**International Journal of Botany Studies**
**ISSN: 2455-541X; Impact Factor: RJIF 5.12**
**Received: 20-09-2020; Accepted: 05-10-2020: Published: 24-10-2020**
**www.botanyjournals.com**
**Volume 5; Issue 5; 2020; Page No. 477-482**

# Mineral nutrient profile of fruits two selected vegetables cultivated near a cement factory in Tamil Nadu, India

**Jemila Roshini C[1], Christudhas Williams B[2*]**

[1] Research Scholar, Department of Botany and Research Centre, Scott Christian College, (Autonomous) Nagercoil, Affiliated to Manonmaniaum Sundaranar University, Abishekapatti, Tirunelveli, Tamil Nadu, India

[2] Assistant Professor, Department of Botany and Research Centre, Scott Christian College, (Autonomous) Nagercoil, Affiliated to Manonmaniaum Sundaranar University, Abishekapatti, Tirunelveli, Tamil Nadu, India

**Abstract**

The present investigation looks into the mineral content of the fruits and leaves of Tomato and Brinjal plants exposed to cement dust deposition from a nearby cement factory. The mineral content in the fruits and leaves analyzed showed decreased levels in cement dust exposed vegetables, when compare in non-polluted ones. The present work was substantiated by evidences of altered soil mineral content and the soil pH, was more to the alkaline side. This indicates the extent to which the soil was polluted by cement dust when compare to control soil. The altered mineral profile of the experimental plants is discussed. Results of the study can contribute to understand how mineral deficiency and toxicity lead to detrimental effects on plant growth and development in the fields contaminated by cement dust. Regular scientific monitoring of diverse crops merits attention for sustainability of agro-ecosystems in the region.

**Keywords:** mineral content, pH of soil

## Introduction

Cement dust has been shown to adversely affect the soil ecological communities. Soils surrounding cement factories, especially downward areas, exhibit elevated pH levels (Mandre *et al*., 1998) [9]. In a soil composition study performed on the surroundings of some cement factories, it was found that there were elevated levels of chromium, silica, iron and calcium with contamination levels decreasing dramatically with distance from the factories. These compositions affect vegetative growth (Ade-Ademilua and Umebese, 2007) [1]. Mandre (1995) [8] reported that calcium is most suitable for monitoring the environmental pollution in the surroundings of Kunda cement plant, because CaO is the most abundant component (over 40 %) of cement dust emissions. The heavy metals present in the cement dust play an important role in disturbing the various metabolic processes in plants (Borka, 1986) and thus lead to detrimental effects on the growth and development of plants (Iqbal and Shafug, 2001 and Uysal *et al*., 2003 and Raajasubramanian, 2011).

*Lycopersicum esculentum*, Mill. (Tomato) is a pubescent herb belonging to the family Solanaceae, the fruits of which whether raw or ripe are of great market value as it is an ingredient of many dishes around the world. Fruits contain proteins, fiber, minerals, trace elements, carbohydrates, sugars and pigments. Many of the constituents of tomato are health ensuring while its high potassium content makes it an ideal food for those suffering from hypertension. The plant also shows many medicinal properties such as to its ability to control high blood pressure, to relieve scurvy, to remove toxic element to dissolve the fat to treat cancer, to cure rickets, to heal wounds and sores, to cure coronary heart diseases, to restore health of liver etc. The fruits are used for Beautification because it cleans and rejuvenates the skin, hence used as face mask. *Solanum melongena* L. (Brinjal) also belongs to the family Solanaceae, having very high market value as it is unavoidable in many south Indian dishes. The fruits are rich in carbohydrates, sugars, fibers, vitamins, and minerals. Some of the medicinal uses are to stop intestinal bleeding, used as an antidote for mushroom poisoning, used as purgative, the ashes of the fruits are used in dry, hot poultices to treat heamorrhoids and the root is powdered used to treat ulcers, applied inside the nostrils.

## Materials and Methods

In the present study investigation, the study area selected was around Thalaiyuth cement factory, Thirunelveli district of Tamil Nadu in India. Fruits from cultivated *Lycopersicum esculentum*, Mill. (Tomato - variety – PKM-1 with growth duration of 135-150 days) and *Solanum melongena* L. Brinjal cultivated around the vicinity of a cement factory (around 1-4 kms) were treated as polluted plants and tomato plants grown beyond 10 kms from the cement factory were treated as non-polluted control plants. Screening of the fruits of selected vegetables grown in the control and cement dust exposed areas were done during summer and monsoon season. The areas were categorized as follows - $A_1$- Non cement polluted area in summer; $A_{2}$- Cement polluted area in summer; $A_3$ – Non cement polluted area in monsoon; $A_4$ – Cement polluted area in monsoon. The fruits from the selected vegetables were subjected to mineral content (quantitative) analysis to evaluate the various ill effects of cement dust emitted from cement factory of the selected area. The mineral content of the soil in the respective areas in which the selected vegetable crop were grown was also subjected to mineral content profiling.

**Estimation of mineral content**

The micro nutrients like Ca, Mg, K, Mn, Al, Fe, Si, Zn, Cu And S can be determined in acid digest of plant samples and soil with the help of Flame photometer or Atomic Absorption Spectrophotometer. Flame photometer is based on the principle that atoms of metallic elements which normally remain in ground state, under flame conditions, absorb energy when subjected to radiation of specific wavelength. The absorbtion of radiation is proportional to the concentration of atoms of that element. The absorption of radiation by the atoms is independent of the wavelength of absorption and temperature of the flame (Piper, 1966).

First apply the respective cathode lamp for the particular nutrient bring determined and then feed the blank of the working standards to the flame photometer, Feed the aliquots (plant digest containing 0.5 g plant material in 50ml volume) directly or after a required dilutions of needed. Note down the readings (and dilution factor if dilution was done) on the flame photometer. Let the reading be 'M' compare the reading of each element with their standard curves prepared already and calculate concentration of each nutrient element in ppm.

Weigh of plant material taken = 0.5 g

Volume made after acid digestion = 50 ml

Dilution factor = 50/0.5 = 100 times

Concentration of Ca, K, Mg, Mn, Al Fe, Si, Zn, Cu and S (ppm) in plant sample – Mx100

Where 'M' stands for the Ca, K, Mg, Mn, al, Fe, Si, Zn, Cu and S concentration in aliquot against the sample readings.

The $p^H$ of soil was also measured directly by $p^H$ meter after making soil suspension (1part soil and 5 parts water ie 20 gms soil is suspended in 100ml distilled water).

Analysis of the observed data were done using statistical analysis, correlation coefficient analysis, multiple regression analysis and multiple linear regression analysis for different variables which were carried out by SPSS software package.

**Results**

In the present investigation the soil pH of the nonpolluted sites during summer the pH was 8.20±0.000 and 8.00±0.008 during monsoon, however the pH increased to an alkaline side during summer and monsoon seasons at the cement dust polluted site (10.50±0.132 and 11.40±0.165 respectively). The mineral content in the soil from cement polluted areas showed a drastic increase when compared with non-polluted areas (Table 1).

A high level of 20.86±0.072 ppm of Ca, 16.21±0.001 ppm of K, 18.21±0.425ppm of Mg, 20.16±0.072ppm of Mn, 12.21±0.142ppm of Al, 26.66±0.342ppm of Fe, 20.41±0.708 ppm of Si, 22.41±0.142 ppm of Cu, and 26.06±0.213ppm of S was calculated from the leaves of Tomato plants exposed to cement dust during summer, while Zn showed an increased level during monsoon from Tomato plants grown in the same site (Table 1). Fruits from Tomato plants grown in the polluted areas during summer showed increased mineral content when compared with plants grown in monsoon season (Table 1). Among the 30 mineral accumulation parameters such as Ca, K, Mg, Mn, Al, Fe, Si, Zn, Cu and S in soil, leaves and Fruits; between the variables $A_1$ and $A_3$, all were NS. Between $A_2$ and $A_1$ all were S. 21 parameters noticed 0.01 level and 9 parameters noticed 0.05 level significance with 100% negative correlation with the corresponding controls (Table 1&2). Correlation between variables $A_3$ and $A_4$; 12 observed 0.01 level S and remaining showed NS with 55% positive and 45% positive correlation. Among the variables $A_4$ and $A_2$, 14 showed 50% positive and remaining 50% negative correlation. From the statistical analysis, it was came to the conclusion that when compared to controls, Polluted plants of summer and monsoon showed more mineral accumulation. Among these 2 categories of polluted plants the polluted plants during summer showed more accumulation than the monsoon (Tables: 2)

In the leaves of Brinjal plants grown in cement dust polluted areas, 10.20±0.141ppm of Ca, 6.20±0.141 ppm of K, 15.10±0.031 ppm of Mg, 5.20±0.076 ppm of Mn, 7.40±0.001ppm of Al, 12.80±0.001pm of Fe, 8.00±0.002ppm of Si, 9.90±0.013 ppm of Zn, were found to be higher ,however, 10.20±0.321ppm of Zn, 9.90±0.002 ppm of Cu and 24.20±0.211ppm of Si was calculated from the leaves of plants grown in the polluted area during winter (Table 3). Fruits from brinjal plants grown in the polluted areas showed higher levels of mineral nutrient during summer season compared plants grown in the area during monsoon (Table 3). Statistical correlation analysis between $A_1$ and $A_3$ showed 100% NS with complete positive correlation. Between the variables $A_2$ and $A_1$, among 30 parameters 15 showed 0.01 level, 6 with 0.05 level of significance and 9 with NS. NS parameters were Al(So), Al(L), Al(F), Si(So), Si(L), Si(F), Cu(So), Cu(L) and Cu(F) with 70% negative and 30% positive correlation. Correlation analysis between the variables $A_3$ and $A_4$; among 30, 15 with 0.01 level, 6with 0.05 level and 9 with NS with same as $A_2$ and $A_1$ with 70% negative and 30% with positive correlation The variables $A_4$ and $A_2$ showed 6 with 0.01 levels and 24 with NS with 20% negative and 80% positive correlation (Table 3 &4). From the statistical analysis, it was clear that between the controls during summer and monsoon seasons there was no significant reduction in the mineral contents. While between the controls and polluted plants during monsoon and summer, significant reductions were observed in 21 parameters (Tables 3 & 4).

**Table 1:** Mineral Content of Tomato Plants from Selected Regions around a Cement Factory.

| | Minerals | $A_1$ | $A_2$ | $A_3$ | $A_4$ |
|---|---|---|---|---|---|
| 1. | Ca(So) | 10.16±0.072 | 20.86±0.072 | 9.76±0.213 | 18.36±0.213 |
| 2. | Ca(L) | 4.66±0.213 | 7.56±0.078 | 4.96±0.072 | 6.86±0.007 |
| 3. | Ca (F) | 3.56±0.496 | 6.21±0.142 | 4.01±0.000 | 5.21±0.000 |
| 4. | K (So) | 5.26±0.072 | 16.21±0.001 | 5.26±0.072 | 12.86±0.015 |
| 5. | K (L) | 3.16±0.213 | 5.66±0.213 | 3.51±0.425 | 5.06±0.213 |

| | | | | | |
|---|---|---|---|---|---|
| 6. | K (F) | 0.11 ± 0.008 | 4.06 ± 0.113 | 0.26 ± 0.072 | 3.86 ± 0.072 |
| 7. | Mg (So) | 7.56 ± 0.084 | 16.21 ± 0.425 | 7.56 ± 0.072 | 14.31 ± 0.142 |
| 8. | Mg (L) | 1.36 ± 0.213 | 5.66 ± 0.213 | 1.31 ± 0.142 | 4.86 ± 0.008 |
| 9. | Mg (F) | 0.36 ± 0.117 | 3.81 ± 0.284 | 0.51 ± 0.001 | 2.91 ± 0.001 |
| 10. | Mn (So) | 9.86 ± 0.072 | 20.16 ± 0.072 | 9.86 ± 0.072 | 18.26 ± 0.071 |
| 11. | Mn (L) | 1.06 ± 0.213 | 4.01 ± 0.142 | 1.06 ± 0.213 | 2.86 ± 0.072 |
| 12. | Mn (F) | 0.76 ± 0.072 | 4.66 ± 0.201 | 0.76 ± 0.043 | 3.86 ± 0.057 |
| 13. | Al (So) | 6.26 ± 0.355 | 12.21 ± 0.142 | 5.86 ± 0.022 | 10.56 ± 0.072 |
| 14. | Al (L) | 4.71 ± 0.284 | 7.06 ± 0.213 | 4.81 ± 0.142 | 6.56 ± 0.072 |
| 15. | Al (F) | 2.46 ± 0.355 | 5.35 ± 0.213 | 2.86 ± 0.007 | 4.16 ± 0.047 |
| 16. | Fe (So) | 14.21 ± 0.001 | 26.66 ± 0.342 | 15.36 ± 0.223 | 24.51 ± 0.142 |
| 17. | Fe (L) | 2.31 ± 0.284 | 12.46 ± 0.355 | 2.66 ± 0.213 | 11.41 ± 0.284 |
| 18. | Fe (F) | 2.61 ± 0.715 | 16.21 ± 0.001 | 3.36 ± 0.354 | 13.96 ± 0.031 |
| 19. | Si (So) | 4.06 ± 0.213 | 20.41 ± 0.708 | 6.01 ± 0.142 | 17.86 ± 0.072 |
| 20. | Si (L) | 0.00 ± 0.000 | 8.11 ± 0.142 | 0.00 ± 0.000 | 6.00 ± 0.000 |
| 21. | Si (F) | 0.00 ± 0.000 | 5.21 ± 0.198 | 0.00 ± 0.000 | 3.86 ± 0.072 |
| 22. | Zn (So) | 7.41 ± 0.284 | 10.31 ± 7.213 | 7.66 ± 0.213 | 12.66 ± 0.213 |
| 23. | Zn (L) | 0.16 ± 0.008 | 10.41 ± 0.142 | 0.21 ± 0.000 | 9.31 ± 0.000 |
| 24. | Zn (F) | 1.76 ± 0.072 | 9.86 ± 0.072 | 1.86 ± 0.071 | 7.86 ± 0.072 |
| 25. | Cu (So) | 8.76 ± 0.213 | 22.41 ± 0.142 | 10.00 ± 0.141 | 20.01 ± 0.142 |
| 26. | Cu (L) | 2.51 ± 0.000 | 11.31 ± 0.001 | 2.56 ± 0.072 | 10.31 ± 0.097 |
| 27. | Cu (F) | 0.11 ± 0.000 | 15.26 ± 0.072 | 0.21 ± 0.000 | 13.86 ± 0.024 |
| 28. | S (So) | 12.31 ± 0.142 | 26.06 ± 0.213 | 12.56 ± 0.072 | 24.51 ± 0.111 |
| 29. | S (L) | 15.01 ± 1.415 | 23.51 ± 0.567 | 16.31 ± 0.142 | 22.71 ± 0.054 |
| 30. | S (F) | 7.76 ± 0.72 | 14.46 ± 0.078 | 8.16 ± 0.056 | 12.56 ± 0.005 |

$A_1$ – Non Cement Polluted Tomato in summer; $A_2$- Cement Polluted Tomato in summer; A3 – Non Cement Polluted Tomato in Monsoon: A4- Polluted Tomato Plants during Monsoon

So - Soil; F – Fruits; L: Leaves: Ca-Calcium; Mg-Magnesium; K- Potassium; Mn-Manganese; Al - Aluminium; Fe- Iron; Si- Silicon; Zn-Zinc; Cu-Copper; S - Sulphur.

**Table 2:** Correlation Coefficient Analysis of Different Variables for Mineral Content of Tomato From selected Areas around a Cement Factory

| Sl.No | H.M.A.P | $A_1$- $A_3$ | $A_2$ - $A_1$ | $A_3$ - $A_4$ | $A_4$ - $A_2$ |
|---|---|---|---|---|---|
| 1. | Ca(So) | 0.01$^{NS}$ | 0.97•• | 0.98•• | -0.27 |
| 2. | Ca(L) | 0.03$^{NS}$ | 0.99•• | 0.99•• | -0.21 |
| 3. | Ca (F) | -0.08$^{NS}$ | 0.99•• | 0.97•• | -0.08 |
| 4. | K (So) | -0.10$^{NS}$ | 0.98•• | -0.28$^{NS}$ | 0.97•• |
| 5. | K (L) | -0.21$^{NS}$ | 0.86• | -0.27$^{NS}$ | 0.98•• |
| 6. | K (F) | -0.27$^{NS}$ | 0.88• | -0.35$^{NS}$ | 0.99•• |
| 7. | Mg (So) | 0.31$^{NS}$ | 0.90• | -0.30$^{NS}$ | 0.96•• |
| 8. | Mg (L) | 0.35$^{NS}$ | 0.97•• | -0.27$^{NS}$ | 0.99•• |
| 9. | Mg (F) | 0.37$^{NS}$ | 0.99•• | 0.97•• | -0.08$^{NS}$ |
| 10. | Mn (So) | -0.43$^{NS}$ | 0.99•• | 0.99•• | -0.02$^{NS}$ |
| 11. | Mn (L) | -0.45$^{NS}$ | 0.96•• | 0.98•• | 0.99•• |
| 12. | Mn (F) | -0.48$^{NS}$ | 0.98•• | 0.99•• | 0.97•• |
| 13. | Al (So) | -0.52$^{NS}$ | 0.99•• | 0.90• | 0.97•• |
| 14. | Al (L) | -0.18$^{NS}$ | 0.99•• | -0.08 | 0.99•• |
| 15. | Al (F) | -0.21$^{NS}$ | 0.99•• | -0.18$^{NS}$ | 0.99•• |
| 16. | Fe (So) | -0.27$^{NS}$ | 0.86• | -0.21$^{NS}$ | -0.63$^{NS}$ |
| 17. | Fe (L) | -0.41$^{NS}$ | 0.90• | 0.99•• | -0.71$^{NS}$ |
| 18. | Fe (F) | -0.61$^{NS}$ | 0.87• | 0.98•• | -0.72$^{NS}$ |
| 19. | Si (So) | 0.03$^{NS}$ | 0.98•• | 0.99•• | -0.55$^{NS}$ |
| 20. | Si (L) | 0.06$^{NS}$ | 0.99•• | -0.31$^{NS}$ | -0.41$^{NS}$ |
| 21. | Si (F) | -0.08$^{NS}$ | 0.99•• | -0.52$^{NS}$ | -0.31$^{NS}$ |
| 22. | Zn (So) | -0.009$^{NS}$ | 0.90• | -0.63$^{NS}$ | -0.18$^{NS}$ |
| 23. | Zn (L) | -0.18$^{NS}$ | 0.86• | -0.27$^{NS}$ | -0.08$^{NS}$ |
| 24. | Zn (F) | -0.21$^{NS}$ | 0.90• | 0.99•• | -0.27$^{NS}$ |
| 25. | Cu (So) | -0.08$^{NS}$ | 0.99•• | 0.01$^{NS}$ | -0.18$^{NS}$ |
| 26. | Cu (L) | 0.01$^{NS}$ | 0.98•• | 0.01$^{NS}$ | -0.26$^{NS}$ |

| | | | | | |
|---|---|---|---|---|---|
| 27. | Cu (F) | 0.02 NS | 0.97•• | 0.99•• | 0.99•• |
| 28. | S (So) | 0.08 NS | 0.97•• | 086• | 0.97•• |
| 29. | S (L) | -0.61 NS | 0.98•• | 0.86• | 0.98•• |
| 30. | S (F) | -0.52 NS | 0.99•• | 0.02 NS | 0.99•• |

$A_1$ – Non Cement Polluted Tomato in summer; $A_2$- Cement Polluted Tomato in summer; A3 – Non Cement Polluted Tomato in Monsoon: A4- Polluted Tomato Plants during Monsoon
So - Soil; F – Fruits; L:Leaves: Ca-Calcium; Mg-Magnesium; K- Potassium; Mn-Manganese; Al - Aluminium; Fe- Iron; Si- Silicon; Zn-Zinc; Cu-Copper; S - Sulphur.

**Table 3:** Mineral Content of Brinjal Plants from Selected Regions around a Cement Factory.

| | Mineral content | $A_1$ | $A_2$ | $A_3$ | $A_4$ |
|---|---|---|---|---|---|
| 1. | Ca(So) | 9.09 ± 0.001 | 20.10 ± 0.232 | 9.70 ± 0.021 | 18.20 ± 0.131 |
| 2. | Ca(L) | 9.08 ± 0.002 | 10.20 ± 0.141 | 4.80 ± 0.002 | 7.10 ± 0.111 |
| 3. | Ca (F) | 3.50 ± 0.031 | 6.20 ± 0.171 | 3.80 ± 0.021 | 4.90 ± 0.171 |
| 4. | K (So) | 2.30 ± 0.171 | 14.90 ± 0.118 | 3.20 ± 0.002 | 4.80 ± 0.008 |
| 5. | K (L) | 2.00 ± 0.000 | 6.20 ± 0.141 | 3.20 ± 0.001 | 4.80 ± 0.137 |
| 6. | K (F) | 0.17 ± 0.001 | 4.60 ± 0.171 | 0.20 ± 0.003 | 4.20 ± 0.100 |
| 7. | Mg (So) | 9.14 ± 0.008 | 15.10 ± 0.031 | 7.40 ± 0.121 | 14.20 ± 0.101 |
| 8. | Mg (L) | 1.60 ± 0.002 | 5.20 ± 0.076 | 1.30 ± 0.131 | 5.20 ± 0.141 |
| 9. | Mg (F) | 0.65 ± 0.008 | 4.20 ± 0.141 | 0.70 ± 0.001 | 3.10 ± 0.171 |
| 10. | Mn (So) | 9.25 ± 0.002 | 19.20 ± 0.004 | 9.70 ± 0.002 | 18.10 ± 0.141 |
| 11. | Mn (L) | 0.80 ± 0.001 | 3.80 ± 0.001 | 1.10 ± 0.008 | 3.10 ± 0.008 |
| 12. | Mn (F) | 0.76 ± 0.002 | 4.70 ± 0.007 | 1.10 ± 0.008 | 4.20 ± 0.232 |
| 13. | Al (So) | 5.90 ± 0.003 | 10.20 ± 0.002 | 5.80 ± 0.232 | 10.40 ± 0.141 |
| 14. | Al (L) | 4.90 ± 0.001 | 7.40 ± 0.001 | 5.20 ± 0.001 | 6.60 ± 0.006 |
| 15. | Al (F) | 2.66 ± 0.002 | 5.10 ± 0.018 | 3.20 ± 0.103 | 3.80 ± 0.171 |
| 16. | Fe (So) | 9.24 ± 0.002 | 25.80 ± 0.232 | 14.10 ± 0.018 | 24.30 ± 0.104 |
| 17. | Fe (L) | 2.60 ± 0.003 | 12.80 ± 0.001 | 2.70 ± 0.171 | 11.50 ± 0.091 |
| 18. | Fe (F) | 2.90 ± 0.001 | 16.50 ± 0.002 | 2.90 ± 0.001 | 15.00 ± 0.001 |
| 19. | Si (So) | 2.70 ± 0.232 | 17.30 ± 0.171 | 5.80 ± 0.001 | 17.80 ± 0.141 |
| 20. | Si (L) | 0.00 ± 0.000 | 8.00 ± 0.002 | 0.00 ± 0.000 | 5.00 ± 0.134 |
| 21. | Si (F) | 0.00 ± 0.000 | 5.20 ± 0.002 | 0.00 ± 0.000 | 4.30 ± 0.087 |
| 22. | Zn (So) | 9.16 ± 0.232 | 12.90 ± 0.144 | 7.20 ± 0.171 | 12.20 ± 0.142 |
| 23. | Zn (L) | 0.13 ± 0.723 | 9.90 ± 0.013 | 0.60 ± 0.008 | 10.20 ± 0.321 |
| 24. | Zn (F) | 1.60 ± 0.002 | 9.70 ± 0.119 | 2.20 ± 0.002 | 8.20 ± 0.021 |
| 25. | Cu (So) | 7.70 ± 0.007 | 20.10 ± 0.002 | 8.50 ± 0.154 | 19.60 ± 0.107 |
| 26. | Cu (L) | 11.40 ± 0.232 | 2.70 ± 0.104 | 2.90 ± 0.131 | 9.90 ± 0.002 |
| 27. | Cu (F) | 0.12 ± 0.732 | 15.20 ± 0.141 | 0.18 ± 0.171 | 14.40 ± 0.131 |
| 28. | S (So) | 13.30 ± 0.002 | 12.10 ± 0.003 | 12.20 ± 0.002 | 24.20 ± 0.122 |
| 29. | S (L) | 12.10 ± 0.017 | 23.10 ± 0.007 | 15.80 ± 0.008 | 24.20 ± 0.211 |
| 30. | S (F) | 7.80 ± 0.007 | 14.1 ± 0.232 | 7.90 ± 0.007 | 13.30 ± 0.281 |

$A_1$ – Non Cement Polluted Tomato in summer; $A_2$- Cement Polluted Tomato in summer; A3 – Non Cement Polluted Tomato in Monsoon: A4- Polluted Tomato Plants during Monsoon
So - Soil; F – Fruits; L: Leaves: Ca-Calcium; Mg-Magnesium; K- Potassium; Mn-Manganese; Al - Aluminium; Fe- Iron; Si- Silicon; Zn-Zinc; Cu-Copper; S - Sulphur.

**Table 4:** Correlation Coefficient Analysis of Different Variables for Mineral Content of Brinjal From selected Areas around a Cement Factory

| | Minerals | $A_1$- $A_3$ | $A_2$ - $A_1$ | $A_3$ - $A_4$ | $A_4$ - $A_2$ |
|---|---|---|---|---|---|
| 1. | Ca(So) | -0.02 NS | 0.90• | 0.86•• | 0.01 NS |
| 2. | Ca(L) | -0.03 NS | 0.92• | 0.88•• | 0.41 NS |
| 3. | Ca (F) | -0.04 NS | 0.91• | 0.87•• | 0.31 NS |
| 4. | K (So) | -0.61 NS | 0.90• | 0.86•• | 0.44 NS |
| 5. | K (L) | -0.02NS | 0.97• | 0.86•• | 0.44 NS |
| 6. | K (F) | 0.4 NS | 0.87• | 0.90•• | 0.90 NS |
| 7. | Mg (So) | -0.02 NS | 0.89• | 0.87• | 0.99•• |
| 8. | Mg (L) | -0.01 NS | 0.87• | 0.90• | 0.99•• |

| | | | | | |
|---|---|---|---|---|---|
| 9. | Mg (F) | -0.31 NS | 0.86• | 0.86•• | -0.41 NS |
| 10. | Mn (So) | -0.41 NS | 0.98•• | 0.98•• | -0.48 NS |
| 11. | Mn (L) | 0.41 NS | 0.97•• | 0.97•• | -0.01 NS |
| 12. | Mn (F) | 0.40 NS | 0.98•• | 0.96•• | -0.01 NS |
| 13. | Al (So) | 0.36 NS | -0.32 NS | 0.01 NS | -0.08 NS |
| 14. | Al (L) | 0.38 NS | -0.41 NS | 0.05 NS | -0.08 NS |
| 15. | Al (F) | -0.41 NS | 0.01 NS | 0.41 NS | -0.01 NS |
| 16. | Fe (So) | -0.61 NS | 0.90• | 0.86• | -0.99•• |
| 17. | Fe (L) | -0.72 NS | 0.96• | 0.87• | -0.98•• |
| 18. | Fe (F) | -0.82 NS | 0.90• | 0.88• | 0.96•• |
| 19. | Si (So) | 0.33 NS | 0.02 NS | 0.31 NS | -0.02 NS |
| 20. | Si (L) | 0.31 NS | 0.02 NS | 0.27 NS | 0.51 NS |
| 21. | Si (F) | -0.21 NS | 0.08 NS | 0.31 NS | 0.41 NS |
| 22. | Zn (So) | -0.32 NS | 0.88•• | 0.99•• | -0.61 NS |
| 23. | Zn (L) | 0.14 NS | 0.88•• | 0.98•• | -0.009 NS |
| 24. | Zn (F) | 0.21 NS | 0.86•• | 0.97•• | 0.08 NS |
| 25. | Cu (So) | 0.31 NS | -0.08 | -0.22 NS | 0.01 NS |
| 26. | Cu (L) | -0.41 NS | -0.18 | -0.35 NS | 0.02 NS |
| 27. | Cu (F) | -0.37 NS | -0.21 | -0.38 NS | 0.08 NS |
| 28. | S (So) | 0.01 NS | 0.98• | -0.86 NS | 0.07 NS |
| 29. | S (L) | 0.01 NS | 0.97• | 0.86• | 0.03 NS |
| 30. | S (F) | 0.01 NS | 0.99• | 0.83• | -0.21 NS |

$A_1$ – Non Cement Polluted Tomato in summer; $A_2$- Cement Polluted Tomato in summer; A3 – Non Cement Polluted Tomato in Monsoon: A4- Polluted Tomato Plants during Monsoon
So - Soil; F – Fruits; L: Leaves: Ca-Calcium; Mg-Magnesium; K- Potassium; Mn-Manganese; Al - Aluminium; Fe- Iron; Si- Silicon; Zn-Zinc; Cu-Copper; S - Sulphur.

**Discussion**

Cement dust is a mixture of Ca, K, Si and Na which often include heavy metals like As, Al, Cd, Pb, Zn, Fe, and Cr. Majority of these elements in excess amounts are potentially harmful to the biotic and abiotic components of the environment (Gbadebe and Bankole, 2007). Heavy metals, such as chromium, nickel, cobalt, lead, and mercury, are readily found in cement dust (Jóźwiak and Jóźwiak, 2009). Likewise, increased concentration of cement dust pollutants causes invisible injuries like progressive decline in the physiological process such as photosynthetic ability and respiration rate of leaves. Similarly, visible injuries such as closure leaf stomata, a marked reduction in growth and productivity were observed due to cement dust. Farmer (1993) reported that cement dust pollutants block the stomata, reduction in number of annual crops and also decreased the productivity and concentration of chlorophyll in a number of crops. In the present work, cement dust polluted selected vegetables had increased concentration of minerals such as Fe, Cu, Zn, Mg, Al, Si and S in the plant parts such as leaves and fruits and its respective cultivated soils. The higher mineral accumulations in the polluted plants and soils were also reported by Ade – Ademilua and Obalola (2007) in *Celosia argentea* and Terivahattau *et al*., in pine (2001). According to Clark (1995), when plants with high levels of heavy metals are consumed, the metals become bioaccumulated in the body overtime ie they remain in the body in an unchanged state and are continuously accumulated during the life of an organism causing biomagnification which may cause various health problems including cardiac arrest synonyms with aluminium toxicity and kidney damage associated with copper toxicity. In the nearest vicinity of the cement plant (15 kms) calcium concentrations were very high. According to Raajasubramanian *et al*., 2011, the presence of increased levels of heavy metals like Zn, Fe, Al in *Arachis hypogea* cultivated in cement dust polluted area and alkalinity of soil was also more as observed in te present work. Similar results was reported by Singh and Rao (1986) in wheat plants and so many other researchers also reported the same. Prolonged cement impact and alkalization of the soil causes change in the availability of several plant essential nutrients. Plants absorption of nutrients drastically decreased due to the high amount of Ca, K content present in the alkaline soil (Mandre, 1995) [8]. A similar result was observed by several authors and stressed the imbalance of nutrients as an important factor in the survival and development of plants (Marschner, 1986; Karblane, 1996) [10, 7]. Photosynthesis as well as optimum quantity of mineral substances essential for structural as well as physiological functioning of the plants. Reduction of photosynthesis leads to affects all the physiological activities of crop one way and on the other hand absorption of mineral substances deficiency also plays most important role for changing the growth and biochemical content of plant, it leads to affect the yield of crop.

According to Tchounwou, 2012 [16], release of cement dust particles, along with heavy metals, has created severe environmental and health issues. Moreover the consumption of cement dust polluted vegetables increases the risk of cancer in humans. The persistent hostile environment created by continuous exposure to cement dust worsens its effects with no time for the plant to scavenge the harmful effects, making them more extensive and damage the homeostasis of the crops. During the last decades, the emission of dust from cement factories has been increased alarmingly due to expansion of more cement plants to meet the requirement of cement materials for construction of building. In comparison with gaseous air pollutants, many of which are readily recognized as being the cause of injure to various types of vegetation. Though studies have been carried out on the effect of cement dust pollution on the growth of plants, assessment of crop plants specially vegetables are scarce, hence the present work taken holds much importance. Further studies are needed to address the effects of cement residues in fruits and any health hazards resulting from their consumption.

**References**


1. Ade-Ademilua OE, Umebese CE. The growth of *Phaseolus vulgaris* L. cv. Ife Brown (Leguminosae) in a cement site rich in heavy metals. Pakistan Journal of Biological Science. 2007; 10:182-185.
2. Borka G. Effects of cement dust of the growth, development, major metabolic processed and yield of winder barely. *In situ* and under controlled conditions; Indian Journal of Air Pollution. 1986; 28:1132-39.
3. Farmer AM. The effect of dust on vegetation – A review. Environmental. Pollution. 1993; 79:63-75.
4. Gbadebe AM, Bankole OD. Analysis of potentially toxic metals in airborne cement dust around Sagamu, South Western Nigeria. Journal of Applied Science. 2007; 7(1):35-40.
5. Iqbal MZ, Shafug M. Periodical effect of cement dust pollution on the growth of some plant species. Turkish Journal of Botany. 2001; 25:19-24.
6. Jóźwiak M, Jóźwiak M. Influence of cement industry on accumulation of heavy metals in bioindicators. *Ecol chem Eng*. 2009; 16:323-334.
7. Karblane H. Taimede toitumise ja vaÈ etamise kaÈ siraamat. EV PoÄ llumajandusministeerium, Tallinn, 1996.
8. Mandre M. Changes in the nutrient composition of trees. In: Mandre, M. (Ed.) Dust pollution and forest ecosystem. A study of conifers in an alkalized environment. Publ. Institute of Ecology, Tallin, 1995, pp.44-65.
9. Mandre M, Klaseiko J, Ots K, Tuulmets L. Changes in phytomass and nutrient partitioning in young conifers in extreme alkaline growth conditions. Environmental. Pollution. 1999; 105:209-220.
10. Marschner H. Mineral nutrition of higher plants. Academic press, London, 1986.
11. Mutlu S, Atici O, Gülen Y. Cement dust pollution induces toxicity or deficiency of some essential elements in wild plants growing around a cement factory. Toxicology and Health. 2012; 29(5):474-80.
12. Piper CS. In soil and plant analysis. Hans. Bombay India, 1966.
13. Singh SN, Rao DN. Effects of cement dust polition on soil properties and wheat plants; Ind. J of Environ. Hlth. 1978; 20:258-67.
14. Uysal I, Karabacak E, Tutenocakli T. The effects of cement kiln dust emitted from C¸ anakkale cement factory on the growth and yield of the olive trees. Ekoloji. 2003; 13(49):17-24.
15. Raajasubramanian D, Sundaramoorthy PM, Baskaran L, Sankar Ganesh K, Chidambaram ALA, Jeganathan M, et al. Ecology Cement dust pollution on growth and yield attributes of groundnut (*Arachis hypogaea* L.) International Multidisciplinary Research Journal. 2011; 1(1):31-36.
16. Tchounwou PB, Yedjou CY, Patlolla AK, Sutton DJ. Heavy metal toxicity and the environment. Molecular, Clinical and Environmental Toxicology, 2011, 133-164.