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# Impact of cement industries dust on soil properties in Bhatapara,Chhattisgarh

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## ABSTRACT

*The present investigation was carried around cement industries at Bhatapara during 2017-18, to study the different soil properties as affected by the dust of cement Industries in Bhatapara Chhattisgarh. Two hundred fifty six composite soil samples were taken from around the cement industries i.e., from eight radiant wind directions viz., North, South, East, West, Northeast, Northwest, Southeast and Southwest in clockwise manner at the distances 0.5, 1, 2, and 3 km from the surface (0-15 cm) and sub-surface (15-30 cm) soil depths. Statistical analysis was done in 3-factors factorial designed experiment using CRD and the effect of cement dust on soil properties were also correlated with wind directions ($X_1$), distances($X_2$) and soil depths ($X_3$). Thephysico-properties of soils showed a significant increase in sand and silt in south-west and west wind directions. Significant increase in clay content was also observed in west and south-wind direction. An increase in pH, electrical conductivity and calcium carbonate content in soil (0-15 cm) soil up to 0.5 km distance in the southwest wind direction was also observed. Organic carbon content in soils also increased significantly with increase in distance at surface soilin the southwest wind direction.*

**Keywords:** Cement dust, pH, EC, organic carbon and $CaCO_3$.

## INTRODUCTION

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 a biotic components of the environment (Gbadebe and Bankole, 2007).The cement particles get deposited on top soil and vegetation as well as enter into the soil as dry, humid or occult deposits and can affect its physicochemical properties (Gupta and Sharma, 2012).The cement dust which is highly alkaline give rise to high pH values (Mlitan*et al.*, 2013). Some of the metals associated with cement dust, such as sodium, potassium, copper, zinc, calcium, magnesium, manganese and iron are necessary for microbial growth and metabolism, but can become toxic if their concentration exceeds certain threshold (Asadu and Agada, 2008). Air pollutants generated by the cement manufacturing process consist primarily of alkaline particulates from the raw and finished materials. The direct effects of cement dust pollution are the alkalization of the ecosystem and the changing of the chemical composition of soils. The main impacts of the cement activity on the environment are the broadcasts of dusts and gases. The pollutant particles can enter into soil as dry, humid or occult deposits and can undermine its physico-chemical properties.Thus, cement dust pollution has a negative effect on the physico-chemical properties and the biological activity of the soil. Soil microbial activity is important for the nutrient biogeochemical cycling and it is negatively affected by the cement dust pollution (Ocak*and* Nowak, 2004). Soil physico-chemical and biological properties are affected by the type of parent materials that formed the soil or various human activities, such as farming, depositions of industrial wastes, and so forth. Cement dust is one of such industrial wastes that affect the soil quality.

## MATERIALS AND METHODS

The experimental site for soil sampling was selected in surrounding area of Ambuja Cement Industries, Rawan, which is situated about 16 km from Bhatapara town of district Balodabazar-bhatapara and 65 km from state capital Raipur in Chhattisgarh. District lies in 21°32 48" north and 81°56 40" east. It has an average elevation of 254 m (833 ft) in Chhattisgarh state.The study area around the cement plant was divided into eight radiant directions of north, south, east, west, northeast,

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northwest, southeast and southwest in clockwise manner. Soil samples were taken in the monthsof June- July 2017 with the help of soil auger at surface (0-15 cm) and sub-surface (15-30 cm) depth at the distances 0.5, 1, 2, and 3 km. (8 samples each)from cement plant and collected in plastic bags and analyzed for pH by glass electrode pH meter taking 1:2.5 soil watersuspensions (Jackson 1973).Electrical conductivity was determined by taking supernatant liquid of soil water suspension by using electrical conductivity and organic carbon was determined by Walkley and Black rapid titration method as described by Jackson (1973) the calcium carbonate content was determined by rapid titration method and soil texture determined by International Pipette Method.

## RESULTS AND DISCUSSION

### *Soil texture*

The sand content in soils varied from 10.7 to 30.3 % with respect to wind direction, distances from industries and soil depth (Table 1). The lowest and highest per cent sand content was recorded 10.7and 27.5 % and 13.3 and 30.3 % in soils at surface (0-15 cm) and sub-surface (15-30cm) soil at 3 and 0.5 km distances in relation to south and west wind directions, respectively. Soil particle sizesand (Y) content in soils was positively and significantly correlated with the distances from industries ($X_2$) and negatively and significantly with soil depth ($X_3$) for all the wind directions. If the wind direction ($X_1$) and distances from industries ($X_2$) are fixed, then the soil particle size(Y) increased with the increasing soil depth. Similarly, if the wind direction and soil depth are fixed, then the soil particle sizes(Y) significantly decreased with the increasing distances from industries. The silt content in soils varied from 27.3 to 44.1 % with respect to wind direction, distances and soil depth. The lowest and highest silt content was recorded 28.0 and 44.1 and 27.3 and 41.3% in soil at surface (0-15 cm) and sub surface (15-30 cm) soil at distances 3 and 2 km in relation to southwest and west wind directions, respectively (Table 1). Soil particle sizesilt (Y) content in soils was positively significantly correlated with the distances from industries ($X_2$) and negatively and significantlywith soil depth ($X_3$) for the all wind directions under study. If the wind direction ($X_1$) and distances from industries ($X_2$) are fixed, then the soil particle sizesilt (Y) decreased with the increasing soil depth. Similarly, if the wind direction ($X_1$) and soil depth ($X_3$) are fixed, then the soil particle sizesilt (Y) significantly increased with the increasing distances from industries.

The clay content in soils varied from 29.3 to 57.3 % with respect to wind direction, distances and soil depth. The lowest and highest clay content was recorded 30.1 and 57.3 and 29.3 and 55.3 % in soils at surface (0-15 cm) and sub-surface (15-30 cm) soil at distances 0.5 and 3 km in relation to west and southwest wind directions respectively (Table 1). Soil particle sizeclay (Y) content in soils was positively and significantly correlated with the distances from industries ($X_2$) and negatively and significantly with soil depth ($X_3$) for all the wind directions. If the wind direction ($X_1$) and distances from industries ($X_2$) are fixed, then the soil particle sizeclay (Y) decreased with the increasing soil depth. Similarly, if the wind direction ($X_1$) and soil depth ($X_3$) are fixed, then the soil clay (Y) significantly increases with the increasing distances from industries. The highest per cent sand in Ulfisol was recorded 30.3 % in sub-surface (15-30cm) soil at 0.5 km distance in relation to west wind directions. The highest per cent silt content in Ulfisol was recorded 44.1 % in soil at surface (0-15 cm) soil depth at distances 3 km in relation to west wind directions. The highest per cent clay in Vertisol was recorded 57.3 % in soils at surface (0-15 cm) soil depth at distances 3 km in relation to southwest wind directions.

Table 1: Effect of wind directions (A), distances from industries (B) and soil depths (C) on particle sand, silt and clay % in soils

| Wind Directions (A) | Distances From Industries (B) Sand | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.5 km | | 1 km | | 2 km | | 3 km | |
| | Soil Depths (C) | | | | | | | |
| | Surface | Sub-surface | Surface | Sub-surface | Surface | Sub-surface | Surface | Sub-surface |
| North | $23.5^{e}_{D}1$ | $25.4^{d}_{F}2$ | $22.6^{e}_{C}1$ | $25.0^{e}_{E}2$ | $21.6^{d}_{B}1$ | $23.3^{c}_{D}2$ | $20.6^{d}_{A}1$ | $22.6^{d}_{C}2$ |
| South | $13.2^{a}_{C}1$ | $15.5^{a}_{E}2$ | $13.2^{a}_{C}1$ | $15.3^{a}_{E}2$ | $12.2^{a}_{B}1$ | $14.6^{a}_{D}2$ | $10.7^{a}_{A}1$ | $13.3^{a}_{C}2$ |
| East | $23.1^{d}_{D}1$ | $26.3^{e}_{G}2$ | $22.2^{d}_{C}1$ | $24.4^{d}_{F}2$ | $21.7^{d}_{B}1$ | $23.5^{c}_{E}2$ | $20.3^{d}_{A}1$ | $22.3^{d}_{C}2$ |
| West | $27.5^{h}_{D}1$ | $30.3^{h}_{G}2$ | $26.3^{h}_{C}1$ | $28.2^{h}_{E}2$ | $25.3^{g}_{B}1$ | $27.6^{f}_{D}2$ | $24.3^{g}_{A}1$ | $28.5^{f}_{F}2$ |
| NE | $24.1^{f}_{D}1$ | $27.3^{f}_{G}2$ | $23.6^{f}_{C}1$ | $26.3^{f}_{F}2$ | $22.2^{e}_{B}1$ | $25.5^{d}_{E}2$ | $21.3^{e}_{A}1$ | $24.2^{e}_{D}2$ |
| NW | $25.6^{g}_{D}1$ | $28.2^{g}_{G}2$ | $24.4^{g}_{C}1$ | $27.3^{g}_{F}2$ | $23.5^{f}_{B}1$ | $26.5^{e}_{E}2$ | $22.5^{f}_{A}1$ | $24.5^{e}_{C}2$ |
| SE | $15.3^{b}_{D}1$ | $17.5^{b}_{G}2$ | $14.5^{b}_{C}1$ | $16.5^{b}_{E}2$ | $13.7^{b}_{B}1$ | $15.4^{b}_{D}2$ | $12.6^{b}_{A}1$ | $14.3^{b}_{C}2$ |
| SW | $16.8^{c}_{D}1$ | $19.9^{c}_{F}2$ | $16.2^{c}_{C}1$ | $19.2^{c}_{G}2$ | $15.4^{c}_{B}1$ | $18.4^{c}_{F}2$ | $14.5^{c}_{A}1$ | $17.3^{c}_{E}2$ |
| AXBXC | | | SEm± 0.12 | | CD-5%0.34 | | | |
| | Silt % | | | | | | | |
| North | $40.4^{d}_{C}2$ | $39.3^{f}_{A}1$ | $40.6^{e}_{D}2$ | $39.9^{f}_{B}1$ | $41.6^{f}_{E}2$ | $40.2^{f}_{C}1$ | $42.4^{e}_{F}2$ | $40.5^{f}_{D}1$ |
| South | $36.1^{c}_{F}2$ | $35.8^{c}_{E}1$ | $35.2^{c}_{D}2$ | $35.0^{c}_{C}1$ | $35.2^{c}_{C}2$ | $34.9^{c}_{B}1$ | $34.8^{c}_{B}2$ | $34.3^{c}_{A}1$ |
| East | $40.2^{d}_{D}2$ | $38.2^{d}_{A}1$ | $40.3^{d}_{D}2$ | $38.6^{d}_{B}1$ | $41.1^{d}_{E}2$ | $39.4^{e}_{C}1$ | $41.3^{d}_{F}2$ | $39.6^{d}_{C}1$ |
| West | $42.2^{g}_{D}2$ | $40.3^{g}_{A}1$ | $42.4^{g}_{D}2$ | $40.5^{g}_{B}1$ | $43.1^{h}_{E}2$ | $41.3^{g}_{C}1$ | $44.1^{f}_{F}2$ | $40.2^{e}_{A}1$ |
| NE | $41.2^{f}_{C}2$ | $39.3^{f}_{A}1$ | $41.4^{f}_{D}2$ | $39.4^{e}_{A}1$ | $42.3^{g}_{E}2$ | $39.3^{d}_{A}1$ | $42.4^{e}_{E}2$ | $40.3^{e}_{B}1$ |
| NW | $40.4^{e}_{C}2$ | $38.6^{e}_{A}1$ | $40.5^{e}_{C}2$ | $38.7^{d}_{A}1$ | $41.4^{e}_{E}2$ | $39.2^{d}_{B}1$ | $42.3^{e}_{F}2$ | $40.7^{g}_{D}1$ |
| SE | $32.3^{b}_{C}2$ | $32.1^{b}_{B}1$ | $32.8^{b}_{D}2$ | $32.6^{b}_{D}1$ | $32.9^{b}_{E}2$ | $32.8^{b}_{D}1$ | $31.5^{b}_{D}2$ | $31.5^{b}_{A}1$ |
| SW | $28.6^{a}_{E}2$ | $27.5^{a}_{B}1$ | $29.0^{a}_{F}2$ | $28.3^{a}_{D}1$ | $29.2^{a}_{G}2$ | $28.1^{a}_{C}1$ | $28.0^{a}_{C}2$ | $27.3^{a}_{A}1$ |
| AXBXC | | | SEm± 0.06 | | CD-5% 0.17 | | | |
| | Clay % | | | | | | | |
| North | 36.0dC2 | 35.2dB1 | 36.7dE2 | 35.0dA1 | 36.7dE2 | 36.4dD1 | 36.9dF2 | 36.7dE1 |
| South | 50.5eC2 | 48.6eA1 | 51.5fE2 | 49.6fB1 | 52.4fF2 | 50.4fC1 | 54.3fG2 | 52.2fF1 |
| East | 36.1dB2 | 35.4dA1 | 37.3eE2 | 36.9eC1 | 37.1eD2 | 36.9eC1 | 38.3eG2 | 37.9eF1 |
| West | 30.1aB2 | 29.3aA1 | 31.2aC2 | 31.1aC1 | 31.4aD2 | 31.0aC1 | 31.4aD2 | 31.1aC1 |
| NE | 34.5cC2 | 33.3cA1 | 34.9bD2 | 34.1cB1 | 35.4cF2 | 35.1cE1 | 36.1cG2 | 35.3cF1 |
| NW | 33.9bB2 | 33.0bA1 | 35.1cE2 | 33.9bB1 | 35.0bE2 | 34.2bC1 | 35.0bE2 | 34.6bD1 |
| SE | 52.2fD2 | 50.2fA1 | 52.6gE2 | 50.7gB1 | 53.2gF2 | 51.7gC1 | 55.7gH2 | 54.0gG1 |
| SW | 54.5gC2 | 52.5gA1 | 54.6hC2 | 52.3hA1 | 55.2hD2 | 53.3hB1 | 57.3hE2 | 55.3hD1 |
| AXBXC | | SEm± 0.07 | | | CD-5% 0.2 | | | |

*Soil reaction (pH)*

The pH content in soils varied from 6.55 to 7.58 at the distances 3 and 0.5 km from industries site in relation to east to southwest wind directions, respectively (Table 2). Significant differences in soil pH were reported with respect to all the four distances viz. 0.5, 1,2 and 3 km and with each fixed wind directions. Soil pH (Y) content in soils was negativelyand significantly correlated with the distances from industries ($X_2$) for all the wind directions. If the wind directions ($X_1$) are fixed, then the soil pH (Y) decreased with the increasing distances from industries.The higher values of pH content noted in soils at the distances of 0.5 and 1 km as compared to distances of 2 and 3 km in relation to southwest wind direction if may be due to high level of dust deposition and as most of the Ca in the cement dust in the form of oxide, hydroxide and carbonate formed lime that increased the soil pH. Similar findings were reported by Ahiamadjie *et al.* (2011) and Raajasubramanian*et al.* (2011).

Table 2: Effect of wind directions (A) and distances from industries (B) on soils pH

| Wind Directions (A) | Distances From Industries (B) | | | |
|---|---|---|---|---|
| | 0.5 km | 1 km | 2 km | 3 km |
| North | $7.01^{b}_{D}$ | $6.95^{b}_{C}$ | $6.86^{b}_{B}$ | $6.76^{bA}$ |
| South | $7.25^{e}_{D}$ | $7.15^{e}_{C}$ | $7.05^{e}_{B}$ | $6.88^{CA}$ |
| East | $6.78^{a}_{D}$ | $6.70^{a}_{C}$ | $6.68^{a}_{B}$ | $6.55^{aA}$ |
| West | $7.18^{d}_{D}$ | $7.08^{d}_{C}$ | $6.98^{d}_{B}$ | $6.85^{dA}$ |
| NE | $7.06^{c}_{D}$ | $7.00^{c}_{C}$ | $6.85^{b}_{B}$ | $6.78^{bA}$ |
| NW | $7.08^{c}_{D}$ | $7.01^{c}_{C}$ | $6.90^{c}_{B}$ | $6.78^{bA}$ |
| SE | $7.38^{f}_{D}$ | $7.25^{f}_{C}$ | $7.06^{e}_{B}$ | $6.96^{dA}$ |
| SW | $7.58^{g}_{D}$ | $7.48^{g}_{C}$ | $7.38^{f}_{B}$ | $7.25^{eA}$ |
| AXB | SEm± 0.019 | CD-5% 0.053 | | |

*Electrical conductivity (EC)*

Overall variations in the electrical conductivity were recorded from 0.15 to 0.33 $dSm^{-1}$ with respects to wind directions, distances and soil depths (Table 3). The lowest and highest electrical conductivity content was recorded 0.16 and 0.33 $dSm^{-1}$and 0.15 and 0.32 $dSm^{-1}$in soil at surface (0-15 cm) and sub-surface (15-30 cm) soil at distances 3 and0.5 km in relation to east to southwest wind directions, respectively. Electrical conductivity (Y) in soils was negatively and significantly correlated with the distances from industries ($X_2$) and soil depth ($X_3$) for all the wind directions. If the wind direction ($X_1$) and distances from industries ($X_2$) are fixed, then the soil electrical conductivity (Y) decreased with the increasing soil depth. Similarly, if the wind direction ($X_1$) and soil depth ($X_3$) are fixed, then the soil electrical conductivity (Y) significantly decreased with the increasing distances from industries. The electrical conductivityincreased significantly with decreasing distances and the higher values were recorded at 0.5 km distances in surface soil in relation to southwest wind direction which may be due to higher deposition of cement dust and its ingredients increased the soluble salt concentration. Similar findings were also reported by Ahiamadjie*et al.*(2011)and Raajasubramanian*et al.*(2011).

Table 3: Effect of wind directions (A), distances from industries (B) and soil depths (C) on electrical conductivity ($dSm^{-1}$) in soils

| Wind Directions (A) | Distances From Industries (B) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.5 km | | 1 km | | 2 km | | 3 km | |
| | Soil Depths (C) | | | | | | | |
| | Surface | Sub-surface | Surface | Sub-surface | Surface | Sub-surface | Surface | Sub-surface |
| North | $0.24^{b}$ | $0.21^{b}$ | $0.21^{b}$ | $0.19^{b}$ | $0.19^{b}$ | $0.17^{b}$ | $0.17^{b}$ | $0.15^{a}$ |
| South | $0.30^{e}$ | $0.27^{e}$ | $0.28^{d}$ | $0.27^{d}$ | $0.27^{f}$ | $0.25^{f}$ | $0.25^{e}$ | $0.22^{e}$ |
| East | $0.21^{a}$ | $0.19^{a}$ | $0.19^{a}$ | $0.17^{a}$ | $0.17^{a}$ | $0.15^{a}$ | $0.16^{a}$ | $0.15^{a}$ |
| West | $0.26^{d}$ | $0.24^{d}$ | $0.25^{c}$ | $0.23^{c}$ | $0.21^{c}$ | $0.20^{c}$ | $0.21^{c}$ | $0.18^{b}$ |
| NE | $0.25^{c}$ | $0.23^{c}$ | $0.25^{c}$ | $0.23^{c}$ | $0.23^{d}$ | $0.21^{d}$ | $0.21^{c}$ | $0.19^{c}$ |
| NW | $0.26^{d}$ | $0.23^{c}$ | $0.25^{c}$ | $0.23^{c}$ | $0.24^{e}$ | $0.22^{e}$ | $0.23^{d}$ | $0.20^{d}$ |
| SE | $0.31^{f}$ | $0.29^{f}$ | $0.29^{e}$ | $0.27^{d}$ | $0.28^{g}$ | $0.26^{g}$ | $0.27^{f}$ | $0.24^{f}$ |
| SW | $0.33^{g}$ | $0.32^{g}$ | $0.31^{f}$ | $0.29^{e}$ | $0.29^{h}$ | $0.27^{h}$ | $0.28^{g}$ | $0.25^{g}$ |
| AXB | | | SEm± 0.002 | | | CD-5% 0.006 | | |

*Organic carbon*

The organic carbon content varied from 2.4 to 5.0 g $Kg^{-1}$the highest organic carbon value is recorded at 3 km distances while the lowest was recorded at 0.5 km distances in relation to south west andeast wind directions, respectively (Table 4). Significant differences in soil organic carbon were recorded with respect to all the four distances and with each fixed wind directions.Organiccarbon (Y) content in soils was significantly and positively correlated with the distances from industries ($X_2$) for all wind directions. If the wind directions ($X_1$) are fixed, then the soil organic carbon (Y) significantly increased with the increasing distances from industries.The organic carbon content in soil increased with increasing distances and recorded higher values at 2and 3 km as compared to nearer distances i.e. 0.5 and1 km distances in relation to southwest to east wind direction. Cement dust alkalinity had negatively affect an organic carbon. Similar findings were reported by Grantz*et al.* (2008) and Pandey *et al.* (2011).

Table 4: Effect of wind directions (A) and distances from industries (B) on organic carbon gkg$^{-1}$) in soil

| Wind Directions (A) | Distances From Industries (B) | | | |
|---|---|---|---|---|
| | 0.5 km | 1 km | 2 km | 3 km |
| North | $2.8^{b}_{A}$ | $3.1^{b}_{B}$ | $3.4^{b}_{C}$ | $3.9^{b}_{D}$ |
| South | $3.8^{g}_{A}$ | $4.2^{g}_{B}$ | $4.6^{g}_{C}$ | $4.7^{e}_{D}$ |
| East | $2.4^{a}_{A}$ | $2.9^{a}_{B}$ | $3.1^{a}_{C}$ | $3.4^{a}_{D}$ |
| West | $3.1^{e}_{A}$ | $3.4^{d}_{B}$ | $3.7^{d}_{C}$ | $4.1^{d}_{D}$ |
| NE | $2.9^{c}_{A}$ | $3.2^{c}_{B}$ | $3.6^{c}_{C}$ | $4.0^{c}_{D}$ |
| NW | $3.0^{d}_{A}$ | $3.6^{e}_{B}$ | $3.8^{e}_{C}$ | $4.0^{c}_{D}$ |
| SE | $3.6^{f}_{A}$ | $3.9^{f}_{B}$ | $4.2^{f}_{C}$ | $4.7^{e}_{D}$ |
| SW | $4.0^{h}_{A}$ | $4.3^{h}_{B}$ | $4.7^{h}_{C}$ | $5.0^{f}_{D}$ |
| AXB | SEm± 0.002 | CD-5% 0.006 | | |

*Calcium carbonate*

The content calcium carbonate in soils ranged from24.6 to 48.7 gkg$^{-1}$ at the distances 3 and 0.5 km in relation to east to southwest wind directions, respectively (Table 5). Significant differences in calcium carbonate content were recorded with respect to all the four distances and with each fixed wind directions.Calcium carbonate (Y) content in soils were negatively and significantly correlated with the distances from industries ($X_2$) for all the wind directions. If the wind directions ($X_1$) are fixed, then the soil $CaCO_3$ (Y) significantly decreased with the increasing distances from industries.

Table 5: Effect of wind directions (A), distances from industries (B) and soil depth (C) on $CaCO_3$ (g kg$^{-1}$) in soils

| Wind Directions (A) | Distances From Industries (B) | | | | Soil Depths ( C ) | |
|---|---|---|---|---|---|---|
| | 0.5 km | 1 km | 2 km | 3 km | 0-15 cm | 15-30 cm |
| North | $38.0^{b}_{D}$ | $33.7^{b}_{C}$ | $29.5^{b}_{B}$ | $26.3^{b}_{A}$ | $33.6^{b}_{B}$ | $30.2^{b}_{A}$ |
| South | $44.5^{d}_{D}$ | $42.0^{e}_{C}$ | $39.2^{e}_{B}$ | $36.0^{f}_{A}$ | $42.1^{f}_{B}$ | $38.8^{f}_{A}$ |
| East | $36.8^{a}_{D}$ | $32.3^{a}_{C}$ | $27.7^{a}_{B}$ | $24.6^{a}_{A}$ | $31.9^{a}_{B}$ | $28.7^{a}_{A}$ |
| West | $41.4^{c}_{D}$ | $38.9^{d}_{C}$ | $36.2^{d}_{B}$ | $33.6^{e}_{A}$ | $39.2^{e}_{B}$ | $35.9^{e}_{A}$ |
| NE | $38.8^{b}_{D}$ | $36.2^{c}_{C}$ | $31.8^{c}_{B}$ | $27.7^{c}_{A}$ | $35.4^{c}_{B}$ | $31.9^{c}_{A}$ |
| NW | $40.7^{c}_{D}$ | $38.1^{c}_{C}$ | $35.1^{d}_{B}$ | $31.6^{d}_{A}$ | $38.0^{d}_{B}$ | $34.8^{d}_{A}$ |
| SE | $43.8^{d}_{D}$ | $44.6^{f}_{C}$ | $41.5^{f}_{B}$ | $38.4^{g}_{A}$ | $42.9^{g}_{B}$ | $41.3^{g}_{A}$ |
| SW | $48.7^{e}_{D}$ | $46.5^{g}_{C}$ | $43.6^{g}_{B}$ | $40.9^{h}_{A}$ | $46.5^{h}_{B}$ | $43.3^{h}_{A}$ |
| AXB | SEm± 0.42CD-5% 1.17 | | | | SEm± 0.29CD-5% 0.83 | |

The calcium carbonate content in soils ranged from 31.9 to 46.5g kg$^{-1}$and 28.7 to43.3 g kg$^{-1}$atsurface and sub-surface soil in relation to east to southwest wind directions, respectively. The calcium carbonate content increased with increasing distance from industries site and higher content at 0.5 km distances in surface soil in relation to southwest wind direction as compared to east wind directions.The higher deposition of cement dust nearer at the distance of 1 km may be due to increase in concentration of lime and $Ca^{++}$mica the soil alkaline. Similar finding was reported by Khampariaet *al.* (2012).

From the results it may be concluded that soil pH, EC and calcium carbonateincresed with decreasing distances from the cement industries at 0.5 km in surface soil in the southwest wind direction. Organic carbon decreased with decreasing in the distances from the cement industries at 3 km in surface soil in the southwest wind direction.

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