# Impact of Cement Dust Deposition on Vegetation around JK Cement Factory, Khrew, Jammu & Kashmir

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**ABSTRACT**

*Air pollution is an additional stress on plants since they often respond to atmospheric contamination in the same way as they respond to drought and other environment stress. Effect of cement dust pollution on the plant species including Plantago lanceolata, Artemesia vestita, Isodon rugosus, Artemesia absinthium, Thymus linearis and Marrubium vulgare was studied for one year time period (April- October 2012) at various distances from the J&K cement factory in the Khrew area. The parameters which were analyzed viz. total chlorophyll, chlorophyll a, chlorophyll b, carotenoids, pheophytins showed a remarkable increase as the distance from the pollution source increased. The pH of leaf wash of plants in the vicinity of factory was strongly alkaline as compared to the plants growing at the reference site. The dust deposition (mg/cm$^2$) on the leaves of all plant species was highest near the factory where as the dust load on leaves of plant species growing at the reference site was almost negligible.*

***Key words: carotenoids, cement dust pollution, dust deposition, Marrubium vulgare, total chlorophyll,***

## I. INTRODUCTION

Pollution of the environment is one of the major effects of human technological advancement. It results when a change in the environment harmfully affects the quality of human life including effects on animals, microorganisms and plants as well as soil ecosystem (Marinescu *et al*., 2010). Most of Indian cities are affecting with the presence of high concentrations of gaseous and particulate pollutants due to industrialization, badly maintained poor roads, poor maintenance of vehicles, use of fuels with poor environmental performance and lack of awareness (Joshi and Chauhan, 2008). Rapid industrialization and addition of the toxic substances to the environment are responsible for altering the ecosystem (Sarala Thambavani and Saravanakumar, 2011; 2012). The Cement industry plays a vital role in the imbalances of the environment and produces air pollution hazards (Stern, 1976; Sarala Thambavani and Saravanakumar, 2011). Industries are emitting toxic substances which adversely affect man's food supply by polluting nearby growing plants. One of the most studies of these stresses is dust accumulation, which provokes severe damage in the photosynthetic apparatus (Santosh and Tripathi, 2008). Plants provide an enormous leaf area for impingement, absorption and accumulation of air pollutants to reduce the pollution level in the air environment (Escobedo *et al*., 2008). Removal of pollutants by plant from air by three processes, namely deposition of particulates, absorption by leaves and aerosols over leaf surface (Prajapati and Tripathi, 2008). 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).

The objective of the present study was to analyse the effects of dust pollutants on chlorophyll *'a', 'b'*, total chlorophyll, pheophytin 'a', 'b', total Pheophytin, carotenoid, dust content, leaf wash pH of selected plant species around JK cement factory, one of the leading cement factory in Kashmir, with a daily production of 1200 tons. Plants around the cement factory were selected for bio-physical analysis. Also, plants from pollution free site were taken as reference for comparison.

## II. MATERIAL AND METHODS

The Khrew industrial area which is located in the Pulwama district of Kashmir was chosen as the study area for the present investigation which is situated about 23 Km away in SE of Srinagar. Vegetation of this area is suffering from dust pollution due to the presence of cement factories. Six dominants plant species including *Plantago lanceolata, Artemesia vestita, Isodon rugosus, Artemesia absinthium, Thymus linearis and Marrubium vulgare* were selected at four different locations (distance wise) from a cement factory in the studying area. Locations (1, 2, 3 and 4) were about 0 km, 1 km, 2 km and 10 km from the factory respectively. Selected plant species were collected randomly from the four locations covering the study area from April-October 2012.

### Table-1: Description of study area

| S.No | Sampling site | Location from Cement Production Unit | Category |
|---|---|---|---|
| 1 | Site-1 | 0 km | Most Polluted area |
| 2 | Site-2 | 1 km | Polluted area |
| 3 | Site-3 | 2 km | Polluted area |
| 4 | Site-4 | 10 km | Reference area |

The studies were conducted on *Plantago lanceolata, Artemesia vestita, Isodon rugosus, Artemesia absinthium, Thymus linearis and Marrubium vulgare* plants growing under natural conditions. The leaves were carefully removed and collected from the plants at all sites, using a snapper blade. The dust deposition on leaf surface was calculated by dry technique recommended by Das and Patanayak (1977). The leaf wash pH was determined following Pawar *et al,* (1988). The concentration of total pigments was determined spectrophotometrically, extracting the pigments in 80% acetone. Chlorophyll, pheophytins and Carotenoids were extracted in 80% acetone and estimated according to the method of Strain *et al.* (1971), Vernon (1960) and Duxbury and Yentesch (1956) respectively using ELICO SL-171 spectrophotometer.

Photosynthetic Pigments were extracted in 80% acetone. 2 ml of 10% plant leaf homogenate was mixed with 8 ml of acetone in 10 ml volumetric flask. After shaking the material was well transferred in centrifuge tubes and centrifuged at 10,000 rpm for 10 minutes at 4º C. The colour intensity of supernatant was measured at different wavelengths like 480nm, 510nm, 649nm, 655nm, 665 nm and 666nm. Using the absorption coefficient, the amount of pigments was calculated.

Chlorophyll content was measured according to the following equation (Strain *et al*, 1971)

Chlorophyll a (µg/ml) = $11.63 \times A_{665} - 2.39 \times A_{649}$

Chlorophyll b (µg/ml) = $20.11 \times A_{649} - 5.18 \times A_{665}$

Total Chlorophyll (µg/ml) = $6.45 \times A_{665} + 17.72 \times A_{649}$

The Pheophytin content was measured by the following equation (Vernon, 1960)

Pheophytin a (µg/ml) = $20.15 \times A_{666} - 5.87 \times A_{665}$

Pheophytin b (µg/ml) = $31.96 \times A_{665} - 13.65 \times A_{666}$

Total Pheophytin (µg/ml) = $6.75 \times A_{666} + 26.03 \times A_{665}$

The Carotenoid content was calculated by the following formula given by Duxbury and Yentesch (1956)

Carotenoid (µg/ml) = $7.6 \times A_{480} - 1.49 \times A_{510}$

## III.RESULTS AND DISCUSSION

Chlorophyll is an index of productivity of plant (Raza & Murthy, 1988). The chlorophyll pigments are essential component for photosynthesis which occur in chloroplast as green pigment in all photosynthetic plant tissue and are called as photoreceptors; hence any alteration in the chlorophyll concentration may change the morphological and physiological behavior of the plant. Air pollution is known to affect the total chlorophyll content and reduce the photosynthetic activity. Of all the plant parts, the leaf is the most sensitive part to air pollutants and several other such external factors (Lalman and Singh, 1990). When plants are exposed to the environmental pollution above normal physiologically acceptable range, photosynthesis gets inactivated. Chlorophyll 'a'content increased as the pollution load decreased with the lowest value of 0.59 µg/ml for *Thymus linearis* in the month of April at site I and the highest value as 18.85 µg/ml for *Plantago lanceolata* in September at site IV (Table.2). The highest value of chlorophyll 'b' was recorded as 17.92 µg/ml for *Marrubium vulgare* in August at site III and the lowest as 0.56 µg/ml for *Marrubium vulgare* in April at site I (Table.3). Similarly, the total chlorophyll content appeared to exhibit lowest value of 1.215 µg/ml for *Marrubium vulgare* at site I (around the cement factory) in the month of April while the highest value was recorded as 27.4 µg/ml for *Isodon rugosus* in the month of April at site III (Table.4). Total chlorophyll content in all species studied decreased as the distance from cement factory increased i.e. the distance from the dust source increased the total chlorophyll content increased. Carotenoids are a class of natural fat-soluble pigments found principally in plants, algae and photosynthetic bacteria, where they play a critical role in the photosynthetic process. They act as accessory pigments in higher plants. They are tougher than chlorophyll but much less efficient in light gathering, help the valuable but much fragile chlorophyll and protect chlorophyll from photoxidative destruction (Joshi *et al*., 2009). Carotenoids protect photosynthetic organisms against potentially harmful photoxidative processes and are essential structural components of the photosynthetic antenna and reaction center (Joshi and Swami, 2009). Present investigation revealed decreased carotenoid content in polluted site in almost all plant leaves as compared to the reference site. In fact, carotenoid content in leaves under air pollution was decreased. This result is in agreement with those of Joshi and Swami (2007) who showed that plant species subjected to air pollution showed highest decrease in carotenoid contents. They reported the reduction in concentration of carotenoids in the leaf samples collected from polluted sites (Joshi and Swami, 2009). Carotenoid contents of some crop plants were found to decrease in response to $SO_2$ (Pandey, 1978; Singh, 1981). It also been noted that carotenoids are more sensitive to $SO_2$ than chlorophyll (Shmimazaki *et al*., 1980). Several researchers have reported reduced carotenoid content under air pollution (Joshi *et al*., 2009; Tiwari *et al*., 2006). Sree Rangaswani *et al*. (1973) observed that deposition of cement dust on herbaceous plants and fruit crops can cause effects that range from blocked stomata, reduced number of plant leaf and injury to complete reduction in vegetative growth and reproductive structures. The different pollutants play a significant role in inhibition of photosynthetic activity that may result in depletion of chlorophyll and carotenoid content of the leaves of various plants (Chauhan and Joshi, 2008). In general the carotenoid content of leaves was observed to exist between 0.251µg/ml for *Artemesia absinthium* in May at site I and 13.97µg/ml for *Isodon rugosus* in September at site III (Table.8). In the present study, dust accumulation altered the chlorophyll and carotenoid contents in all plants in the polluted location (near the cement factory) compared with plants far from the factory at reference site. The total chlorophyll content decreased in the plants growing in the vicinity of the cement factory. The amounts of chlorophyll ‘a’, chlorophyll ‘b’, total chlorophyll and carotenoid contents of cement dust treated samples were always lower than that of control plants in the present study. Reduction in chlorophyll content as a result of cement dust deposition has been reported for *Helianthus annuus* (Borkha, 1980), *Triticum aestivum* (Singh & Rao 1981), *Zea mays*, *Amaranthus viridus* and *Abelmoscus esculentus* (Odu, 1994). Singh and Rao (1981) noted that changes associated with chlorophyll content in a cement-polluted environment, were associated with a decrease in the levels of stomatal and cuticular transpiration of encrusted leaf surfaces. Decrease in chlorophyll content might be due to chloroplast damage by incorporation of cement kiln dust into leaf tissues (Singh and Srivastava, 2002). For Pheophytins, the same trend was observed for the different study sites during the study period. The cement kiln dust decrease chlorophyll content, confirming the findings by Prasad and Inamdar (1990). Bhatnagar *et al*., (1985) concluded that less chlorophyll in leaves of plants growing in polluted area was due to toxic effect of industrial dust and other gaseous pollutants on leaf. The reduction in chlorophyll concentration in the polluted leaves could be due to chloroplast damage (Pandey *et* *al*., 1991), inhibition of chlorophyll biosynthesis (Esmat, 1993) or enhanced chlorophyll degradation. The present results are consistent with Nanos and Ilias, (2007) who reported that cement dust decreased the leaf total chlorophyll content. The pheophytin 'a' content varied from1.02 µg/ml to 29.4 µg/ml (Table.5). The highest value was observed at site IV and the lowest at site I. Pheophytin 'b' content varied between 1.05 µg/ml to 31.83 µg/ml (Table.6). Total pheophytin ranged between 2.22 µg/ml and 58.4 µg/ml (Table.7). In general the dust content of leaves was observed to range from 0.09 $mg/cm^2$ to 6.05 $mg/cm^2$ (Table.9). The values of leaf wash pH ranged between for 7 for *Plantago lanceolata* at site IV and 10.55 for *Marrubium vulgare* at site I (Table.10). The dust content at all sites in all months ranged between 0.06 $mg/cm^2$ in *Thymus linearis* at site IV and 6.05 $mg/cm^2$ in *Marrubium vulgare* at site I. Analysis of the present investigation shows that in all the months, dust fall on the leaves of all the plants under study was observed very high in polluted area, which was due to more pollutants releasing through cement factory while at the reference site i.e. Site IV. Same result of high dust deposition on leaf surface in industrial area have been reported by Shetye and Chaphekar (1980). According to Prajapati and Tripathi (2006), dust interception and its accumulation in different plant species not only depends upon the sources and amount of pollutants in the environment but also depends on various morphological characters such as leaf shape and size, orientation, texture, presence/absence of hairs, length of petioles etc., weather conditions and direction of wind and anthropogenic activities. Therefore, high dust content on the leaves of *Marrubium vulgare* at the most polluted site (site I) can be attributed to presence of hairs on the rough leaf surface that accumulated comparatively more dust content. pH of Leaf wash was higher in affected plants at site I than the Site IV. In all months of the study period, the pH of leaf wash was estimated to be exhibiting a declining trend as one moved away from the cement factory i.e. Site I > Site II > Site III > Site IV. The strongly alkaline nature of pH values could be attributed to the formation of hydroxides of calcium which is supported by the quite similar observations of Misra *et al*., 1980. Also the strong alkaline nature of the leaf wash at site I might be due to the dust from limestone materials which factory uses for the manufacturing of cement and the dust which arises during quarrying and transportation of the raw materials. The results are also consistent with Nilson, 1995 who observed that in the nearest surroundings of the cement plant, the stems of trees were covered with a cement crust and recorded a striking increase in the pH of the pine bark.

## IV.CONCLUSIONS

On the basis of this study, it could be concluded that the vegetation of the area was found to be affected by cement dust, which might be due to the presence of varied pollutants in the cement dust of the study area. From the observations made during the study it appeared that the cement factory is responsible for the substantial amount of dust in the atmosphere resulting in damage not only to the air quality but also to soil and vegetation. The need for appropriate device installation and development of green belts in the area is highly recommended in the area to mitigate the increasing dust emission from cement factories.

**V.ACKNOWLEDGEMENT**

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**Table-2: Monthly estimation of Chlorophyll 'a' (µg/ml) of different plant species during the study period at the four study sites.**

| Plant Species | Sites | April | May | June | July | August | September | October | Mean | S.D. |
|---|---|---|---|---|---|---|---|---|---|---|
| *Marrubium vulgare* | Site I | 0.655 | 0.746 | 4.86 | 5.21 | 2.87 | 7.22 | 2.98 | 3.50 | 2.41 |
| | Site II | 2.997 | 3.893 | 6.11 | 8 | 4.61 | 7.96 | 3.75 | 5.33 | 2.05 |
| | Site III | 3.97 | 4.17 | 7.47 | 8.06 | 5.64 | 8.72 | 12.07 | 7.15 | 2.85 |
| | Site IV | 4.27 | 5.14 | 8.59 | 8.94 | 12.1 | 11.93 | -- | 8.49 | 3.29 |
| *Plantago lanceolata* | Site I | 2.04 | 3.13 | 8.76 | 9.96 | 2.64 | 9.61 | 3.3 | 5.63 | 3.60 |
| | Site II | 2.06 | 3.41 | 10.13 | 14.18 | 2.65 | 16.18 | 11.78 | 8.62 | 5.86 |
| | Site III | 6.67 | 5.7 | 12.19 | -- | 5.27 | 16.18 | 16.57 | 10.43 | 5.23 |
| | Site IV | 7.04 | 7.13 | 15.04 | 18.18 | 6.16 | 18.85 | 18.82 | 13.03 | 6 |
| *Isodon rugosus* | Site I | 4.22 | 1.18 | 1.2 | 1.71 | 7.18 | 4.07 | 0.84 | 2.91 | 2.34 |
| | Site II | 4.86 | 4.22 | 1.71 | 2.7 | 8.63 | 13.44 | 2.78 | 5.47 | 4.17 |
| | Site III | 10.79 | 4.62 | 3.28 | 4.9 | 12.75 | 13.81 | 2.98 | 7.59 | 4.68 |
| | Site IV | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Thymus linearis* | Site I | 0.59 | 0.65 | 5.45 | 5.48 | 2.74 | 4.55 | 3.27 | 3.24 | 2.07 |
| | Site II | 1.67 | 2.61 | 5.87 | 5.94 | 3.37 | 4.98 | 5.22 | 4.23 | 1.69 |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Site III | 3.08 | 2.66 | 7.36 | 7.46 | -- | 8.96 | -- | 5.90 | 2.85 |
| | Site IV | 4.4 | 4.35 | -- | 7.48 | 5.63 | 9.95 | 5.514 | 6.22 | 2.15 |
| *Artemesia absinthium* | Site I | 1.47 | 1.67 | 6.72 | 2.69 | 2.89 | 6.88 | 5.57 | 3.98 | 2.34 |
| | Site II | 1.32 | 2.5 | 6.8 | 7.25 | 7.4 | 9.52 | 6.68 | 5.92 | 2.92 |
| | Site III | 4.59 | 4.82 | 7.97 | 9.45 | 8.23 | 9.6 | 10.05 | 7.81 | 2.25 |
| | Site IV | 4.98 | 5.41 | 8.11 | 10.71 | 10.43 | 11.07 | 11.98 | 8.955 | 2.83 |
| *Artemesia vestita* | Site I | 2.17 | 1.37 | 1.71 | 2.125 | 3.17 | 7.3 | 4.22 | 3.15 | 2.07 |
| | Site II | 2.86 | 3.52 | 2.64 | 3.07 | 6.75 | 13.99 | 9.47 | 6.04 | 4.33 |
| | Site III | 3.8 | 3.8 | 4.73 | 4.84 | 9.13 | 15.65 | 13.39 | 7.90 | 4.91 |
| | Site IV | 1.52 | 5.22 | 7.07 | 8.11 | 10.56 | 18.36 | 13.47 | 9.18 | 5.55 |

**Table-3: Monthly estimation of Chlorophyll 'b' (µg/ml) of different plant species during the study period at the four study sites.**

| Plants Species | Sites | April | May | June | July | August | September | October | Mean | S.D. |
|---|---|---|---|---|---|---|---|---|---|---|
| *Marrubium vulgare* | Site I | 0.56 | 0.58 | 1.35 | 1.74 | 2.44 | 2.92 | 2.14 | 1.67 | 0.90 |
| | Site II | 2.096 | 5.26 | 2.45 | 2.87 | 2.41 | 3.81 | 3.07 | 3.13 | 1.09 |
| | Site III | 2.538 | 2.39 | 2.58 | 2.57 | 17.92 | 3.57 | 5.05 | 5.23 | 5.68 |
| | Site IV | 3.25 | 3.65 | 4.11 | 4.27 | 5.7 | 7.2 | -- | 4.69 | 1.48 |
| *Plantago lanceolata* | Site I | 3.51 | 1.32 | 2.58 | 3.14 | 2.32 | 2.81 | 1.67 | 2.47 | 0.78 |
| | Site II | 2.096 | 1.59 | 2.99 | 5.05 | 2.61 | 6.37 | 2.87 | 3.36 | 1.71 |
| | Site III | 10.68 | 1.55 | 4.17 | -- | 3.58 | 7.5 | 5.61 | 5.51 | 3.22 |
| | Site IV | 2.32 | 2.49 | 4.55 | 7.19 | 4.82 | 7.55 | 4.92 | 4.83 | 2.03 |
| *Isodon rugosus* | Site I | 2.98 | 6.986 | 0.8 | 0.85 | 7.4 | 1.76 | 0.89 | 3.09 | 2.91 |
| | Site II | 10.35 | 2.98 | 0.59 | 2.87 | 14.58 | 3.8 | 1.96 | 5.30 | 5.14 |
| | Site III | 16.6 | 3.73 | 1.23 | 1.88 | 7.22 | 4.29 | 2.14 | 5.29 | 5.37 |
| | Site IV | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Thymus linearis* | Site I | 1.02 | 1.04 | 1.89 | 2.15 | 1.79 | 1.96 | 2.58 | 1.77 | 0.57 |
| | Site II | 1.36 | 2.2 | 2.03 | 2.11 | 1.69 | 4.3 | 2.71 | 2.34 | 0.96 |
| | Site III | 3.51 | 2.05 | 2.88 | 2.54 | -- | 3.51 | -- | 2.89 | 0.63 |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Site IV | 7.32 | 2.16 | -- | 2.46 | 1.85 | 3.57 | 2.53 | 3.315 | 2.05 |
| *Artemesia absinthium* | Site I | 1.58 | 1.36 | 2.05 | 1.31 | 1.4 | 3.32 | 3.2 | 2.03 | 0.88 |
| | Site II | 1.04 | 2.29 | 9.62 | 2.3 | 4.17 | 3.34 | 2.96 | 3.67 | 2.80 |
| | Site III | 3.91 | 3.94 | 2.57 | 3.56 | 4.2 | 6.38 | 4.23 | 4.11 | 1.15 |
| | Site IV | 2.12 | 2.65 | 5.53 | 3.82 | 5.16 | 4.16 | 3.14 | 3.79 | 1.26 |
| *Artemesia vestita* | Site I | 6.29 | 2.66 | 0.59 | 1.09 | 2.68 | 0.73 | 4.41 | 2.63 | 2.11 |
| | Site II | 3.72 | 2.83 | 1.05 | 1.11 | 4.12 | 4.7 | 4.07 | 3.08 | 1.48 |
| | Site III | 3.66 | 2.66 | 1.78 | 1.79 | 5.48 | 6.38 | 7.74 | 4.21 | 2.35 |
| | Site IV | 1.91 | 2.59 | 5.15 | 5.53 | 6.95 | 7.26 | 6.23 | 5.088 | 2.08 |

**Table-4 : Monthly estimation of Total Chlorophyll (μg/ml) of different plant species during the study period at the four study sites.**

| **Plant Species** | **Sites** | **April** | **May** | **June** | **July** | **August** | **September** | **October** | **Mean** | **S.D.** |
|---|---|---|---|---|---|---|---|---|---|---|
| *Marrubium vulgare* | Site I | 1.21 | 1.32 | 6.21 | 6.95 | 5.3 | 10.14 | 5.11 | 5.17 | 3.15 |
| | Site II | 5.09 | 9.15 | 8.56 | 10.87 | 7 | 11.75 | 6.82 | 8.46 | 2.35 |
| | Site III | 6.50 | 6.56 | 10.05 | 10.62 | 23.56 | 12.27 | 17.12 | 12.38 | 6.11 |
| | Site IV | 7.52 | 8.78 | 12.7 | 13.21 | 17.79 | 19.13 | -- | 13.18 | 4.65 |
| *Plantago lanceolata* | Site I | 5.54 | 4.45 | 11.34 | 13.1 | 4.94 | 12.4 | 4.97 | 8.10 | 3.95 |
| | Site II | 4.15 | 5 | 13.12 | 19.23 | 5.25 | 22.55 | 14.65 | 11.99 | 7.39 |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Site III | 17.35 | 7.25 | 16.36 | -- | 8.84 | 23.69 | 22.18 | 15.94 | 6.74 |
| | Site IV | 9.36 | 9.62 | 19.59 | 25.37 | 10.97 | 26.39 | 23.78 | 17.86 | 7.69 |
| *Isodon rugosus* | Site I | 7.21 | 8.16 | 2 | 2.56 | 14.58 | 5.81 | 1.74 | 6 | 4.58 |
| | Site II | 15.2 | 7.21 | 2.3 | 5.57 | 23.21 | 17.23 | 4.73 | 10.77 | 7.79 |
| | Site III | 27.4 | 8.35 | 4.51 | 6.78 | 19.97 | 18.09 | 5.11 | 12.88 | 8.91 |
| | Site IV | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Thymus linearis* | Site I | 1.6 | 1.69 | 7.34 | 7.63 | 4.53 | 6.51 | 5.85 | 5.021 | 2.52 |
| | Site II | 3.04 | 4.81 | 7.89 | 8.05 | 5.06 | 9.27 | 7.94 | 6.58 | 2.27 |
| | Site III | 6.59 | 4.71 | 10.25 | 9.99 | -- | 12.47 | -- | 8.80 | 3.11 |
| | Site IV | 11.72 | 6.51 | -- | 9.93 | 7.47 | 13.52 | 8.04 | 9.53 | 2.70 |
| *Artemesia absinthium* | Site I | 3.05 | 3.04 | 8.77 | 4 | 4.29 | 10.2 | 8.76 | 6.01 | 3.09 |
| | Site II | 2.36 | 4.79 | 16.42 | 9.53 | 11.56 | 12.86 | 9.64 | 9.59 | 4.77 |
| | Site III | 8.5 | 8.76 | 10.54 | 9.85 | 12.41 | 15.98 | 14.28 | 11.47 | 2.85 |
| | Site IV | 7.1 | 8.06 | 13.64 | 14.52 | 15.58 | 15.22 | 15.12 | 12.74 | 3.60 |
| *Artemesia vestita* | Site I | 8.46 | 4.03 | 2.3 | 3.21 | 5.85 | 8.02 | 8.63 | 5.78 | 2.65 |
| | Site II | 6.58 | 6.35 | 3.68 | 4.17 | 10.85 | 18.69 | 13.54 | 9.12 | 5.51 |
| | Site III | 7.46 | 6.47 | 6.51 | 6.62 | 14.61 | 22.03 | 21.13 | 12.11 | 7.08 |
| | Site | 3.43 | 7.81 | 12.2 | 13.6 | 17.5 | 25.62 | 19.69 | 14.27 | 7.4 |

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|---|---|---|---|---|---|---|---|---|---|---|
| | IV | | | 1 | 4 | | | | | 4 |

**Table-5: Monthly estimation of Carotenoids (µg/ml) of different plant species during the study period at the four study sites.**

| Plant Species | Sites | April | May | June | July | August | September | October | Mean | S.D. |
|---|---|---|---|---|---|---|---|---|---|---|
| *Marrubium vulgare* | Site I | 0.98 | 1.08 | 3.23 | 3.49 | 4.46 | 7.39 | 4.47 | 3.58 | 2.20 |
| | Site II | 6.82 | 5.57 | 3.36 | 4.96 | 4.66 | 8.72 | 5.66 | 5.68 | 1.71 |
| | Site III | 7.13 | 4.4 | 4.89 | 4.43 | 7.05 | 7.16 | 9.61 | 6.38 | 1.91 |
| | Site IV | 8.21 | 5.6 | 5.77 | 6.88 | 9.55 | 11.67 | -- | 7.94 | 2.36 |
| *Plantago lanceolata* | Site I | 4.55 | 1.41 | 5.93 | 6.58 | 4.66 | 10.98 | 7.76 | 5.98 | 2.98 |
| | Site II | 5.82 | 1.62 | 6.31 | 9.38 | 4.73 | 9.32 | 7.41 | 6.37 | 2.72 |
| | Site III | 8.28 | 2.47 | 6.89 | -- | 5.67 | 11.74 | 9.11 | 7.36 | 3.16 |
| | Site IV | 2.7 | 2.73 | 7.44 | 12.29 | 7.1 | 11.65 | 12.48 | 8.05 | 4.26 |
| *Isodon rugosus* | Site I | 1.48 | 6.49 | 6.15 | 2.39 | 12.91 | 7.13 | 2.25 | 5.54 | 3.99 |
| | Site II | 8.27 | 1.48 | 2.75 | 7.31 | 9.78 | 8.52 | 7.46 | 6.51 | 3.13 |
| | Site III | 10.6 | 3.33 | 2.3 | 3.49 | 13.04 | 13.97 | 4.47 | 7.31 | 5.03 |
| | Site IV | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Thymus linearis* | Site I | 1.41 | 1.39 | 3.58 | 5.4 | 8.67 | 8.07 | 1.66 | 4.31 | 3.13 |
| | Site II | 1.40 | 1.92 | 3.99 | 5.61 | 7.85 | 10.08 | 0.96 | 4.54 | 3.48 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Site III | 4.55 | 2.51 | 4.13 | 6.1 | -- | 8.12 | -- | 5.08 | 2.13 |
| | Site IV | 4.77 | 3.45 | -- | 6.5 | 7.73 | 10.13 | 8.87 | 6.9 | 2.51 |
| *Artemesia absinthium* | Site I | 2.52 | 0.25 | 5.43 | 3.4 | 6.18 | 6.82 | 11.08 | 5.09 | 3.49 |
| | Site II | 2.67 | 3.57 | 7.72 | 6.18 | 2.87 | 8.33 | 5.05 | 5.19 | 2.30 |
| | Site III | 2.93 | 3.45 | 6.1 | 6.16 | 6.81 | 6.76 | 7.12 | 5.61 | 1.70 |
| | Site IV | 3.02 | 1.40 | 5.8 | 5.1 | 8.46 | 9.18 | 4.46 | 5.34 | 2.78 |
| *Artemesia vestita* | Site I | 3.72 | 3.13 | 2.75 | 2.4 | 6.18 | 6.84 | 4.63 | 4.23 | 1.72 |
| | Site II | 3.88 | 3.37 | 2.38 | 2.93 | 7.64 | 11.61 | 10.48 | 6.04 | 3.83 |
| | Site III | 3.95 | 3.72 | 3.75 | 3.8 | 10.74 | 7.2 | 4.04 | 5.31 | 2.70 |
| | Site IV | 3.29 | 4.97 | 5.2 | 5.8 | 11.29 | 12.55 | 9.74 | 7.54 | 3.59 |

**Table-6: Monthly estimation of Pheophytin 'a' (µg/ml) of different plant species during the study period at the four study sites.**

| **Plant Species** | **Sites** | **April** | **May** | **June** | **July** | **August** | **September** | **October** | **Mean** | **S.D.** |
|---|---|---|---|---|---|---|---|---|---|---|
| *Marrubium vulgare* | Site I | 1.02 | 1.13 | 5.26 | 6.85 | 3.8 | 9.77 | 4.34 | 4.59 | 3.10 |
| | Site II | 4.92 | 6.6 | 5.29 | 10.75 | 6.16 | 11.22 | 5.5 | 7.20 | 2.64 |
| | Site III | 7.5 | 8.56 | 10.26 | 10.94 | 7.96 | 13.44 | 17.75 | 10.91 | 3.64 |
| | Site IV | 7.68 | 8.15 | 15.21 | 13.03 | 16.97 | 15.96 | -- | 12.83 | 4.03 |
| *Plantago lanceolata* | Site I | 3.17 | 2.72 | 11.42 | 15.18 | 3.17 | 13.67 | 5.07 | 7.77 | 5.45 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Site II | 3.84 | 2.54 | 13.4 | 18.59 | 3.6 | 21.89 | 16.14 | 11.42 | 8 |
| | Site III | 10.84 | 5.26 | 15.53 | -- | 6.78 | 21.15 | 24.78 | 14.05 | 7.85 |
| | Site IV | 3.89 | 4.99 | 18.78 | 24.39 | 7.92 | 25.64 | 28.18 | 16.25 | 10.43 |
| *Isodon rugosus* | Site I | 7.05 | 8.42 | 7.6 | 2.94 | 13.3 | 6.53 | 1.42 | 6.75 | 3.86 |
| | Site II | 8.6 | 7.05 | 2.54 | 8.71 | 11.54 | 19.37 | 4.02 | 8.83 | 5.54 |
| | Site III | 4.34 | 8.03 | 4.87 | 7.13 | 19.37 | 20.49 | 4.34 | 9.79 | 7.07 |
| | Site IV | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Thymus linearis* | Site I | 1.1 | 1.2 | 7.98 | 8.01 | 4.67 | 7.77 | 5.39 | 5.16 | 3.04 |
| | Site II | 3.11 | 4.33 | 8.56 | 8.91 | 5.61 | 8.44 | 7.52 | 6.64 | 2.30 |
| | Site III | 4.54 | 4.4 | 10.98 | 11.08 | -- | 13.86 | -- | 8.972 | 4.27 |
| | Site IV | 6.98 | 6.93 | -- | 11.11 | 8.77 | 14.93 | 7.74 | 9.41 | 3.12 |
| *Artemesia absinthium* | Site I | 3.71 | 3.11 | 10.09 | 3.77 | 4.86 | 13.43 | 6.49 | 6.49 | 3.88 |
| | Site II | 3.97 | 4.33 | 10.02 | 11.01 | 12.86 | 14.48 | 10.35 | 9.57 | 4.01 |
| | Site III | 8.01 | 8.14 | 9.89 | 13.85 | 14.11 | 14.78 | 15.41 | 12.02 | 3.23 |
| | Site IV | 7.21 | 8.73 | 11.75 | 16.62 | 18.25 | 16.91 | 12.04 | 13.07 | 4.28 |
| *Artemesia vestita* | Site I | 3.81 | 2.98 | 2.54 | 6.92 | 5.29 | 11.14 | 10.25 | 6.13 | 3.45 |
| | Site II | 5.3 | 5.88 | 3.93 | 4.44 | 11.92 | 20.78 | 14.62 | 9.55 | 6.41 |
| | Site III | 5.97 | 5.97 | 6.94 | 7.04 | 15.99 | 22.63 | 24 | 12.64 | 8.09 |
| | Site IV | 3.72 | 7.02 | 10.86 | 11.75 | 18.5 | 26.62 | 29.4 | 15.41 | 9.76 |

**Table-7: Monthly estimation of Pheophytin 'b' (µg/ml) of different plant species during the study period at the four study sites.**

| Plant species | Sites | April | May | June | July | August | September | October | Mean | S.D. |
|---|---|---|---|---|---|---|---|---|---|---|
| *Marrubium vulgare* | Site I | 1.42 | 1.3 | 5.36 | 9.1 | 5.46 | 12.58 | 5.29 | 5.78 | 4.02 |
| | Site II | 4.721 | 7.12 | 5.4 | 13.9 | 8.26 | 13.74 | 6.74 | 8.55 | 3.78 |
| | Site III | 8.33 | 8.64 | 10.75 | 13.84 | 10 | 14.12 | 20.16 | 12.26 | 4.17 |
| | Site IV | 8.12 | 9.68 | 15.35 | 18.25 | 20.97 | 21.7 | -- | 15.67 | 5.73 |
| *Plantago lanceolata* | Site I | 4.096 | 2.85 | 11.75 | 19.86 | 5.24 | 15.98 | 5.47 | 9.32 | 6.61 |
| | Site II | 2.88 | 2.95 | 17.57 | 24.99 | 5.09 | 28.22 | 19.88 | 14.51 | 10.75 |
| | Site III | 12.83 | 5.36 | 21.57 | -- | 9.88 | 29.21 | 27.12 | 17.66 | 9.73 |
| | Site IV | 4.65 | 4.79 | 22.17 | 31.83 | 11.71 | 29.83 | 30.22 | 19.31 | 12.10 |
| *Isodon rugosus* | Site I | 6.9 | 10.33 | 13.11 | 12.05 | 11.45 | 6.44 | 1.47 | 8.82 | 4.11 |
| | Site II | 9.65 | 6.9 | 3.16 | 10.11 | 14.83 | 22.16 | 4.95 | 10.25 | 6.49 |
| | Site III | 5.67 | 7.67 | 4.63 | 8.19 | 21.37 | 22.49 | 5.29 | 10.75 | 7.74 |
| | Site IV | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Thymus linearis* | Site I | 1.12 | 1.17 | 9.59 | 9.16 | 4.33 | 8.47 | 5.18 | 5.57 | 3.61 |
| | Site II | 2.56 | 4.37 | 9.68 | 9.75 | 5.29 | 8.22 | 9.01 | 6.98 | 2.88 |
| | Site III | 5.31 | 4.41 | 11.32 | 12.23 | -- | 15.6 | -- | 9.77 | 4.77 |
| | Site IV | 8.01 | 7.14 | -- | 12.23 | 8.92 | 16.25 | 9.53 | 10.34 | 3.37 |
| *Artemesia absinthium* | Site I | 3.41 | 2.56 | 11.59 | 4.69 | 4.46 | 14.38 | 10.72 | 7.40 | 4.70 |

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|---|---|---|---|---|---|---|---|---|---|---|
| | Site II | 4.25 | 4.12 | 11.23 | 11.66 | 11.35 | 15.4 | 10.87 | 9.84 | 4.15 |
| | Site III | 6.71 | 7.88 | 6.76 | 15.68 | 12.61 | 15.36 | 16.36 | 11.62 | 4.39 |
| | Site IV | 7.04 | 8.62 | 17.33 | 17.09 | 15.7 | 17.93 | 13.3 | 13.85 | 4.41 |
| *Artemesia vestita* | Site I | 4.77 | 2.43 | 3.16 | 1.05 | 5.29 | 11.19 | 5.09 | 4.71 | 3.25 |
| | Site II | 6.5 | 6.7 | 4.37 | 5.14 | 10.31 | 22.89 | 15.36 | 10.18 | 6.75 |
| | Site III | 6.43 | 6.43 | 7.97 | 8.07 | 14.01 | 26.37 | 20.15 | 12.77 | 7.82 |
| | Site IV | 9.87 | 12.56 | 15.92 | 17.33 | 16.41 | 31.05 | 22.78 | 17.98 | 7.03 |

**Table-8: Monthly estimation of Total Pheophytin (µg/ml) of different plant species during the study period at the four study sites.**

| Plant Species | Sites | April | May | June | July | August | September | October | Mean | S.D. |
|---|---|---|---|---|---|---|---|---|---|---|
| *Marrubium vulgare* | Site I | 2.44 | 2.43 | 10.62 | 15.95 | 9.26 | 22.35 | 9.63 | 10.38 | 7.10 |
| | Site II | 9.65 | 13.72 | 10.69 | 24.65 | 14.42 | 24.96 | 12.24 | 15.76 | 6.39 |
| | Site III | 15.83 | 17.2 | 21.01 | 24.78 | 17.96 | 27.56 | 37.91 | 23.17 | 7.75 |
| | Site IV | 15.8 | 17.83 | 30.56 | 31.28 | 37.94 | 37.66 | -- | 28.51 | 9.59 |
| *Plantago lanceolata* | Site I | 7.266 | 5.57 | 23.17 | 35.04 | 8.41 | 29.65 | 10.54 | 17.09 | 12.00 |
| | Site II | 6.72 | 5.49 | 30.97 | 43.58 | 8.69 | 50.11 | 36.02 | 25.94 | 18.74 |
| | Site III | 23.67 | 10.62 | 37.1 | -- | 16.66 | 50.36 | 51.9 | 31.71 | 17.44 |
| | Site IV | 8.54 | 9.78 | 40.95 | 56.22 | 19.63 | 55.47 | 58.4 | 35.57 | 22.44 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *Isodon rugosus* | Site I | 13.95 | 18.75 | 20.71 | 14.99 | 24.75 | 12.97 | 2.89 | 15.57 | 6.97 |
| | Site II | 18.25 | 13.95 | 5.7 | 18.82 | 26.37 | 41.53 | 8.97 | 19.08 | 12.01 |
| | Site III | 10.01 | 15.7 | 9.5 | 15.32 | 40.74 | 42.98 | 9.63 | 20.55 | 14.80 |
| | Site IV | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Thymus linearis* | Site I | 2.22 | 2.37 | 17.57 | 17.17 | 9 | 16.24 | 10.57 | 10.73 | 6.63 |
| | Site II | 5.67 | 8.7 | 18.24 | 18.66 | 10.9 | 16.66 | 16.53 | 13.62 | 5.15 |
| | Site III | 9.85 | 8.81 | 22.3 | 23.21 | -- | 29.46 | -- | 18.72 | 9.02 |
| | Site IV | 14.99 | 14.07 | -- | 23.34 | 17.69 | 31.18 | 17.27 | 19.75 | 6.46 |
| *Artemesia absinthium* | Site I | 7.12 | 5.67 | 21.68 | 8.46 | 9.32 | 27.81 | 17.21 | 13.89 | 8.46 |
| | Site II | 8.22 | 8.45 | 21.25 | 22.67 | 24.21 | 29.88 | 21.22 | 19.41 | 8.12 |
| | Site III | 14.72 | 16.02 | 16.65 | 29.53 | 26.72 | 30.14 | 31.77 | 23.65 | 7.52 |
| | Site IV | 14.25 | 17.35 | 29.08 | 33.71 | 33.95 | 34.84 | 25.34 | 26.93 | 8.34 |
| *Artemesia vestita* | Site I | 8.58 | 5.41 | 5.7 | 7.97 | 10.58 | 22.33 | 15.34 | 10.84 | 6.08 |
| | Site II | 11.8 | 12.58 | 8.3 | 9.58 | 22.23 | 43.67 | 29.98 | 19.73 | 13.12 |
| | Site III | 12.4 | 12.4 | 14.91 | 15.11 | 30 | 49 | 44.15 | 25.42 | 15.72 |
| | Site IV | 13.59 | 19.58 | 26.78 | 29.08 | 34.91 | 57.67 | 52.18 | 33.39 | 16.28 |

**Table-9: Monthly estimation of dust content (mg/cm$^2$) on different plant species during the study period at the four study sites.**

| **Plant Species** | **Sites** | **April** | **May** | **June** | **July** | **August** | **September** | **October** | **Mean** | **S.D.** |
|---|---|---|---|---|---|---|---|---|---|---|
| *Marrubium vulgare* | Site I | 3.57 | 1.91 | 2.18 | 4.81 | 2.36 | 2 | 6.05 | 3.26 | 1.62 |
| | Site II | 2.48 | 1.16 | 1.5 | 2.69 | 1.125 | 1.35 | 3.21 | 1.93 | 0.85 |
| | Site III | 2.06 | 0.84 | 1.2 | 2.33 | 1.1 | 0.63 | 1.87 | 1.43 | 0.65 |
| | Site IV | 0.28 | 0.3 | 0.51 | 0.74 | 0.72 | 0.56 | -- | 0.51 | 0.20 |
| *Plantago lanceolata* | Site I | 1.81 | 3.15 | 1.46 | 4.01 | 2.32 | 1.66 | 3.72 | 2.59 | 1.03 |
| | Site II | 1.45 | 0.71 | 1.18 | 3.38 | 1.55 | 1.24 | 2.57 | 1.72 | 0.92 |
| | Site III | 1.36 | 0.43 | 0.54 | 3 | 1.3 | 1.38 | 1.24 | 1.32 | 0.84 |
| | Site IV | 0.1 | 0.3 | 0.6 | 1.67 | 0.88 | 0.18 | 0.84 | 0.65 | 0.54 |
| *Isodon rugosus* | Site I | 3.79 | 1.14 | 3.7 | 4.17 | 2.16 | 1.8 | 5.05 | 3.11 | 1.43 |
| | Site II | 1.40 | 0.81 | 2 | 2.1 | 1.7 | 1.65 | 5.04 | 2.1 | 1.36 |
| | Site III | 1.34 | 1.63 | 1.87 | 1.92 | 0.10 | 1.27 | 2.46 | 1.51 | 0.73 |
| | Site IV | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Thymus linearis* | Site I | 2.2 | 2.3 | 2.97 | 1.1 | 3.75 | 2.81 | 3.27 | 2.62 | 0.86 |
| | Site II | 1.22 | 1.5 | 2.32 | 1.05 | 2.8 | 0.95 | 2.43 | 1.75 | 0.75 |
| | Site III | 1.7 | 1.2 | 1.73 | 0.37 | -- | 0.75 | -- | 1.15 | 0.59 |
| | Site IV | 0.2 | 0.4 | -- | 0.09 | 0.60 | 0.41 | 0.97 | 0.44 | 0.31 |
| *Artemesia* | Site I | 2.3 | 2.55 | 2.77 | 3.09 | 5.3 | 2.3 | 5.5 | 3.40 | 1.3 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| *absinthium* | | | | | | | | | | 9 |
| | Site II | 0.89 | 0.8 | 0.65 | 0.8 | 0.78 | 1.05 | 2.80 | 1.11 | 0.76 |
| | Site III | 0.55 | 0.5 | 0.56 | 0.67 | 0.57 | 0.75 | 2.44 | 0.86 | 0.70 |
| | Site IV | 0.11 | 0.12 | 0.2 | 0.29 | 0.54 | 0.42 | 0.77 | 0.35 | 0.24 |
| *Artemesia vestita* | Site I | 0.79 | 0.70 | 1.25 | 4.13 | 3.24 | 0.78 | 1.73 | 1.80 | 1.36 |
| | Site II | 0.54 | 0.61 | 1.13 | 1.97 | 1.6 | 0.69 | 1.31 | 1.12 | 0.54 |
| | Site III | 1.2 | 0.3 | 0.48 | 1.68 | 1.44 | 0.42 | 0.55 | 0.86 | 0.56 |
| | Site IV | 0.13 | 0.18 | 0.27 | 0.35 | 0.90 | 0.153 | 0.52 | 0.35 | 0.28 |

**Table-10: Monthly estimation of Leaf wash pH of different plant species during the study period at the four study sites.**

| Plant Species | Sites | April | May | June | July | August | September | October | Mean | S.D. |
|---|---|---|---|---|---|---|---|---|---|---|
| *Marrubium vulgare* | Site I | 8.1 | 8.8 | 8.65 | 8.47 | 9.44 | 10.06 | 10.55 | 9.15 | 0.90 |
| | Site II | 7.95 | 8.48 | 8.38 | 8.25 | 9.2 | 9.98 | 10.42 | 8.95 | 0.94 |
| | Site III | 7.98 | 8.32 | 8.31 | 8.04 | 9.09 | 9.74 | 10.27 | 8.82 | 0.90 |
| | Site IV | 7.22 | 7.57 | 7.59 | 7.93 | 7.99 | 7.98 | -- | 7.71 | 0.41 |
| *Plantago lanceolata* | Site I | 7.4 | 8.66 | 8.31 | 8.36 | 9.29 | 10.14 | 10.32 | 8.92 | 1.05 |
| | Site II | 7.28 | 8.63 | 8.31 | 8.22 | 8.89 | 9.81 | 10.33 | 8.78 | 1.02 |
| | Site III | 7.1 | 8.64 | 7.71 | -- | 8.88 | 9.68 | 10.29 | 8.71 | 1.19 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Site IV | 7 | 7.48 | 7.37 | 7.7 | 7.85 | 7.83 | 8.03 | 7.60 | 0.73 |
| *Isodon rugosus* | Site I | 8.58 | 8.67 | 8.35 | 8.43 | 9.41 | 9.7 | 9.55 | 8.95 | 0.57 |
| | Site II | 8.45 | 8.44 | 8.32 | 8.27 | 8.96 | 9.2 | 9.01 | 8.66 | 0.38 |
| | Site III | 8.18 | 7.95 | 8.01 | 8.21 | 8.82 | 9.08 | 9.13 | 8.48 | 0.51 |
| | Site IV | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| *Thymus linearis* | Site I | 7.93 | 8.71 | 8.53 | 8.27 | 9.29 | 9.8 | 9.53 | 8.86 | 0.69 |
| | Site II | 7.3 | 8.37 | 8.44 | 8.11 | 9.12 | 9.74 | 9.34 | 8.63 | 0.83 |
| | Site III | 7.45 | 8 | 8.12 | 8.05 | -- | 9.64 | -- | 8.25 | 0.82 |
| | Site IV | 7.2 | 7.5 | -- | 7.49 | 7.66 | 8.57 | 7.74 | 7.69 | 0.94 |
| *Artemesia absinthium* | Site I | 7.7 | 8.8 | 8.73 | 8.43 | 9.05 | 9.75 | 9.13 | 8.79 | 0.64 |
| | Site II | 7.49 | 8.66 | 8.39 | 8.22 | 8.91 | 9.45 | 8.7 | 8.54 | 0.61 |
| | Site III | 7.28 | 8.63 | 8.41 | 8.29 | 8.76 | 9.43 | 8.68 | 8.49 | 0.65 |
| | Site IV | 7.13 | 7.64 | 7.56 | 7.82 | 7.79 | 7.86 | 7.32 | 7.58 | 0.47 |
| *Artemesia vestita* | Site I | 7.55 | 8.8 | 8.61 | 8.36 | 9.36 | 9.78 | 9.79 | 8.89 | 0.82 |
| | Site II | 7.55 | 8.48 | 8.5 | 8.35 | 9.13 | 9.66 | 9.54 | 8.74 | 0.75 |
| | Site III | 7.22 | 7.29 | 8.79 | 8.3 | 9.09 | 9.51 | 8.07 | 8.32 | 0.87 |
| | Site IV | 7.16 | 7.25 | 7.22 | 7.37 | 7.85 | 8.3 | 7.83 | 7.56 | 0.43 |

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