7 | 13.2 | 19.2 | 23.3 | 657 | 800 | 1042 | 23.4 | 30.5 | 32.8 | 13.9 | 16.9 | 20.6 | 720 | 734 | 684 |
| 0.08 | 24.8 | 34.3 | 35.2 | 12.2 | 16.5 | 19.7 | 643 | 755 | 910 | 21.6 | 28.2 | 29.3 | 12.6 | 14.7 | 16.3 | 712 | 720 | 657 |
| foliar | | | | | | | | | | | | | | | | | | |
| 0.02 | 27.2 | 37.2 | 36.3 | 15.5 | 19.0 | 23.7 | 681 | 826 | 1143 | 25.3 | 32.4 | 34.6 | 14.7 | 19.2 | 23.3 | 743 | 750 | 772 |
| 0.04 | 24.3 | 35.0 | 37.7 | 13.2 | 18.8 | 23.8 | 666 | 817 | 1101 | 23.9 | 31.3 | 33.3 | 14.2 | 18.4 | 21.7 | 734 | 742 | 675 |
| 0.08 | 22.5 | 31.7 | 33.7 | 12.8 | 17.3 | 20.2 | 654 | 779 | 898 | 22.2 | 29.5 | 30.7 | 13.4 | 16.6 | 19.4 | 703 | 641 | 609 |
| L.S.D. (5%) | 3.3 | 5.8 | 2.2 | 0.8 | 1.7 | 2.5 | 18 | 23 | 27 | 1.2 | 1.7 | 2.3 | 0.7 | 1.1 | 1.5 | 20 | 20 | 16 |

* Control values were used for all pollutant treatments.

observation that dimethoate was more deleterious than other pollutants. The effect of those pollutants in reducing plant height might be due to its effect on the activity of the top meristim and consequently, retardation of the vertical expansion and longitudinal growth. Similar results were obtained by Ali (1982) for lead, Schuster (1978) for dimethoate and Tomer and Kumer (1987) for acids.

The same Table showed that root length was affected seriously by all pollution sources during the growth period of both seasons. In this concern, soil pollution was more effective than foliar treatments. It was, generally, obvious that the highest concentrations were more harmful for root length than other levels. It was clear that dimethoate treatments, particularly as soil application, was the most harmful pollutant as compared with others. Stiborova et al. (1986) found that the high levels of lead were toxic to the meristimatic regions of barely roots, thus retarded their growth and distribution. The negative effect of dimethoate on root growth might be attributed to the inhibitory effect on the vegetative growth, thus reduction in the nutrient supply to other plant organs might occur (McConnell et al., 1985). The deleterious effects of acids on root development were reported by Tomer and Kumer (1987).

It was clear that the middle and high levels of lead significantly decreased the leaf area (Table 1). In this respect, foliar application was more harmful than soil pollution. These findings were in full agreement with those obtained by Bazzaz et al. (1975). Dimethoate and sulfuric acid affected, similarly, the leaf area/plant; in this concern, the highest concentration of both pollutants reduced significantly the area of the leaves. The soil application of either chemical was more harmful than the foliar spray treatments.

The reduction in leaf area/plant resulted from dimethoate and sulfuric acid treatments could be attributed to the less foliage, the small and narrow leaves produced on treated plants. Similar results were found by Venkatesulu and Bhat (1987) for dimethoate; and Cowling and Lockyer (1987) for sulfuric acid.

Dry matter content: A gradual increase in the dry matter deposition in the control-plant organs (leaves, stems and roots), as plants grew toward maturity, was indicated in Table (2).

It was noticeable that all pollutant treatments, particularly at highest concentrations, reduced the dry matter contents of the treated-plant organs. In general, soil pollution was more deleterious in reducing the dry matter content than foliar spray treatments. One exception was that, the dry matter of leaves was affected more seriously by lead spray than soil application.

The phytotoxicity of these chemicals could be ascribed to their adverse effects on the vegetative growth, consequently reduced the dry matter accumulation in plant organs. This conclusion was in harmony with those drawn in earlier studies (McConnell *et al*., 1985, on dimethoate; Jacobson *et al*., 1986, on acids; and Xian, 1989, on lead).

Growth analyses: Data in Table (3) showed that LAI and SLW values were increased with increasing plant age, while LAR and SLA values were decreased as plants grew. These results may be due to increasing the leaf area and deposition dry matter with leaf age as discussed previously (Tables 1 and 2), with the emphasis that the increase of leaf dry matter was proportionally more than that of the leaf area.

It was clear that the highest levels of lead decreased significantly the LAI, SLW and LAR of treated, comparing with untreated plants.

Table (2): Effect of lead, dimethoate and sulfuric acid on dry weights (g/plant) of leaves, stems and roots of tomato plants at different stages of growth.

| Treatments and Method of application | first season | | | | | | | | | second season | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | days after transplanting | | | | | | | | | | | | | | | | | |
| | 45 | 60 | 75 | 45 | 60 | 75 | 45 | 60 | 75 | 45 | 60 | 75 | 45 | 60 | 75 | 45 | 60 | 75 |
| | leaves | | | stems | | | roots | | | leaves | | | stems | | | roots | | |
| Control* | 2.9 | 3.8 | 5.9 | 3.9 | 7.2 | 9.2 | 2.6 | 4.1 | 4.9 | 3.3 | 4.5 | 6.2 | 5.9 | 8.6 | 11.4 | 3.3 | 4.6 | 4.7 |
| Lead (ppm) | | | | | | | | | | | | | | | | | | |
| soil | | | | | | | | | | | | | | | | | | |
| 50 | 2.7 | 4.0 | 5.3 | 3.9 | 7.1 | 8.7 | 2.7 | 4.2 | 4.6 | 3.1 | 4.5 | 6.5 | 5.9 | 8.4 | 11.6 | 3.6 | 4.7 | 4.8 |
| 100 | 2.0 | 3.6 | 5.7 | 3.9 | 6.9 | 8.5 | 2.2 | 3.9 | 4.1 | 3.2 | 3.9 | 4.8 | 5.3 | 7.2 | 9.7 | 2.6 | 4.5 | 4.6 |
| 200 | 1.9 | 3.9 | 3.9 | 3.6 | 6.7 | 8.1 | 2.0 | 3.8 | 4.0 | 2.2 | 2.9 | 4.3 | 4.2 | 5.7 | 8.6 | 2.5 | 3.8 | 3.4 |
| foliar | | | | | | | | | | | | | | | | | | |
| 50 | 2.9 | 3.9 | 4.3 | 3.9 | 7.1 | 9.1 | 2.7 | 4.1 | 4.9 | 3.1 | 4.4 | 5.6 | 5.7 | 7.8 | 10.3 | 2.8 | 4.8 | 4.9 |
| 100 | 2.4 | 4.4 | 4.7 | 3.9 | 7.1 | 8.7 | 2.6 | 4.0 | 4.8 | 2.6 | 3.1 | 4.7 | 4.6 | 6.3 | 9.3 | 2.6 | 3.9 | 4.2 |
| 200 | 2.1 | 3.5 | 3.2 | 3.7 | 6.9 | 8.6 | 2.5 | 4.0 | 4.8 | 2.1 | 2.7 | 3.1 | 4.4 | 5.1 | 8.2 | 2.5 | 3.6 | 3.8 |
| L.S.D.(5%) | 0.1 | 0.2 | 0.8 | 0.1 | 0.2 | 0.8 | 0.20 | NS | 0.11 | 0.4 | 0.5 | 1.4 | 0.4 | 0.9 | 2.1 | 0.7 | 0.7 | 0.5 |
| Dimethoate (%) | | | | | | | | | | | | | | | | | | |
| soil | | | | | | | | | | | | | | | | | | |
| 0.2 | 3.3 | 3.8 | 5.3 | 3.8 | 7.1 | 9.3 | 2.6 | 3.8 | 3.8 | 3.1 | 4.1 | 4.7 | 5.7 | 7.6 | 10.1 | 3.3 | 3.9 | 4.1 |
| 0.4 | 2.6 | 3.2 | 4.2 | 3.6 | 6.5 | 8.9 | 2.5 | 3.4 | 3.5 | 2.7 | 3.1 | 3.0 | 5.2 | 6.3 | 8.4 | 3.1 | 3.5 | 3.6 |
| 0.8 | 2.4 | 2.9 | 3.1 | 3.5 | 6.1 | 7.5 | 2.4 | 3.2 | 3.2 | 2.5 | 2.9 | 2.1 | 4.7 | 6.1 | 6.3 | 2.6 | 3.0 | 3.1 |
| foliar | | | | | | | | | | | | | | | | | | |
| 0.2 | 3.1 | 3.9 | 5.7 | 4.0 | 7.2 | 8.9 | 2.7 | 4.1 | 4.2 | 3.2 | 4.3 | 5.4 | 5.7 | 8.5 | 10.9 | 3.3 | 4.3 | 4.5 |
| 0.4 | 2.9 | 3.4 | 4.9 | 3.7 | 7.1 | 8.4 | 2.6 | 3.9 | 4.0 | 3.1 | 4.1 | 4.5 | 5.4 | 7.7 | 9.2 | 3.5 | 3.9 | 4.1 |
| 0.8 | 2.5 | 3.1 | 4.0 | 3.6 | 6.9 | 8.2 | 2.5 | 3.8 | 3.9 | 2.9 | 3.2 | 3.7 | 5.6 | 6.3 | 7.1 | 3.0 | 3.5 | 3.6 |
| L.S.D. (5%) | 0.2 | NS | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.4 | 0.2 | 0.2 | 0.7 | 0.5 | 0.4 | 0.6 | 1.2 | 0.4 | 0.5 | 0.5 |
| Sulfuric acid (N) | | | | | | | | | | | | | | | | | | |
| soil | | | | | | | | | | | | | | | | | | |
| 0.02 | 2.2 | 2.4 | 3.5 | 3.9 | 6.9 | 8.0 | 2.7 | 4.0 | 4.2 | 3.3 | 3.8 | 5.6 | 5.2 | 7.7 | 10.1 | 3.2 | 4.2 | 4.4 |
| 0.04 | 2.1 | 2.4 | 3.3 | 3.6 | 6.4 | 7.7 | 2.6 | 3.7 | 3.7 | 2.9 | 3.2 | 5.2 | 4.4 | 6.4 | 9.3 | 3.0 | 3.7 | 4.1 |
| 0.08 | 2.0 | 2.1 | 3.2 | 3.6 | 6.0 | 7.0 | 2.1 | 3.4 | 3.5 | 2.1 | 2.6 | 4.3 | 4.0 | 5.8 | 8.6 | 2.5 | 3.1 | 3.7 |
| foliar | | | | | | | | | | | | | | | | | | |
| 0.02 | 2.3 | 2.5 | 4.3 | 3.9 | 7.1 | 8.8 | 2.6 | 4.1 | 4.4 | 3.5 | 4.1 | 5.7 | 5.1 | 6.9 | 9.6 | 3.3 | 4.3 | 4.6 |
| 0.04 | 2.4 | 2.3 | 4.0 | 3.7 | 6.8 | 8.5 | 2.5 | 3.9 | 3.9 | 3.2 | 3.9 | 5.5 | 4.7 | 6.7 | 8.9 | 3.1 | 3.8 | 4.3 |
| 0.08 | 2.3 | 2.3 | 3.9 | 3.7 | 6.3 | 7.1 | 2.3 | 3.6 | 3.7 | 2.8 | 3.3 | 4.4 | 4.2 | 6.1 | 8.4 | 2.8 | 3.4 | 3.8 |
| L.S.D. (5%) | NS | 0.5 | 0.2 | 0.4 | 0.5 | 0.2 | 0.2 | 0.2 | 0.2 | 0.7 | 0.1 | 0.7 | 0.6 | 1.9 | 1.8 | 0.3 | 0.4 | 0.3 |

* control values were used for all pollutant treatments.

Table (3): Effect of lead, dimethoate and sulfuric acid on LAI*, LAR, SLA and SLW of tomato plants at different stages of growth.

**First season** (days after transplanting)

| Treatments and Method of application | LAI ($cm^2/cm^2$) 45 | LAI 60 | LAI 75 | LAR ($cm^2.g^{-1}$) 45 | LAR 60 | LAR 75 | SLA ($cm^2.g^{-1}$) 45 | SLA 60 | SLA 75 | SLW ($mg/cm^2$) 45 | SLW 60 | SLW 75 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| control** | 0.96 | 1.18 | 1.63 | 72.2 | 55.4 | 57.5 | 234 | 220 | 195 | 4.27 | 4.55 | 5.13 |
| Lead (ppm) soil | | | | | | | | | | | | |
| 50 | 0.95 | 1.17 | 1.47 | 78.0 | 53.9 | 55.9 | 249 | 206 | 196 | 4.02 | 4.85 | 5.10 |
| 100 | 0.93 | 1.15 | 1.35 | 80.7 | 56.7 | 52.2 | 327 | 227 | 168 | 3.06 | 4.41 | 5.97 |
| 200 | 0.92 | 1.08 | 1.15 | 86.5 | 53.0 | 50.6 | 342 | 208 | 196 | 2.93 | 5.11 | 4.81 |
| foliar | | | | | | | | | | | | |
| 50 | 0.95 | 1.15 | 1.43 | 70.4 | 53.7 | 55.4 | 231 | 208 | 236 | 4.33 | 4.81 | 4.24 |
| 100 | 0.94 | 1.13 | 1.26 | 74.6 | 51.4 | 49.0 | 277 | 181 | 190 | 3.61 | 5.52 | 5.30 |
| 200 | 0.87 | 1.06 | 1.12 | 73.9 | 50.3 | 47.5 | 292 | 214 | 246 | 3.43 | 4.67 | 4.06 |
| L.S.D.(5%) | 0.05 | 0.10 | 0.24 | 9.2 | 2.4 | 5.3 | 78 | 13 | 66 | 0.89 | 0.78 | 0.90 |
| Dimethoate (%) soil | | | | | | | | | | | | |
| 0.2 | 0.95 | 1.13 | 1.64 | 69.2 | 54.4 | 56.0 | 203 | 211 | 195 | 4.92 | 4.75 | 5.14 |
| 0.4 | 0.94 | 1.09 | 1.42 | 76.2 | 58.9 | 60.6 | 255 | 241 | 240 | 3.92 | 4.15 | 4.17 |
| 0.8 | 0.90 | 1.04 | 1.23 | 77.0 | 60.0 | 63.3 | 266 | 252 | 282 | 3.76 | 3.96 | 3.55 |
| foliar | | | | | | | | | | | | |
| 0.2 | 0.96 | 1.19 | 1.62 | 69.4 | 42.0 | 60.7 | 219 | 215 | 200 | 4.56 | 4.65 | 4.99 |
| 0.4 | 0.95 | 1.17 | 1.57 | 72.8 | 57.4 | 68.0 | 231 | 243 | 226 | 4.33 | 4.12 | 4.42 |
| 0.8 | 0.93 | 1.11 | 1.50 | 74.2 | 56.2 | 63.2 | 264 | 254 | 265 | 3.79 | 3.94 | 3.77 |
| L.S.D. (5%) | 0.04 | 0.11 | 0.28 | 8.7 | 3.6 | 5.8 | 21 | 23 | 72 | 0.90 | 0.82 | 0.78 |
| Sulfuric acid (N) soil | | | | | | | | | | | | |
| 0.02 | 0.95 | 1.15 | 1.51 | 67.0 | 61.0 | 68.2 | 304 | 338 | 306 | 3.29 | 2.96 | 3.27 |
| 0.04 | 0.93 | 1.13 | 1.47 | 79.2 | 64.0 | 70.9 | 313 | 333 | 316 | 3.20 | 3.00 | 3.17 |
| 0.08 | 0.91 | 1.07 | 1.29 | 83.5 | 65.7 | 66.4 | 322 | 360 | 284 | 3.11 | 2.78 | 3.52 |
| foliar | | | | | | | | | | | | |
| 0.02 | 0.96 | 1.17 | 1.62 | 77.4 | 60.3 | 65.3 | 296 | 330 | 265 | 3.38 | 3.03 | 3.76 |
| 0.04 | 0.94 | 1.16 | 1.56 | 77.4 | 62.8 | 67.1 | 278 | 355 | 275 | 3.60 | 2.82 | 3.63 |
| 0.08 | 0.83 | 1.10 | 1.27 | 68.8 | 63.9 | 61.1 | 284 | 339 | 230 | 3.51 | 2.95 | 4.34 |
| L.S.D. (5%) | 0.03 | 0.07 | 0.34 | 7.2 | 6.4 | 9.3 | 76 | 93 | 86 | 0.79 | 1.88 | 1.30 |

**Second season** (days after transplanting)

| Treatments and Method of application | LAI ($cm^2/cm^2$) 45 | LAI 60 | LAI 75 | LAR ($cm^2.g^{-1}$) 45 | LAR 60 | LAR 75 | SLA ($cm^2.g^{-1}$) 45 | SLA 60 | SLA 75 | SLW ($mg/cm^2$) 45 | SLW 60 | SLW 75 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| control** | 1.05 | 1.07 | 1.15 | 59.7 | 42.8 | 36.4 | 225 | 168 | 131 | 4.44 | 5.94 | 7.64 |
| Lead (ppm) soil | | | | | | | | | | | | |
| 50 | 1.05 | 1.09 | 1.12 | 58.7 | 50.3 | 34.6 | 239 | 171 | 122 | 4.19 | 5.95 | 8.20 |
| 100 | 1.03 | 1.03 | 1.05 | 65.9 | 50.6 | 67.0 | 228 | 187 | 155 | 4.38 | 5.35 | 6.45 |
| 200 | 0.90 | 0.99 | 1.01 | 71.5 | 48.8 | 80.0 | 289 | 242 | 166 | 3.46 | 4.13 | 6.04 |
| foliar | | | | | | | | | | | | |
| 50 | 1.04 | 1.05 | 1.08 | 63.2 | 49.1 | 41.9 | 236 | 169 | 137 | 4.23 | 5.93 | 7.30 |
| 100 | 1.00 | 1.02 | 1.04 | 72.1 | 46.5 | 40.3 | 272 | 233 | 156 | 3.68 | 4.30 | 6.40 |
| 200 | 0.86 | 0.92 | 0.92 | 68.0 | 43.4 | 39.3 | 291 | 240 | 211 | 3.43 | 4.17 | 4.75 |
| L.S.D.(5%) | 0.07 | 0.04 | 0.06 | 8.9 | 3.3 | 12.0 | 37 | 61 | 43 | 0.27 | 0.42 | 1.05 |
| Dimethoate (%) soil | | | | | | | | | | | | |
| 0.2 | 1.04 | 1.05 | 1.07 | 60.5 | 47.6 | 40.1 | 236 | 181 | 161 | 4.23 | 5.53 | 6.20 |
| 0.4 | 1.01 | 0.92 | 0.76 | 64.6 | 50.2 | 35.8 | 263 | 209 | 179 | 3.80 | 4.79 | 5.59 |
| 0.8 | 0.96 | 0.74 | 0.51 | 68.7 | 43.4 | 31.5 | 269 | 180 | 172 | 3.71 | 5.57 | 5.80 |
| foliar | | | | | | | | | | | | |
| 0.2 | 1.05 | 1.06 | 1.10 | 60.7 | 43.9 | 37.6 | 231 | 175 | 145 | 4.32 | 5.73 | 6.91 |
| 0.4 | 1.03 | 1.05 | 0.72 | 60.5 | 47.3 | 27.9 | 234 | 181 | 113 | 4.72 | 5.52 | 8.86 |
| 0.8 | 1.01 | 0.90 | 0.58 | 61.8 | 49.0 | 38.5 | 245 | 199 | 111 | 4.08 | 5.02 | 9.00 |
| L.S.D. (5%) | 0.08 | 0.05 | 0.23 | 3.9 | 4.3 | 9.7 | 20 | 22 | 19 | 0.39 | 0.46 | 1.21 |
| Sulfuric acid (N) soil | | | | | | | | | | | | |
| 0.02 | 1.04 | 1.06 | 1.07 | 63.0 | 47.7 | 37.6 | 223 | 197 | 135 | 4.48 | 5.07 | 7.41 |
| 0.04 | 1.02 | 1.04 | 0.97 | 69.9 | 55.2 | 36.8 | 248 | 225 | 131 | 4.03 | 4.36 | 7.60 |
| 0.08 | 1.01 | 1.02 | 0.93 | 82.8 | 62.6 | 39.6 | 339 | 276 | 152 | 2.95 | 3.61 | 6.54 |
| foliar | | | | | | | | | | | | |
| 0.02 | 1.05 | 1.06 | 1.09 | 62.4 | 49.0 | 38.8 | 212 | 182 | 135 | 4.71 | 5.47 | 7.38 |
| 0.04 | 1.04 | 1.05 | 0.95 | 66.7 | 51.5 | 36.1 | 229 | 190 | 122 | 4.36 | 5.26 | 8.15 |
| 0.08 | 0.99 | 0.91 | 0.86 | 71.7 | 50.1 | 36.7 | 251 | 194 | 138 | 3.98 | 5.15 | 7.22 |
| L.S.D. (5%) | 0.05 | 0.06 | 0.09 | 9.9 | 8.8 | 3.4 | 29 | 98 | 23 | 0.30 | 0.88 | 0.78 |

* LAI, LAR, SLA, and SLW are leaf area index, leaf area ratio, specific leaf area and specific leaf weight, respectively.
** control values were used for comparing all pollutant treatments.

In contrast, the SLA was increased with increasing lead levels. The decrease in LAI and LAR under lead treatments could be attributed to the deleterious effect on leaf area. It seems that the effect on leaf dry-matter deposition was much more harmful than on leaf area, as a consequence lead caused a significant decrease in SLW and increase in SLA as compared with control plants.

It was obvious that foliar spray was more harmful in reducing these growth parameters than soil application. The harmful effects of lead pollution to the leaf area and dry matter accumulation were also reported by Bazzaz et al. (1975) and Ali (1982).

The highest levels of dimethoate caused a significant decrease in both LAI and SLW; while LAR and SLA were increased under the middle and high levels. It seems that dimethoate affected the dry matter accumulation more seriously than the leaf area. It was obvious, in general, that foliar spray was more harmful in decreasing LAR, SLA and SLW values; while LAI values were affected more negatively under soil application methods. The reduction in leaf area/plant resulted from dimethoate was ascribed to the less foliage developed per plant (Venkatesulu and Bhat, 1987) and to the small leaflets (Kiplinger et al., 1973). The adverse effect of dimethoate on the dry matter deposition might be attributed to the injuring effect on the growth of plant organs (Schuster, 1978)

Most sulfuric acid concentrations, particularly the middle and high ones, caused a remarkable decrease in LAI and SLW; while LAR and SLA were increased under the same concentrations. It was clear from the data that soil application affected both LAI and SLW more negatively than the foliar application; while the reverse was true for LAR and SLA. The adverse effects of $H_2SO_4$ on leaf area and dry weight were reported also by Tang (1986) and (Jacobson et al., 1986), respectively.

Data presented in Table (4) showed clearly that NAR and RGR were decreased with time toward maturity; in contrast, RLGR values were increased. The harmful effect of pollutants on these growth parameters was clearly observed during the period between 60-75 days after transplanting; the time by which plants were close to the senescence stage.

The foliar spray of lead caused more damaging effects on NAR, RGR and RLGR than that obtained from soil pollution. The decrease in those parameters might be attributed to the low deposition of dry matter in plant tissues as a result of lead accumulation in plant parts causing a toxicity or inhibition of physiological processes. This conclusion is in full agreement with that reported by Ali (1982). On the other hand, dimethoate and sulfuric acid as soil treatments caused more deleterious effects on the above parameters than the foliar spray method. The deleterious effects of both compounds on the photosynthetic activity and hence the dry matter accumulation were reported to decrease the NAR and RGR (Granett and Taylor, 1980 and McConnell et al., 1985).

Flowering and Yield: Data presented in Table (5) illustrated that the high concentrations of lead decreased the tomato yield as flowering time was affected negatively. In this concern, soil pollution was more harmful in reducing fruit yield than foliar spray. These findings might indicate that lead exhibited its effect after longer period of growth at which plants might be shifted from vegetative to reproductive stage. Consequently, affecting fruit formation process. Similar results were obtained by Mengel and Kirkby (1987) and Xian (1989).

Flowering and fruit yield were also affected by dimethoate, since 0.8% (foliar spray) and 0.4 and 0.8% (soil application) altered completely the production of flowers and

Table (4): Effect of lead, dimethoate and sulfuric acid on RGR*, RLGR and NAR of tomato plants at different stages of growth.

| Treatments and Method of application | season (1989) | | | | | | season (1990) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | days after transplanting | | | | | | | | | | | |
| | RGR ($mg.g^{-1}.d^{-1}$) | | RLGR ($cm^{2}.d^{-1}$) | | NAR ($mg.g^{-1}.d^{-1}$) | | RGR ($mg.g^{-1}.d^{-1}$) | | RLGR ($cm^{2}.d^{-1}$) | | NAR ($mg.g^{-1}.d^{-1}$) | |
| | 45-60 | 60-75 | 45-60 | 60-75 | 45-60 | 60-75 | 45-60 | 60-75 | 45-60 | 60-75 | 45-60 | 60-75 |
| Control** | 116 | 106 | 0.337 | 0.383 | 0.393 | 0.267 | 97 | 64 | 0.171 | 0.267 | 0.349 | 0.386 |
| **Lead (ppm)** | | | | | | | | | | | | |
| soil | | | | | | | | | | | | |
| 50 | 127 | 80 | 0.336 | 0.358 | 0.350 | 0.207 | 135 | 66 | 0.224 | 0.212 | 0.350 | 0.443 |
| 100 | 123 | 91 | 0.339 | 0.329 | 0.238 | 0.179 | 140 | 80 | 0.231 | 0.181 | 0.238 | 0.302 |
| 200 | 129 | 31 | 0.316 | 0.287 | 0.217 | 0.186 | 114 | 85 | 0.279 | 0.154 | 0.217 | 0.408 |
| foliar | | | | | | | | | | | | |
| 50 | 115 | 78 | 0.330 | 0.354 | 0.304 | 0.176 | 84 | 78 | 0.146 | 0.215 | 0.304 | 0.331 |
| 100 | 126 | 66 | 0.326 | 0.304 | 0.204 | 0.229 | 116 | 66 | 0.176 | 0.171 | 0.207 | 0.420 |
| 200 | 126 | 35 | 0.327 | 0.244 | 0.137 | 0.182 | 181 | 35 | 0.237 | 0.119 | 0.137 | 0.356 |
| LSD (5%) | 5 | 24 | 0.013 | 0.033 | 0.097 | 0.021 | 18 | 16 | 0.065 | 0.089 | 0.120 | 0.068 |
| **Dimethoate (%)** | | | | | | | | | | | | |
| soil | | | | | | | | | | | | |
| 0.2 | 107 | 87 | 0.324 | 0.363 | 0.288 | 0.277 | 84 | 80 | 0.184 | 0.185 | 0.344 | 0.262 |
| 0.4 | 99 | 84 | 0.313 | 0.364 | 0.193 | 0.133 | 43 | 49 | 0.146 | 0.175 | 0.313 | 0.259 |
| 0.8 | 91 | 31 | 0.302 | 0.330 | 0.115 | 0.075 | 53 | 35 | 0.130 | 0.164 | 0.304 | 0.120 |
| foliar | | | | | | | | | | | | |
| 0.2 | 155 | 75 | 0.338 | 0.381 | 0.332 | 0.296 | 106 | 87 | 0.160 | 0.229 | 0.354 | 0.209 |
| 0.4 | 110 | 43 | 0.337 | 0.376 | 0.303 | 0.167 | 87 | 61 | 0.189 | 0.210 | 0.357 | 0.194 |
| 0.8 | 109 | 67 | 0.323 | 0.374 | 0.152 | 0.092 | 27 | 22 | 0.160 | 0.180 | 0.358 | 0.120 |
| LSD (5%) | 23 | 34 | 0.015 | 0.024 | 0.125 | 0.143 | 32 | 24 | 0.017 | 0.120 | 0.013 | 0.065 |
| **Sulfuric acid (N)** | | | | | | | | | | | | |
| soil | | | | | | | | | | | | |
| 0.02 | 100 | 58 | 0.330 | 0.370 | 0.288 | 0.157 | 92 | 99 | 0.166 | 0.252 | 0.269 | 0.372 |
| 0.04 | 96 | 53 | 0.031 | 0.366 | 0.275 | 0.161 | 73 | 111 | 0.176 | 0.261 | 0.212 | 0.439 |
| 0.08 | 89 | 53 | 0.315 | 0.336 | 0.240 | 0.165 | 71 | 109 | 0.139 | 0.276 | 0.216 | 0.444 |
| foliar | | | | | | | | | | | | |
| 0.02 | 106 | 89 | 0.332 | 0.384 | 0.299 | 0.240 | 82 | 102 | 0.130 | 0.235 | 0.215 | 0.375 |
| 0.04 | 99 | 82 | 0.334 | 0.377 | 0.288 | 0.236 | 82 | 97 | 0.139 | 0.280 | 0.246 | 0.355 |
| 0.08 | 91 | 61 | 0.322 | 0.319 | 0.238 | 0.188 | 73 | 89 | 0.141 | 0.231 | 0.240 | 0.341 |
| LSD (5%) | 18 | 40 | 0.012 | 0.022 | 0.067 | 0.120 | 20 | 32 | 0.022 | 0.025 | 0.090 | 0.038 |

* RGR, RLGR, and NAR are relative growth rate, relative leaf area growth rate, and net assimilation rate, respectively.
** control values were used for comparing all pollutant treatments.

Table (5):Effect of lead, dimethoate and sulfuric acid on flowering date and fruit yield (g/plant) of tomato plants.

| Method of application | first season days to flower | first season fruit yield (g/plant) | second season days to flower | second season fruit yield (g/plant) |
|---|---|---|---|---|
| Lead (ppm) | | | | |
| control | 51.4 | 750.3 | 50.2 | 834.3 |
| soil | | | | |
| 50 | 50.0 | 740.7 | 49.0 | 811.6 |
| 100 | 48.0 | 639.6 | 48.0 | 740.4 |
| 200 | 46.0 | 525.5 | 47.0 | 647.7 |
| foliar | | | | |
| 50 | 52.1 | 745.5 | 51.3 | 826.5 |
| 100 | 50.3 | 740.2 | 50.4 | 789.7 |
| 200 | 49.0 | 631.3 | 48.0 | 706.3 |
| LSD (5%) | 2.6 | 48.9 | 2.3 | 43.6 |
| Dimethoate (%) | | | | |
| soil | | | | |
| 0.2 | 53.1 | 646.2 | 49.2 | 640.0 |
| 0.4 | 0.0 | 0.0 | 0.0 | 00.0 |
| 0.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| foliar | | | | |
| 0.2 | 51.6 | 756.4 | 50.6 | 830.1 |
| 0.4 | 56.4 | 497.3 | 53.4 | 720.5 |
| 0.8 | 0.0 | 0.0 | 0.0 | 0.0 |
| LSD (5%) | 2.4 | 56.7 | 2.8 | 67.9 |
| Sulfuric acid (N) | | | | |
| soil | | | | |
| 0.02 | 49.0 | 633.7 | 50.0 | 713.0 |
| 0.04 | 38.8 | 500.6 | 50.0 | 500.6 |
| 0.08 | 00.0 | 000.0 | 00.0 | 000.0 |
| foliar | | | | |
| 0.02 | 50.0 | 665.1 | 50.0 | 782.6 |
| 0.04 | 53.3 | 521.2 | 53.4 | 560.5 |
| 0.08 | 55.1 | 278.3 | 54.2 | 311.5 |
| LSD (5%) | 4.8 | 55.7 | 1.1 | 68.4 |

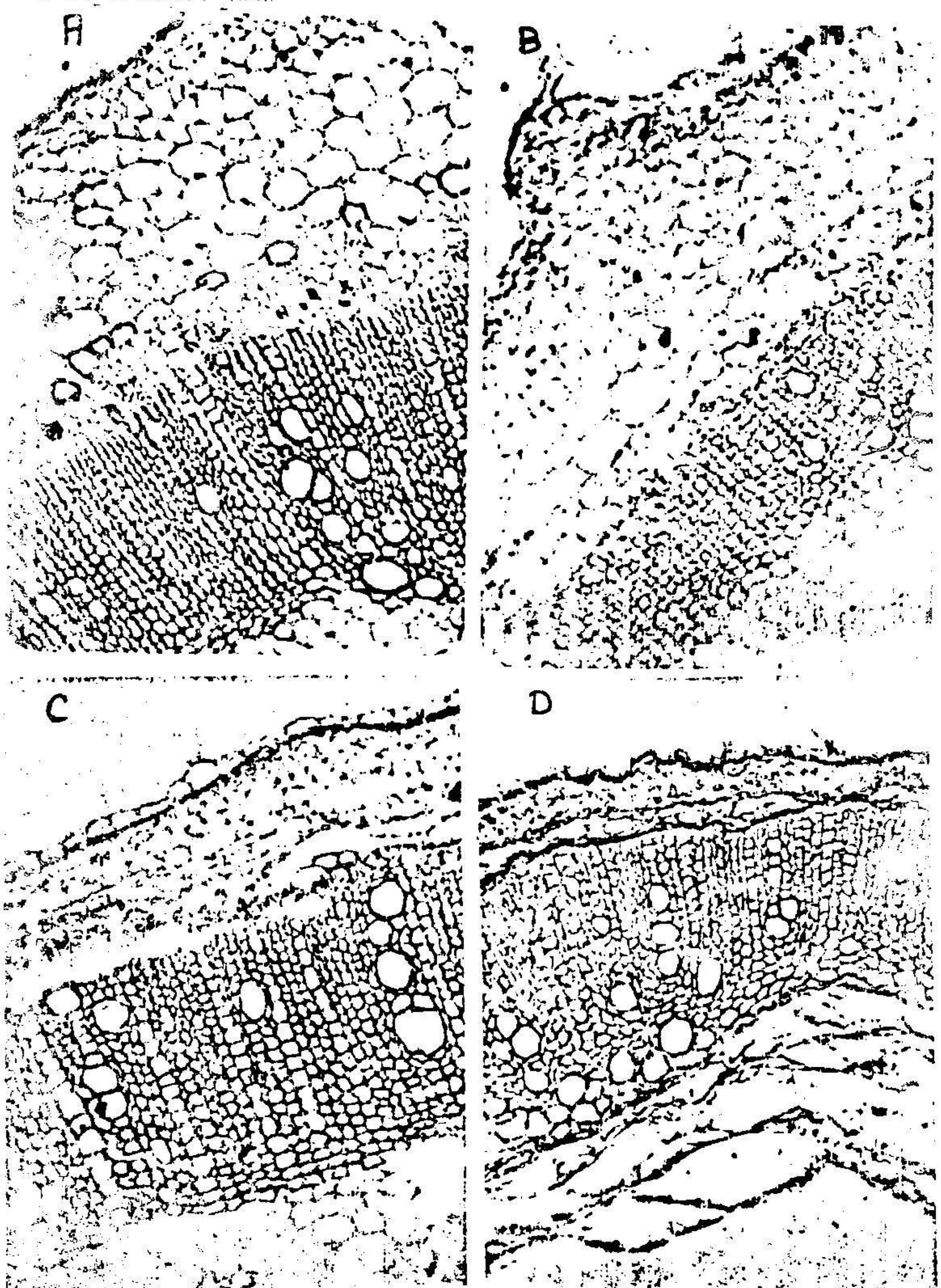
fruits. The harmful effect of dimethoate on flowering and fruit yield was reported also by Lal (1975) and Elmer and Embleton (1975).

Low acid concentration enhanced flowering, while high concentrations delayed the process. However, all treatments caused a marked reduction in fruit yield. The highest acid concentration caused a complete cessation of flowering, thus plants under this treatment were almost fruitless. The reduction in flowering and yield production of many plant species as a result of sulfuric and other inorganic acids were also reported by Heggested et al. (1986).

Stem Structure: Fig. (1-B) showed clearly the effect of 200 ppm lead, in soil application form, on the anatomy of tomato stems. It was clear that the area and thickness of xylem tissues in treated plants became smaller than those of control (Fig. 1-A). Moreover, the width of xylem vessels was less than those of untreated plants. It appeared also that lead treatments affected the walls of cortex cells as they became thinner and relatively loose. The secondary xylem elements of treated stems became more impact with each other than those of untreated ones. The reduction in the area of vascular tissues might be attributed to the negative effect of lead on the division and enlargement of the vascular and intervascular cambial cells, thus decreasing the number of vascular elements.

Fig. (1-C) indicated clearly that the effect of dimethoate 0.8 % was mainly on the parenchyma tissues such as that of cortex and pith. It was evident from the figures that cortex area became small and narrow. Some layers of the cortex cells, particulary those near to the vascular tissues, were crushed and many cells in those layers were completely destroyed. Phloem tissues appeared to be affected as some of its component became loose comparing to control stems (Fig. 1-A). Pith cells were also

Fig. (1): Cross sections of tomato stems as affected by pollutants. A, control; B, lead (200ppm); C, dimethoate (0.8%); and D, sulfuric acid (0.08%), 450X



affected and many of these cells were distributed with dimethoate spray. The decrease in the area of cortex region might be attributed to the effect of the high concentration of dimethoate on the activity of the enzymes which activate the division and elongation of cells of parenchyma tissues.

The cross section of tomato stems appeared in Fig. (1-D) showed markedly that H2SO4 (0.08 N) caused a complete destruction to cortex and pith cells. Both regions appeared as if they are completely empty of cells except some filaments remained from the walls of decomposed cells. Regarding vascular tissues, it was clear that xylem region become narrow. Phloem tissue was also affected as the remaining cortex cells stacked with the xylem elements. The harmful effect of H2SO4 on the tissues might be attributed to the effect of acidity on the chemical compositions of the cell walls and also, as it is well known, to increasing activity of some hydrolytic enzymes that influence the decomposition of parenchyma cells. In this respect, Uhring (1978) found that acidity caused a destruction of the vascular system and a breakdown of the parenchyma cells in petunia plants.

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# تأثير بعض مصادر التلوث البيئي على نباتات الطماطم
# ١-التأثير على النمو والمحصول والتركيب التشريحي

## ملخص البحث


أجري هذا البحث بكلية الزراعة ، جامعة المنوفية خلال الموسم الصيفي لعامي ١٩٨٩ و ١٩٩٠ لدراسة تأثير بعض الملوثات البيئية المنتشرة في البيئة المصرية. وقد اختبر الرصاص (ممثلا لتأثير التلوث بالعناصر الصغرى) بتركيز ٥٠و ١٠٠ و ٢٠٠ جزء في المليون والدايمثويت (ممثلا لتأثير التلوث بالمبيدات الحشرية) بتركيز ١و ٢ و ٤ و٨م في الماء كما اختبر حمض الكبريتيك (ممثلا لتأثير التلوث الناتج عن انخفاض رقم الحموضة) بتركيز ٢ م و٤ م و٨ م عياري على النمو الخضري والزهري والمحصول الثمري وأيضا التركيب التشريحي لنباتات الطماطم. وقد استخدم الماء كمعاملة مقارنة وتم استخدام هذه الملوثات بطريقتين احداهما هي الاضافة مع ماء الري (تلوث مائي وتلوث التربة) والاخرى رشا على المجموع الخضري (تلوث هوائي).

وقد اظهرت النتائج المتحصل عليها ان التلوث بالرصاص خاصة ٢٠٠ ج ف م ادى الى نقص واضح في طول سوق وجذور النباتات المعاملة وأيضا مساحة أوراقها والوزن الجاف للاعضاء النباتية. بالاضافة لذلك، كان هناك نقص واضح في نسبة المساحة الورقية و معدل نموها وأيضا الوزن النوعي للاوراق بينما ازدادت المساحة النوعية للاوراق. وقد كان واضحا ان المعاملة بالرش ذات اثر أكثر ضررا من معاملة التربة (تحت التركيز الواحد) ليس فقط على صافي معدل التمثيل ومعدل النمو النسبي للاوراق او النبات ككل ولكن أيضا على قياسات النمو الاخرى. أما بالنسبة للمحصول الثمري فقد تناقص بدرجة ملموسة بالتلوث بالرصاص على الرغم من ان كان هناك تبكيرا في تزهير النباتات المعاملة عن مثيلتها الغير معاملة. وبالنسبة للتغيرات في التركيب التشريحي فقد اظهرت المعاملة بالتركيز العالي نقصا واضحا في مساحة الاسطوانة الوعائية كما اصبحت عناصر الخشب واللحاء اقل اتساعا عن نباتات المقارنة.

أدت التركيزات العالية من الدايمثويت الى توقف شبه كامل لنمو النباتات، حيث تناقص معدل تراكم المادة الجافة وأيضا نمو الاوراق بدرجة كبيرة مما أدى الى تناقص المساحة الورقية للنبات والوزن النوعي لها وعلى العكس من ذلك ازدادت المساحة النوعية للاوراق. أما صافي معدل التمثيل وأيضا معدل النمو النسبي سواء للاوراق او للنبات ككل فقد تأثرا بشدة بالمعاملة بالدايمثويت. وقد اوضح الفحص التشريحي ان التركيز المرتفع من المبيد ادى الى انكماش مساحة الانسجة البارنشيمية خاصة منطقة القشرة والنخاع للنباتات المعاملة.

بالنسبة للتلوث الحمضي فقد اثرت التركيزات المتوسطة والمرتفعة من حمض الكبريتيك على جميع قيم النمو تأثيرا سالبا مماثلا لتأثير التلوث بالدايمثويت الا انه كان اشد ضررا عند المستويات العالية. وفي جميع الحالات كانت معاملة التربة الاكثر تأثيرا من رش المجموع الخضري. وقد لوحظ تهتك شديد للخلايا البارنشيمية الموجودة في مناطق القشرة والنخاع وأيضا نقص في عدد الاوعية الناقلة.