Environmental Management and Health

An analysis of pesticide impact on air quality, especially surface ozone

Hoda F.S. Rizk
Air Pollution Research Department, National Research Center, Cairo, Egypt
Ahmed A. El-Abssawy
Air Pollution Research Department, National Research Center, Cairo, Egypt
Mamdouh I. Khoder
Air Pollution Research Department, National Research Center, Cairo, Egypt

Environmental Management and Health, Vol. 13 No. 2, 2002, *Environmental Management and Health* examines in a deep and objective manner the various environmental factors and their impact on human health, to suggest possible remedies and to adopt an inter-disciplinary approach to the problem of managing the environment so as to reduce the deleterious effects of man's activities in this century.

ISSN 0956-6163

Environmental Management and Health
is indexed and abstracted in:
Academic Search
Anbar International Management Database
Autographics
Barbour Index
CAB Abstracts
CAB Health
CSA Mechanical & Transport Engineering Abstracts (Selective)
Current Citations Express
Environmental Abstracts
Environmental Periodicals Bibliography
EP Collection
Galileo
Health Source
Health & Safety Science Abstracts
Innovative
Manning & Napier
MasterFILE
OCLC
Pollution Abstracts (Published by Cambridge Scientific Abstracts)
Research Trends in Environmental Technology
Soils and Fertilizers
Telebase

In Cooperation with The United Nations Environment Programme (UNEP)

UNEP

ISOQAR QUALITY ASSURED FIRM ISO 9002 UKAS QUALITY MANAGEMENT 026
Certificate number ...1985/99.........

Pre-press activities, comprising origination and pagination, associated with the publication of management journals

Internet services available worldwide on URL http://www.emeraldinsight.com

For customer service enquiries http://www.emeraldinsight.com/customer/home.htm

Emerald
60/62 Toller Lane, Bradford,
West Yorkshire, England BD8 9BY
Telephone: (44) 1274 777700
Fax: (44) 1274 785200

INVESTOR IN PEOPLE

Regional offices:

For North America
Emerald, 44 Brattle Street, 4th Floor,
Cambridge, MA 02138, USA
Tel: Toll free +1 888 622 0075
Fax: +1 617 354 6875
E-mail: america@emeraldinsight.com

For South East Asia
Emerald, 7-2, 7th Floor, Menara KLH,
Bandar Puchong Jaya, 47100 Puchong,
Selangor, Malaysia
Telephone: 603-5766 009
Fax: 603-5766 007
E-mail: asiapacific@emeraldinsight.com

For Japan
Emerald, 256-25 Kounosudai, Nagareyama City,
Chiba Prefecture, Japan 270-0102
Telephone: (81) 471 54 6245
Fax: (81) 471 54 6268
E-mail: japan@emeraldinsight.com

Please contact the following for further information:

Missing issue claims*: (44) 1274 777700

Sample copy requests: Customer Help Desk at Bradford (44) 1274 785280 or your regional office.

All orders and subscription enquiries: Customer Operations at Bradford or your regional office.

*Missing issue claims will be fulfilled if claimed within four months of date of despatch. Maximum of one claim per issue.

Reprint service enquiries:
Carole Noble, Bradford
E-mail: cnoble@emeraldinsight.com

Copyright permissions:
Charles Parker, Bradford

Printed by Printhaus Graphique, 2 North Portway Close, Round Spinney, Northampton NN3 8RQ

The research register for this journal is available at
http://www.emeraldinsight.com/researchregisters

The current issue and full text archive of this journal is available at
http://www.emeraldinsight.com/0956-6163.htm

An analysis of pesticide impact on air quality, especially surface ozone

Hoda F.S. Rizk, Ahmed A. El-Abssawy and Mamdouh I. Khoder
Air Pollution Research Department, National Research Center, Cairo, Egypt

Keywords *Pest control, Environment*

Abstract *The present study aims at shedding some light on the serious effect of insecure pesticides to the surface ozone as a secondary pollutant resulting from some photochemical reactions during the sunny days. The temporal variation in O_3 concentrations due to pesticide spray, the corresponding temperature and relative humidity have been monitored and discussed. The air quality index (AQI) for the maximum concentrations of O_3 within each day of study has also been deduced. The obtained results illustrated that O_3 concentrations had been increased after pesticide spray with different values from hour to hour and then began to decay after one day or more according to its concentrations. The second day had the highest concentrations of the O_3 including the maximum concentration, which was recorded at hour 14 local time. Furthermore, most of AQI values were restricted between harmful and very harmful index during the second days and only the third day of the first experiment. Moreover, temperature and relative humidity have significantly influenced ozone concentrations with positive and negative correlation coefficients, respectively.*

Introduction

Pesticides, as is well known, play a serious role among the environment contaminating xenobiotics. First of all are the pesticide-exposed workers, humans, animals and plants, which are nearby the treated land. But the total number of those who may be endangered include those affected by the contamination of food, water, and air and indirectly through that sort of soil. Moreover, the toxicity of the pesticides, the organic carcinogenic components will be produced during the pesticide decomposition, photodecomposition and degradation by UV solar radiation. Many kinds of pesticides undergo photodecomposition and degradation in the environment hence they give rise to high concentrations of surface ozone and other hazardous pollutants.

One of the well known insecticides applied for cotton and other crops in Egypt is Lannate (Aly, 1989). Lannate represents a carbamate pesticide which has a methyl group (WHO, 1986). Thus, Lannate is a hydrocarbon organic pesticide, which acts as ozone precursor as n-methyl carbamates absorb radiation available in the solar region (wavelength, $\lambda = 300$nm) and hence would be expected to undergo photooxidation as well as metabolic degradation

The authors are greatly thankful to Mrs Salwa M. Hassan for her sharing of part of the experimental work of the present study.

Environmental Management and Health, Vol. 13 No. 2, 2002, pp. 152-162. © MCB UP Limited, 0956-6163
DOI 10.1108/09566160210424581

(Addison *et al.*, 1974). In spite of its distribution by air as a minor factor, its slow volatilization from water or soil at normal temperature may increase with high temperature (WHO, 1986; Aly, 1989). Another organic hydrocarbon, which has a considerable contact activity on cotton plants, is an organophosphorous systemic insecticide called Dimethoate. Apart from its toxicity, during photolysis under the climatic conditions in Egypt, particularly during summer (Khalil *et al.*, 1984a), this insecticide is enhanced by UV solar radiation (Mitchel, 1961). Furthermore, its decomposition and degradation in the environment may be an effective hydrocarbon precursor for surface ozone. Its photodecomposition and degradation, as many other insecticides like methyl parathion, in the environment during suitable climatic conditions may be an effective hydrocarbon precursor for surface ozone which increases its toxic effects and carcinogenic hazards, as well as enhancing the "greenhouse effects" (Khalil *et al.*, 1984b; Farag *et al.*, 1993). Photochemical reactions are of importance in air pollution because of their products, (mainly free radicals). These products initiate or participate in a number of other reactions leading to the conversion of primary pollutants to secondary ones. Ozone is a prevalent secondary pollutant and a photochemical oxidant, and the major component of smog.

Ozone is formed in air, in the presence of sunlight, as a result of the chemical combination of reactive hydrocarbons with nitrogen oxides (NO_x). It is also deduced from the complex chemical interactions of NO_x and organic species (Haagen-Smit, 1952). Ozone is likewise considered as a product of the photochemical oxidation of carbon monoxide in presence of NO_x (Sanford *et al.*, 1990). Bottenheim *et al.* (1977) clarified the radical and vital role of the solar radiation and nitrogen oxides on the surface ozone formation from the following equation:

$$O_3 \simeq K_1\{NO_2\}/K_2\{NO\} \tag{1}$$

where K_1, K_2 are the specific reaction rate constants for the solar radiation (at $\lambda < 430$nm) and nitrogen dioxide reaction which leads to ozone production. In winter k_1/k_2 are about 30 per cent less than in summer because of lower solar intensity and temperature. Equation (1) also illustrates the increase in NO concentration will be decrease the level of the atmospheric ozone as reported by Kuklin (1987).

The prospective object of the present study is to highlight the serious effects of insecure pesticide spray, particularly through the sunny days which through the pesticides photolysis cause a high increase in surface ozone concentration in the ambient air and accordingly increases the dangerous smog level concentration.

Materials and methods

The experimental work of the current study had been undertaken in a cotton farm of the Agricultural Research Institute in Giza through two months represented the spring and summer seasons. The farm locates at the south of

Cairo University and is downwind of an industrial area (Shoubra El-Kheima) and it is surrounded by a heavy vehicular traffic motion from the east and west side. The hourly O_3 concentrations, the temperature and relative humidity were recorded at a fixed site 500m from the treated farm and the site was at a height of 20m. The temporal variations in the O_3 concentration during the background (control) day (the day before the pesticide spray) and after spray process have been hourly measured by using Dasibi Ozone Monitor, which was directly calibrated before the experimental work. The monitor is based on UV absorption spectroscopy by ozone in the range of 200-300nm wavelengths (Hodgeson, 1972). While the temperature and relative humidity had been monitored by using a Sigma-II Thermohygrograph (NO 7210, SK Sato Keiryoki MFG-Co, Ltd, Japan).

It is necessary to denote to a close attention that the spray took place at morning (around 9 and 7hr local time through the cold and hot weather, respectively) and the second day means that day directly followed the spray day. Furthermore, the period between the first and the second experiments was about 50 days. Otherwise, there were only three days between the two following spray days during the second and third experiments. The day (14/7/1999) represented the third day through the second experiment and simultaneously represented the day before the third-pesticide spray process during the third experiment. Finally, there were no measurements of O_3 concentrations at the hour 15 during the third day of the first experiment and also at 8hr during the two background days of the second and third experiments.

Two different pesticide kinds were used during the present study the first of them was called Courakron and its formula is as following: O-(4-bromo-2-chlorophenyl)-O-ethyl 8-propylphosphorothionate.

While the second one was called Cutabroon and its formula is as following: *N*-(4-(3-chloro-5-trifluoromethyl 2-pyridyloxy 2-pyridyloxy) 3, 5-dichlorophenyl Ni (2-6 difluorobenzol urea). The pH of the solution of the used pesticide in distilled water was between 6 and 7.

The increase percentages in O_3 concentrations have been calculated by the following equation:

$$\text{Increase\%} = \left\{\frac{(C_2 - C_1)}{C_1}\right\} * 100 \quad (2)$$

where:

C_1: represents the hourly O_3 concentration in parts per billion (ppb) during the background day; and

C_2: represents the corresponding O_3 concentration in ppb during the following day at the same hour.

On other hand, air quality index (AQI) was calculated according to Prusty and Rout (1993) equation which was firstly deduced by Ott and Thom (1976) as:

$$I = (X/X_s) * 100 \quad (3)$$

where X is the observed value of the pollutant and X_s is the prescribed standard for the pollutant. According to Egyptian environmental protection low (EEAA, 1995) X_s for O_3 concentration equals 100ppb for one hour. If $I \leq 100$ the given parameter is within the prescribed limit. But if $I > 100$ it implies that the parameter exceeded the prescribed standard and the ambient air is harmful for inhalation by human lungs (Tiwari and Ali, 1987).

Results and discussions

The results illustrated in Figures 1, 2 and 3 show the hourly O_3 concentrations in ppb before and after pesticide spray from 8hr local time until 15hr during the investigated days through the first, second and third experiments beside the corresponding temperature and relative humidity. Figure 1 signifies that there is a direct relationship between ozone concentrations and the temperature degrees while it was reversal proportion with relative humidity. The figure also demonstrates that O_3 concentrations were gradually increased towards the hour 15, whereas it increased during the background day from 40ppb (at 8hr) to 91ppb (at 15hr) with an average of O_3 concentrations of order of 70ppb. The corresponding O_3 concentrations during the spray day were suddenly increased after noon. Its measurements increased from 53 (at 8hr) to 73ppb (at 12hr) and jumped to 159ppb (at 15hr) with an average was found to be 91ppb. Figure 1 likewise manifests that the peak and the highest O_3 concentrations were recorded during the second day which through O_3 concentrations were increased from 150 to 175ppb (which represented the maximum of O_3 concentration and was monitored at 14hr) with an average equalled 163ppb. While during the third day O_3 concentrations were lower than that of the

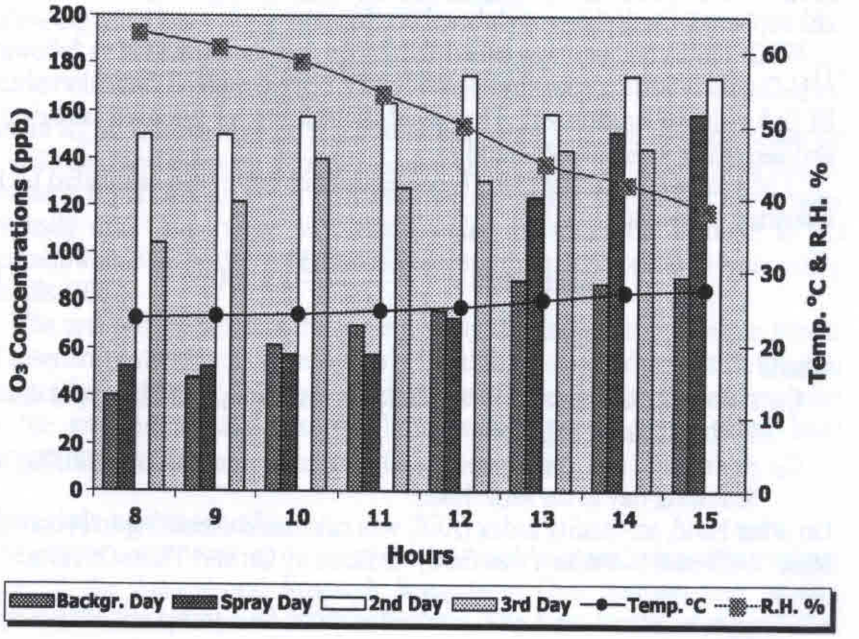

Figure 1. Pesticide effect on the hourly O_3 concentration in ppb during and after spray day and the corresponding temperature, °C and RH per cent through the first experiment

second day and these concentrations were between 104 and 145ppb (at 14hr) with an average of O_3 concentrations of order of 130ppb. This means that there was a clear decay in O_3 concentrations through the third day after spray during the first experiment.

By examining Figure 2 it is evidently clear that, the trend of the relative humidity variations is somewhat different from that recorded during the first experiment particularly after 13hr. The figure also illustrates that during the background day O_3 concentrations were increased from 60 (at 9hr) to 86ppb (at 14hr) and decreased to 81ppb (at 15hr) with an average of order of 75ppb. Whilst during the spray day the corresponding O_3 concentrations increased from 50 (at 8hr) to 109ppb (at 14hr) and decreased to 106ppb (at 15hr) with an average was found to be 85ppb. Similar to first experiment the highest O_3 concentrations were found during the second day but here O_3 concentrations ranged from 83 to 145ppb (the maximum concentration of O_3 during the second experiment and was recorded at 14hr) with an average equaled 123.3ppb. In addition, during the third day O_3 concentrations increased from 70 (at 8hr) to 125 ppb (at 13hr) and decreased after that to be 122 and 117ppb at hours 14 and 15, respectively and the corresponding average equalled 106ppb.

From Figure 3 it can be clearly seen that, the trend of the hourly variations of the relative humidity during the third experiment is somewhat different from that recorded during the first experiment but similar to that obtained during

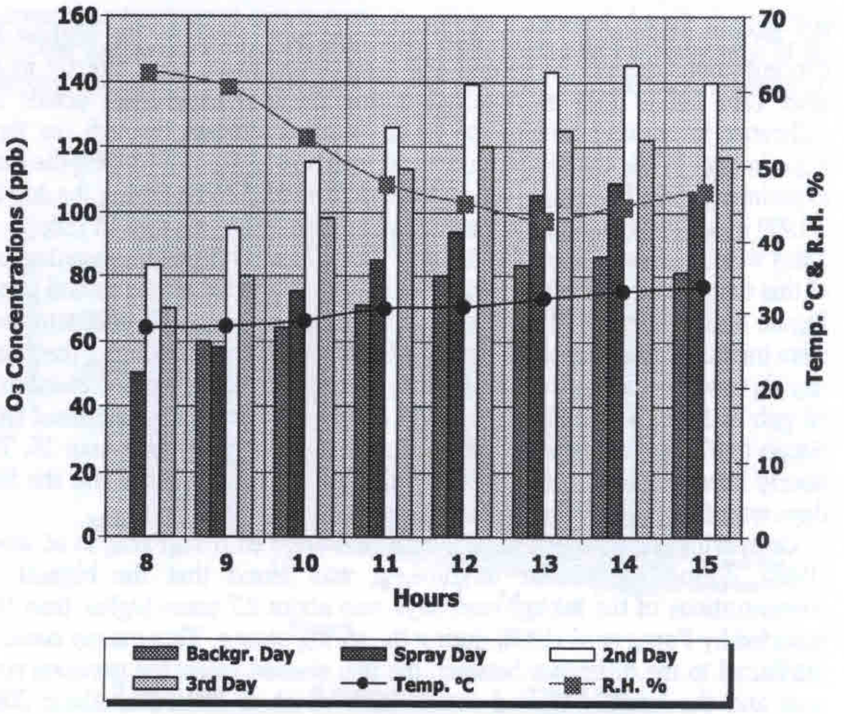

Figure 2.
Pesticide effect on the hourly O_3 concentration in ppb during and after spray day and the corresponding temperature, °C and RH per cent through the second experiment

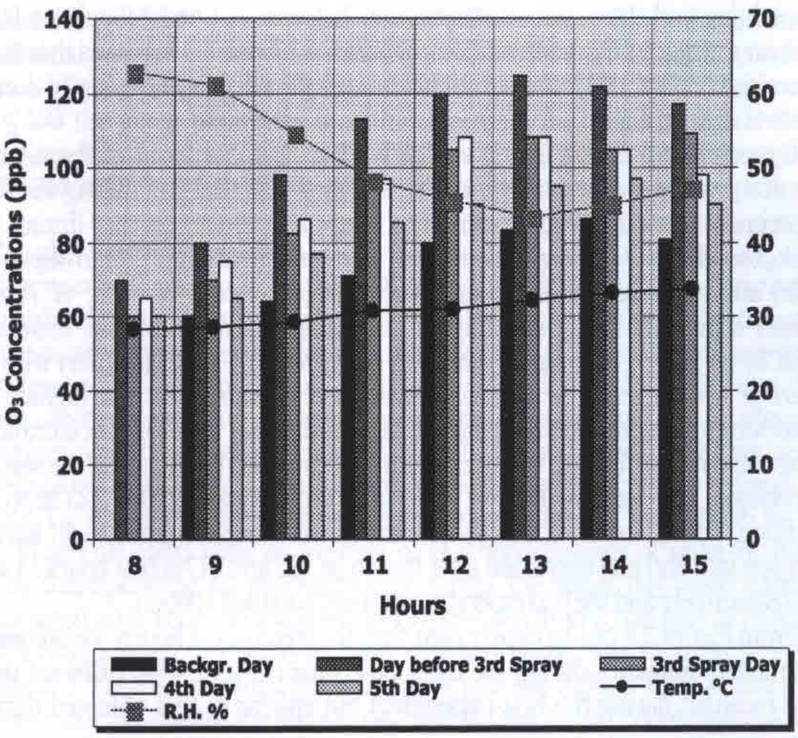

Figure 3.
Pesticide effect on the hourly O_3 concentration in ppb during and after spray day and the corresponding temperature, °C and RH per cent through the third experiment

the second experiment. This may interpret why most of the highest O_3 concentrations during the second and third experiments were directly found after 13hr not at 15hr as occurred during the first experiment beside the difference in starting time of the pesticide spray process through the three experiments. While the temperature trend was nearly the same during the three experiments. The highest O_3 concentrations were monitored during the day 14/7/1999 in which O_3 concentrations increased from 70ppb (at 8hr) to 125ppb (at 13hr) with an average equalled 106ppb. The relatively high O_3 concentrations of this day could be motivated with; this day was affected by the second spray. Figure 3 also shows that during the spray day the hourly O_3 concentrations were increased from 60ppb (at 8hr) to 109ppb (at 15hr). While during the fourth day O_3 concentrations increased from 65 to 108ppb at 13hr then decreased to be 98 ppb at 15hr. Whilst during the fifth day O_3 concentrations increased from 60ppb to 97ppb at 14hr and decreased after that to be 90ppb at hour 15. The hourly averages of O_3 concentrations during the spray, fourth and the fifth days were found to be 92, 93 and 82ppb respectively.

Comparing the obtained results with that deduced from Farag *et al.* study (1993), during the similar daytime, it was found that the highest O_3 concentrations of the background days was about 2.7 times higher than that reported by Farag *et al.* (1993) during the spring season. This mainly could be attributed to the difference between the two studied areas; the previous rural area and the recently treated cotton farm which is located at about 30km downwind of one of the three biggest industrial areas in Greater Cairo. Moreover, the farm is surrounded by a heavy vehicular traffic motion, which added more pollutants to the background of this area. Consequently, this contamination of air by incomplete combustion fuels or other carcinogenic organic gases or particulates which are photochemically oxidized by sunlight causes an increase in ozone concentrations (Meyer, 1983). Furthermore, the meteorological conditions, play a vital role in the ozone formation in the ambient air (Pearson and Mansfield, 1993). This may be also explain why the obtained O_3 concentrations during the background days were higher than the prescribed limit of O_3 concentrations during the clean background (the clean background concentration of ozone according to WHO, 1978 is 40ppb).

The results presented in Figures 4, 5 and 6 reveal the increase percentages in hourly O_3 concentrations during the investigated days, compared to those during the background days. In general view, it could be noticed that there was a reduction in O_3 concentrations at hours 10, 11 and 12 during the first spray day (Figure 4) and at 9hr during the second spray day (Figure 5). While this phenomenon disappeared during the third spray day because of this day was affected by the second spray for only three days before. The reduction percentages in O_3 concentrations at these hours were 5.7, 17.9 and 3.9 per cent during the first experiment and 3 per cent during the second experiment, respectively. This could be attributed to the fact that during the pesticide photolysis some of the surface ozone molecules, which naturally exist in the air surrounding the treated cotton farm, would be consumed during the reaction. Whereas the pesticide spray process was often started at the early time of the morning (around 9 and 7hrs through the cold and hot weather, respectively

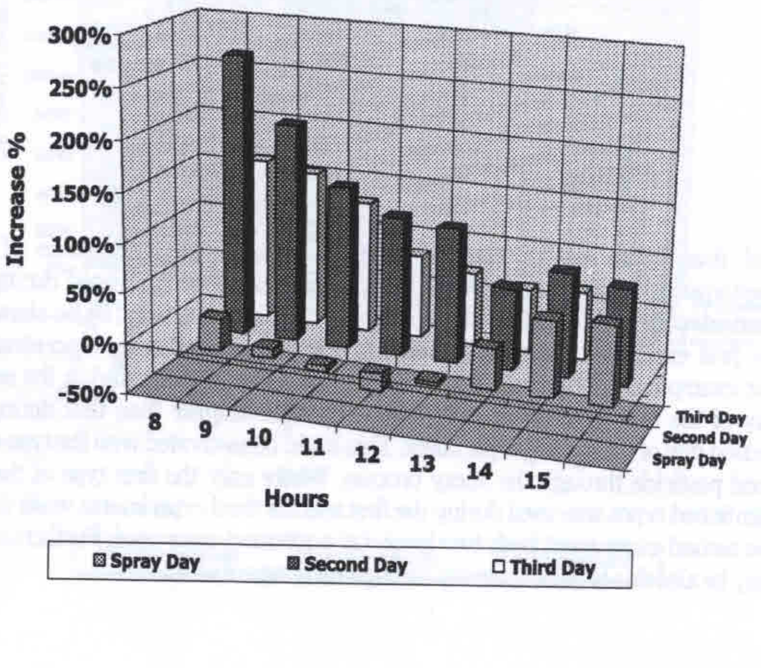

Figure 4.
The increase in percentages in hourly surface O_3 concentrations during the spray, second and third days of first experiment, compared to those of background day

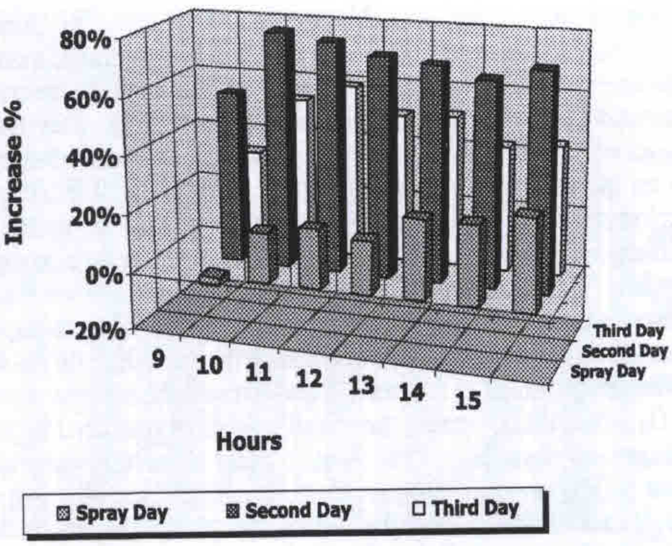

Figure 5. The increase percentages in hourly surface O_3 concentrations during the spray, second and third days of second experiment, compared to those of background day

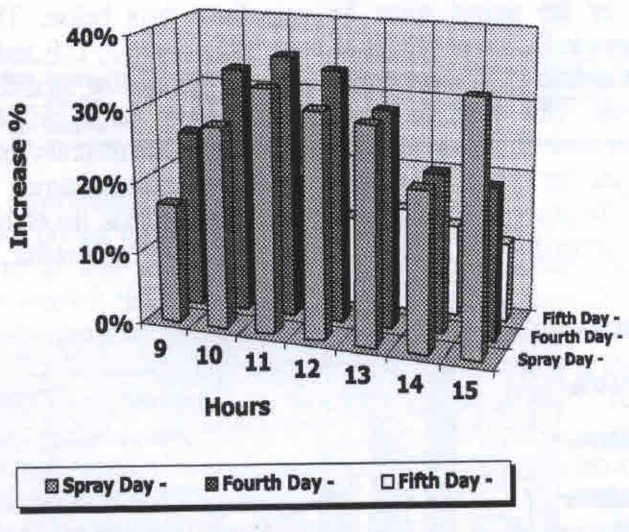

Figure 6. The increase percentages in hourly surface O_3 concentrations during the spray, fourth and fifth days of third experiment, compared to those of background day

and this would explain the difference in time of the appearance of this phenomenon). Consequently, O_3 concentrations might be decreased during the pesticide photolysis time. The results obtained in Figures 4, 5 and 6 also show that the first experiment had the highest increase percentages in O_3 concentrations. For example the increasing percentages in O_3 concentrations during the second day of the first experiment were (about 1.3 times) higher than that during the second day of the second experiment. This could be motivated with the type of the used pesticide through the spray process. Where only the first type of the two mentioned types was used during the first and the third experiments while during the second experiment both two kinds (as a mixture) were used. Furthermore, it may be also due to solar intensity through each experiment.

Air quality index (AQI) study

The AQIs were calculated for all O_3 concentration measurements according to equation (3). The output results clarified that during the first and the second experiments the AQI of the background days was unharmful before noon and increased to be an alarming index after noon. While during the first and second spray days it increased after noon to be a harmful and very harmful index, respectively. Furthermore, during the two second days most of the AQIs registered as very harmful during the first experiment (a peak had a magnitude about 175 per cent) and harmful during the second experiments. While during the two third days the index registered as harmful (for all the investigated hours during first experiment and after the hour 10 during the second experiment). On other hand, during the third experiment AQI values of the fourth day were alarming before noon and harmful indices after that. The index registered as alarming for all fifth day hours. The results presented in Figure 7 show the minima and the maxima of AQIs during the investigated days through the current study period.

Finally, the output results manifested that O_3 concentrations were correlated significantly positive with temperature and this is in accordance with Colton (1974), Clark and Karl (1982), Colbeck and Harrison (1985), Meleigy (1993) and Khoder (1997). The averages of the correlation coefficient of the hourly O_3 concentrations with temperature were found to be 0.85 and 0.91 during the

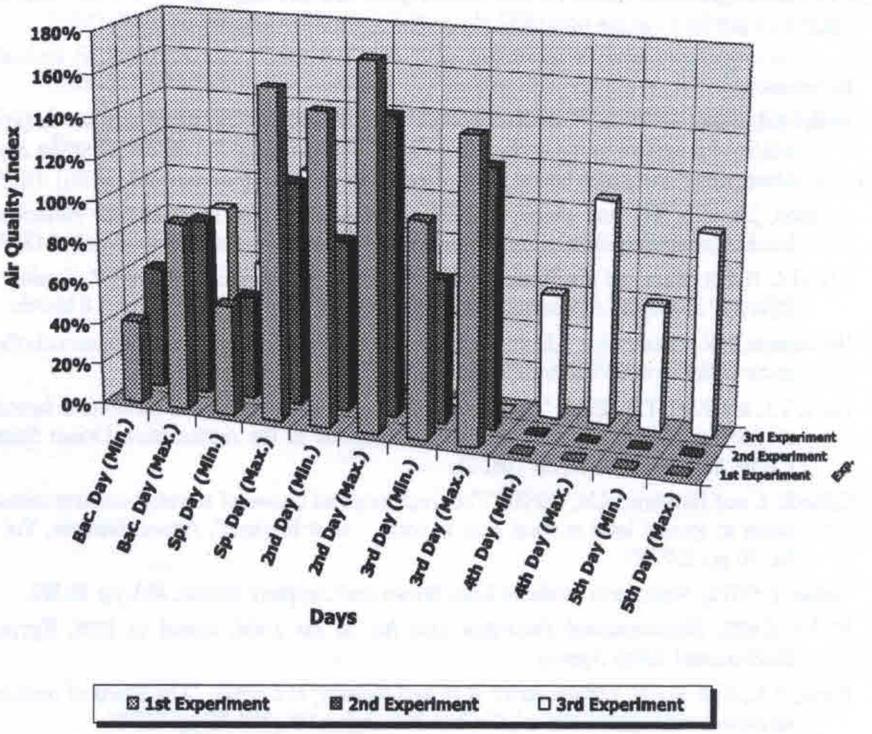

Figure 7.
The minimum and maximum air quality indices during the investigated days through the three experiments

spring and summer seasons, respectively. Otherwise, the hourly O_3 concentrations were correlated negatively with the relative humidity during the two seasons which consider in agreement with Abdel-Aal *et al.* (1994). The averages of the correlation coefficient of the hourly O_3 concentrations with the relative humidity were of order of 0.90 and 0.97 during the spring and summer, respectively.

Conclusion

The study illustrated that most of the hourly O_3 concentrations had been increased after pesticide spray with different values from hour to hour and then began to decay after one day or more according to the concentrations. The averages mean of the increase percentages in hourly O_3 concentrations, compared to those of background days, during the three spray days was found to be 32.4 per cent. While the corresponding mean of the second days of the first and second experiments equalled 110 per cent. Whilst during the third days of the first and second experiments the average mean of these percentages equalled 75.4 per cent. The averages of the increase percentages of the fourth and fifth days during the third experiment were 29.2 and 14.2 per cent respectively. Furthermore, the AQIs during the second days and only the third day of the first experiment were found between harmful and very harmful index with a peak had a magnitude about 175 per cent. Finally, it could be concluded that the use of poisonous pesticides might provide an insecure source of surface ozone particularly in the agricultural area in Egypt.

References

Abdel-Aal, M.M., Al-Gamal, S.A. and Abdel-Hay, F.A. (1994), "Construction of an empirical relation for surface ozone over greater Cairo", *Proceeding of the 4th Int. Conf. on Egypt, Development and Environment*, Cairo, Egypt.

Addison, J.B., Silk, P.J. and Unger, I. (1974), "The solution photochemistry of Metacil and Landrin", *Bull. Environ. Contam. Toxicol.*, Vol. 11, p. 250.

Aly, O.A. (1989), "Fate and distribution of insecticides in the aquatic environment", *Seminar on Effects of Intensified Agricultural Production to Environment*, Cairo, Egypt, 7-8 March.

Bottenheim, J.W., Braslavsky, S.E. and Strausz, O.P. (1977), "Modeling study of seasonal effects on air pollution at 60N latitude", *Environ. Sci. Technol.*, Vol. 2, pp. 801-8.

Clark, T.L. and Karl, T.R. (1982), "Application of prognostic meteorological variables to forecasts of daily maximum one-hour ozone concentrations in the northeastern United States", *J. Appl. Meteorol.*, Vol. 21, pp. 1661-71.

Colbeck, I. and Harrison, R.M. (1985), "The frequency and causes of elevated concentrations of ozone at ground level at rural sites in north – west England", *Atmos. Environ.*, Vol. 19 No. 10, pp. 1577-87.

Colton, T. (1974), *Statistics in Medicine*, Lille, Brown and Company, Boston, MA, pp. 16-125.

EEAA (1995), *Environmental Protection Low No. 4, for 1994*, issued in 1995, Egyptian Environment Affair Agency.

Farag, S.A., Rizk, H.F.S., ElBahnasawy, R.M. and Meleigy, M.I. (1993), "The effects of pesticides on surface zone concentration", *Environ. Edu. Infor.*, UK., Vol. 12, pp. 217-24.

Haagen-Smit, A.J. (1952), "Chemistry and physiology of Los Angeles smog", *Ind. Eng. Chem.*, Vol. 44, p. 1342.

Hodgeson J.A. (1972), "Review of analytical methods for atmospheric oxidants measurements", *J. Environ. Anal. Chem.*, Vol. 2, p. 113.

Khalil, M.R., Hegazi, M.E.A and Balba M.H. (1984a), "Photodecomposition of dimethoate and chemical and biological effects of its degradation products", *Agriculture Research Review*, Vol. 62 No. 1, pp. 403-9.

Khalil, M.R., Hegazi, M.E.A and Balba M.H. (1984b), "Photodecomposition of methyl parathion and chemical and biological effects of its degradation products", *Agriculture Research Review*, Vol. 62 No. 1, pp. 393-401.

Khoder, M.I.M. (1997), "Assessment of some air pollutants in Cairo and their role in atmospheric photochemistry", PhD thesis, Faculty of Science, Ain Shams University, Cairo, Egypt.

Kuklin, A.M. (1987), "Ozone and transformation of nitrogen oxide in atmospheric air", *Khim. Tekhnol.*, Kiev, Vol. 1, pp. 66-70.

Meleigy, M.I. (1993), "Photochemical formation of ozone in the atmosphere of greater Cairo", MSc thesis, Faculty of Science, Menofia University, Egypt.

Meyer, B. (1983), *Indoor Air Quality*, Addison-Wesley, London, p. 103.

Mitchel, L.C. (1961), "The effects of ultraviolet 2537A on 141 pesticide chemists by paper chromatography", *J. Agric. Food Chem.*, Vol. 44, pp. 643-712.

Ott, W.R. and Thom, G. (1976), "A criterial review of air pollution index systems in US and Canada", *J. Air Pollution Cont. Assoc.*, Vol. 26 No. 5, pp. 460-70.

Pearson, M. and Mansfield, T.A. (1993), "Interacting effects of O_3 and water stress on the stimulate resistance of beech Fags Sylvatica L", *New Phytol.*, Vol. 123, pp. 351-8.

Prusty, P.K. and Rout, S.R. (1993), "Air quality index and its variations in Angul Talchr area, India", *Environ. Edu. Infor.*, UK, Vol. 21 No. 3, pp. 243-56.

Sanford, S., Logan, A. and Wofsy, S. (1990), "The sensitivity of ozone to nitrogen oxides and hydrocarbons n regional ozone episodes", *J. Geophs. Res.*, Vol. 95, pp. 1837-51.

Tiwari, and Ali, M. (1987), "Air quality index for Calcutta and its monthly variation", *Indian J. Env. Protection*, Vol. 7 No. 3, pp. 172-6.

WHO (1978), *Environmental Health Criteria*, Vol. 7, World Health Organization, Geneva, pp. 12-25.

WHO (1986), *Environmental Health Criteria*, Vol. 64, World Health Organization, Geneva, p. 12.

Notes for contributors

Environmental Management and Health

Copyright

Articles submitted to the journal should be original contributions and should not be under consideration for any other publication at the same time. Authors submitting articles for publication warrant that the work is not an infringement of any existing **copyright** and will indemnify the publisher against any breach of such warranty. For ease of dissemination and to ensure proper policing of use, papers and contributions become the legal copyright of the publisher unless otherwise agreed. Submissions should be sent to:

The Editor

Professor Walter Leal Filho PhD, TU-TECH/Technical University Hamburg-Harburg, Arbeitsbereich Umweltschutztechnik, Eißendorfer Straße 40, D-21073 Hamburg, Germany.
Tel: 49 40 766180 56; Fax: 49 40 766180 58;
E-mail: leal@tu-harburg.de

Submissions from America and Australia should be sent to the Deputy Editor: Professor J.G. Llaurado, Veterans' Hospital, 11201 Benton Street #115, Loma Linda, CA92357, USA.

Editorial objectives

To examine in a deep and objective manner the various environmental factors and their impact on human health, to suggest possible remedies and to adopt an inter-disciplinary approach to the problem of managing the environment so as to reduce the deleterious effects of man's activities in this century. All papers are reviewed and subject to stringent consideration by subject specialists on the Editorial Review Board.

The reviewing process

Each paper submitted to *EMH* is subjected to the following review procedures:

(1) It is reviewed by the editor for general suitability for this publication.
(2) If it is judged suitable two reviewers are selected and a double blind review process takes place.
(3) Based on the recommendations of the reviewers, the editor then decides whether the particular article should be accepted as it is, revised or rejected.

Final submission requirements

Manuscripts must:

- be clean, good quality hard copy
- include an abstract and keywords
- have Harvard style references
- include any figures, photos and graphics electronically and as good quality originals
- be accompanied by a labelled disk
- be accompanied by a completed Journal Article Record Form

Manuscript requirements

Three copies of the manuscript should be submitted in double line spacing with wide margins. All authors should be shown and **author's details** must be printed on a separate sheet and the author should not be identified anywhere else in the article.

As a guide, articles should be between 3,000 and 6,000 words in **length.** A **title** of not more than eight words should be provided. A brief **autobiographical note** should be supplied including full name, affiliation, e-mail address and full international contact details. Authors must supply an **abstract** of 100-150 words. Up to six **keywords** should be included which encapsulate the principal subjects covered by the article.

Where there is a **methodology,** it should be clearly described under a separate heading. **Headings** must be short, clearly defined and not numbered. **Notes** or **Endnotes** should be used only if absolutely necessary and must be identified in the text by consecutive numbers, enclosed in square brackets and listed at the end of the article.

Figures, charts and **diagrams** should be kept to a minimum. They should be provided both electronically and as good quality originals. They must be black and white with minimum shading and numbered consecutively using arabic numerals.

Artwork should be either copied and pasted from the origination software into a blank Microsoft Word document, or saved and imported into a blank Microsoft Word document. Artwork created in MS Powerpoint is also acceptable. Artwork may be submitted in the following standard image formats: .eps – Postscript, .pdf – Adobe Acrobat portable document, .ai – Adobe Illustrator, .wmf – Windows Metafile. If it is not possible to supply graphics in the formats listed above, authors should ensure that figures supplied as .tif, .gif, .jpeg, .bmp, .pcx, .pic, .pct are supplied as files of at least 300dpi and at least 10cm wide.

In the text the position of a figure should be shown by typing on a separate line the words "take in Figure 2". Supply succinct captions.

For photographic images good quality original **photographs** should be submitted. If submitted electronically they should be saved as tif files of at least 300dpi, and at least 10cm wide. Their position in the text should be shown by typing on a separate line the words "take in Plate 2".

Tables should be kept to a minimum. They must be numbered consecutively with roman numerals and a brief title. In the text, the position of the table should be shown by typing on a separate line the words "take in Table IV".

References to other publications must be in Harvard style. That is, shown within the text as the first author's name followed by a comma and year of publication all in round brackets, e.g. (Fox, 1994). At the end of the article a reference list in alphabetical order must be given as follows:

For books: surname, initials, (year) *title*, publisher, place of publication, e.g. Casson, M. (1979), *Alternatives to the Multinational Enterprise*, Macmillan, London.

For journals: surname, initials, (year) "title", journal, volume, number, pages, e.g. Fox, S. (1994), "Empowerment as a catalyst for change: an example from the food industry", *Supply Chain Management*, Vol. 2 No. 3, pp. 29-33.

Final submission of the article

Once accepted for publication, the final version of the manuscript must be provided, accompanied by a 3.5" **disk** of the same version labelled with: disk format; author name(s); title of article; journal title; file name.

Each article must be accompanied by a completed and signed **Journal Article Record Form** available from the Editor or on http://www.literaticlub.co.uk.

The manuscript will be considered to be the definitive version of the article. The author must ensure that it is complete, grammatically correct and without spelling or typographical errors.

In preparing the disk, please use one of the following preferred formats: Word, Word Perfect, Rich text format or TeX/LaTeX.

Technical assistance is available from Emerald's Literati Club on http://www.literaticlub.co.uk or by contacting Mike Massey at Emerald, e-mail mmassey@emeraldinsight.com