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Effect of cement dust pollution on germination and growth of groundnut (*Arachis hypogaea* L.)

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Abstract: Air pollution has been described as 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. The role of air pollutants causing injury to plants either by direct toxic effect or modifying the host physiology rendering it more susceptible to infection. In severe case of pollution, the injury symptoms were expressed as foliar necrosis or completely disappearance of the plant. In that way the present research work carried out cement dust pollution on germination growth and biochemical of groudnut. The cement dust artificially sprayed on the plant surface with different levels. All the morphological and biochemical were analyzed. Morphological parameters Root length, Shoot Length, and dry weight were inhibited in high dose of cement deposition when compare control plant. The highest amount of all biochemical content which present in control set and lowest one recorded in 25g/pot sprayed with cement dust.

INTRODUCTION

Air pollution has become a major threat to the survival of plants in the industrial areas (Gupta & Mishra, 1994). Rapid industrialization and addition of the toxic substances to the environment are responsible for altering the ecosystem (Mudd & Kozlowski, 1975; Niragau & Davidson, 1986; Clayton & Clayton, 1982). Air pollution has been described as 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. The role of air pollutants causing injury to plants either by direct toxic effect or modifying the host physiology rendering it more susceptible to infection. In severe case of pollution, the injury symptoms were expressed as foliar necrosis or completely disappearance of the plant. Several workers have also previously studied the impact of air pollution on plants with reference to foliar anatomical and biochemical changes by experimenting on various sensitive plants (Samal and Santra, 2002).

The main atmospheric pollutants are: gaseous - mainly SO_2 NO_x, O_3, heavy metals and dust, which often includes heavy metals. Increased concentrations of the above pollutants cause progressive reduction in the photosynthetic ability of leaves, closure of leaf stomata and, mainly, a reduction in growth and productivity of plants (Larcher 1995). Environmental contamination due to dust particle coming from Cement Industries, Coal Mining, Quarrying, Stone Crushing, Thermal Power Plant etc., has drawn much attention to the environmental scientists today as they create serious pollution problems and pose threat to the ecosystem. The cement industry also plays a vital role in the imbalances of the environment and produces air pollution hazards (Stern, 1976). These dust particulates are causing large scale deforestation destruction of Biota (Panda, 1996) and other natural resources. Among these deposition of cement kiln dust in large quantities around cement factories causes changes in soil physical chemical properties (Asubiojo, 1991; Saralabai, 1993). The effect of such deposition affects the growth and biochemical characteristics of field crops has also been widely studied (Prasad and Inamadar, 1990; Prasad et al., 1991). According to Farmer (1993) cement industrial regions are confronted with the problems of alkalization due to high deposition of alkaline cement dust and their ash in the pollution complex. In addition, the growth of quarrying and open cast mining suggest the dust deposition on vegetation may be increasing. Recent work showed that cement dust decreased the productivity and concentration of chlorophyll in a number of annual non-leguminous crops (Liu et al. 1997, Pandey andKumar 1996, Saralabai and Vivekanandan 1997, Satao et al. 1993). Also, in recent years, many effects of cement dust have been studied on conifers growing in central European forests (Lepedus et al. 2003, Mandre and Ots 1999, Mandre

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and Tuulmets 1997). However, not enough information available in relation to the germination and biochemical behavior of crops under cement dust polluted soil. The present research paper reveals the effect of cement dust to the soil on the germination and biochemical behavior of groundnut (*Arachis hypogaea* L.).

MATERIALS AND METHOD

Cement dust collected from nearby TANCEM, Ariyalur, Tamil Nadu, were mixed with garden soil from Dept. of Botany, Annamalai University, Tamil Nadu. Groundnut (*Arachis hypogaea* L.) Var. Vri.3 was procured form Tamil Nadu Agriculture University, Regional Research Station Virudhachalam, Tamil Nadu. It is used as a test crop for germination study. The seeds were surface sterilized with 0.1% Hgcl for 10 minutes and then soaked for overnight before sowing. Cement dust mixed with soil were kept in germination cups in the ratio of Control, 5g/Kg, 10g/Kg, 15g/Kg, 20g/Kg, 25g/Kg, without cement dust treated as control. Germination test were carried out triplicate samples were maintained (each containing 20 seeds), under natural photoperiod of day and night temperature 27-31˚ C and 23-26˚C respectively. The seedlings raised in dust free soil were treated as control. In the third day of germination test, the seeds were germinated through the breakage of seed coat were visible. In the seventh day of seedling growth parameters such as Germination percentage, Seedling length (Cm/Seedling), Fresh weight (g/seedling), Dry weight (g/seedling), Vigour index, Tolerance Index and percentage of Phytotoxicity, were measured and recorded, in addition to that above said parameters, bio-chemical parameters like chlorophyll (Arnon, 1949), Protein (Lowry, 1951), Amino acid (Moore and Stein, 1948), Total sugar (Nelson, 1944) were estimated and recorded

RESULT AND DISCUSSION

To find out the effect of cement dust on germination, we made different concentration (Control, 5g/Kg, 10g/Kg, 15g/Kg, 20g/Kg, 25g/Kg) of cement dust with soil were taken. Seed germination percentage, Seedling length (Cm/Seedling), Fresh weight (g/seedling), Dry weight (g/seedling), Vigour index, Tolerance Index and percentage of Phytotoxicity, were measured and recorded, in addition to that above said parameters , bio-chemical parameters like chlorophyll, Protein, Amino acid, Total sugar were estimated and recorded on the seventh day after sowing. The effect of cement dust pollution on germination studies of groundnut are represented in Fig 1 – 7. The higher germination percentage (100%), seedling length (9.967 cm/seedling), fresh weight (1.90 g /seedling), dry weight (0.666 g/seedling), vigour index (487) was observed in control plants. The lower germination percentage (30), seedling length (5.766 cm/seedling), fresh weight (0.75 g/seedling), dry weight (0.250 g/seedling) and vigour index (172.98) was observed in 25 g/kg cement dust sprayed seedlings. Seed germination and growth are vital for continuation of plant life. Seeds and seedlings are extremely vulnerable to environment stress due to presence of polluting agents in the environment especially during seed hydration period which is very much important for initiating and triggering the investigate sequence of metabolisms essential for germination and growth of seedlings (Anujsaxena, 2003). The critical phase of germination in the life cycle of the crop plants is subjected to many environmental stresses. Any disturbance in the environment in which the seed germination affect the germination and ultimately the growth and yield of the crop (Dixit *et al.,* 1986). The germination percentage of groundnut seeds was gradually decreased with the increase in the cement dust weight. Moreover 50% reduction of germination percentage was observed at 25 g/kg soil amended concentrations. The better result of germination was observed at control plants. Prasad and Inamdar (1991) reported the gradual decrease of germination was observed when the amount of cement increased. The decrease in germination of seeds with increasing concentrations may be due to toxic effects of metals present in the cement dust which interfere with the normal synthesis of metabolic products, thus directly affecting the cell division and cell elongation (Singh and Srivastava, 2002). Saralabai and Vivekanandan (1992) reported that the application of cement dust to the soil did not affect the seed germination of some legumes. The positive effects observed may be attributed to the presence of plant growth promoting elements (N, P, Ca, Mg, Mn, Fe, S, Cu, Pb and Zn) in the cement dust. But, the germination of some leguminous seeds were totally affected in higher cement concentration. Germination of seeds was not found to be affected. Addition of the cement dust upto 200 g/kg soil did not affect germination. But any further increase resulted in serious inhibition of germination of seeds. Even at 200 g dust/kg soil about 100% germination was observed. The time taken for plumule and radicle emergence was seriously affected at increasing concentrations of the cement dust above 200 g/kg soil (Saralabai and Vivekanandan, 1995).

The germination percentage growth and their weight were found higher in control when compared to treated seeds. They are not affected at lower concentrations of dust applied upto 5%. The time taken for plumule and radicle emergence was seriously affected at increasing concentrations of the dust (Sundaramoorthy *et al.,* 1997a,b). There was a similar trend of increasing vigour index with increasing dust concentration upto 5% and then gradually declined beyond that level. The length of radicle and plumule is dose dependent which got decreased with increasing concentrations of the cement dust pollution. Reduction in seedling growth with increasing concentrations of cement dust solution has also been observed by Prasad and Inamdar (1991), Lerman (1972) and Singh (2000).

Fig 8- 13 represents the impact of cement dust pollution on biochemical changes of groundnut. The higher content of chlorophyll (0.281), protein (0.751), amino acid (2.758), total sugar (2.437) and the lower content chlorophyll (0.101), protein (0.305), amino acid (0.603) and total sugar (1.078) was observed in control and 25g cement dust treatment. They are expressed in mg g^{-1} fr. wt. basis. Studies of pollution on biochemical changes the plant metabolism *i.e.,* reduction in chlorophyll and clogged stomata (Ahmed and Gardir, 1975) reveals that these parameters are important in regulating the productivity and also the number of flowers and seeds produced. In this experiment, the biochemical studies such as chlorophyll, carotenoid, protein, amino acid and total sugars were analyzed. All the biochemicals are gradually decreased with the increase in cement dust concentrations. The higher chlorophyll, carotenoid, protein, amino acid and sugars were observed in control plants and the lower values of these parameters were observed in higher concentrations of cement dust sprayed plants. Moreover 50% reduction of biochemical contents was observed at 25 g soil mixing cement dust concentrations when compared with control. Similarly, these parameters were increased with the increase in the age of the plant. The shoot contains higher protein, amino acid and sugars than the root in all the concentrations. The chlorophyll ‘a’, chlorophyll ‘b’, total sugars, protein, starch, lipids and amino acids are gradually decreased in dust polluted plants than in control plants (Uma and Ramana Rao, 1996). 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. A maximum reduction of 1.80% of total chlorophyll was recorded in 10% treatment at the age of 45 days. Decrease in chlorophyll content might be due to chloroplast damage by incorporation of cement kiln dust into leaf tissues (Singh and Srivastava, 2002). The similar results were observed in maize crop (Pandey *et al.,* 1999), water (Pandey and Simba, 1990b) and gram leaves (Pandey and Simba, 1989). Chlorophyll ‘a’, chlorophyll ‘b’ and total chlorophyll showed a similar trend of reduction. They are sample of evidence concerning the detrimental effects of gaseous pollutants, which are acidic in nature on chlorophyll molecules (Treshow, 1984). The gaseous pollutants such as SO_2 at higher concentrations, degrades chlorophyll to a photosynthetically inactive phaeophytin and Mg^{++}. A similar conversion of chlorophyll to phaeophytin can occur with acids where Mg^{++} in the chlorophyll molecule is replaced by two atoms of hydrogen, thereby changing the light spectrum characteristics of chlorophylls (Rao and Le Blanc, 1966). A considerable loss in total chlorophyll in the leaves of plants exposed in severe air pollution supports the argument that the chloroplast is the primary site of attack by air pollutants which make their entrance into the tissues through the stomata and cause partial denaturation of the chloroplast and decreases pigment content in the cells of polluted leaves. In the present study, the protein content were found to be decreased in both germination studies and pot culture experiments. Reduction in protein content might be due to the enhanced rate of protein denaturation (Tripathi and Gautham, 2007; Prasad and Inamdar, 1990a). The enhanced protein denaturation and breakdown of existing protein to amino acid is the main cause of reduction in protein content (Constantinidou and Kozlowski, 1979). The reduction in protein content might be due the results of decreased photosynthesis on the other hand, decrease in protein content could be attributed either to break down of existing protein or due to reduced de novo synthesis (Singh and Jothi, 1999). Soluble sugar is an important constituent and source of energy for all living organisms. Plants manufacture this organic substance during photosynthesis and breakdown during respiration. The concentration of soluble sugar is indicative of the physiological activity of a plant and it determines the sensitivity of plants to air pollution. The sugar content was found to be reduced with the increase in the of amount cement dust applied. Reduction in soluble sugar content in polluted stations can be attributed to increased respiration and decreased CO_2 fixation because of chlorophyll deterioration (Tripathi and Gautam, 2007).

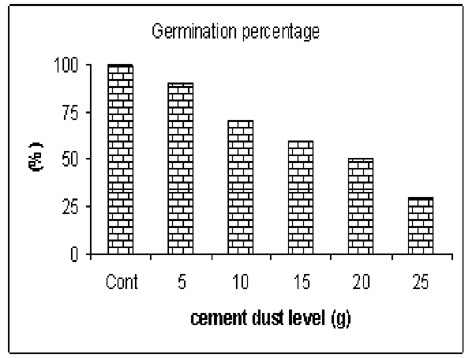

Fig.1. Effect of cement dust pollution on germination of groundnut

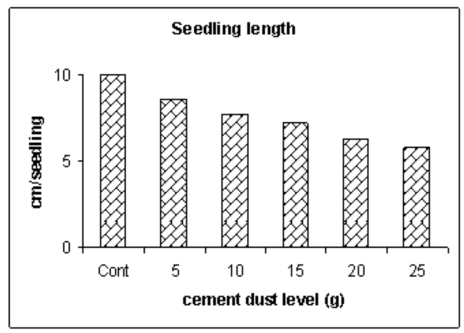

Fig.2. Effect of cement dust pollution on seedling length of groundnut

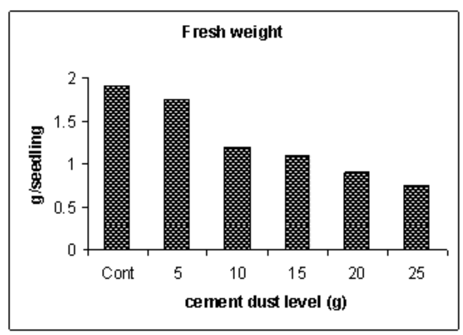

Fig.3. Effect of cement dust pollution on fresh weight of groundnut

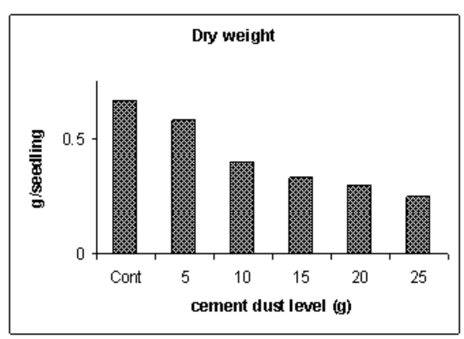

Fig.4. Effect of cement dust pollution on dry weight of groundnut

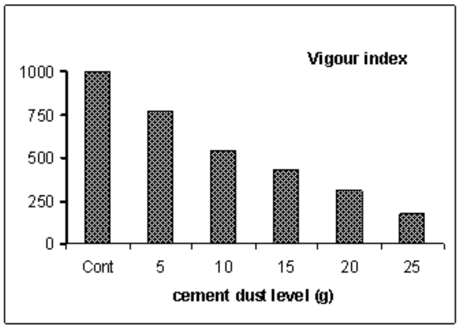

Fig.5. Effect of cement dust pollution on vigor index of groundnut

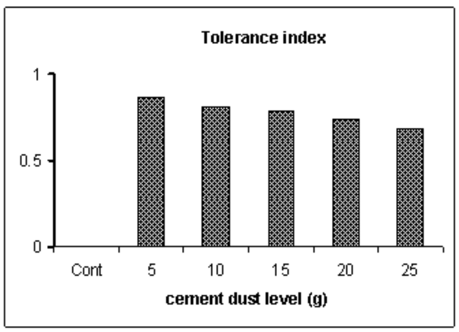

Fig.6. Effect of cement dust pollution on tolerance index of groundnut

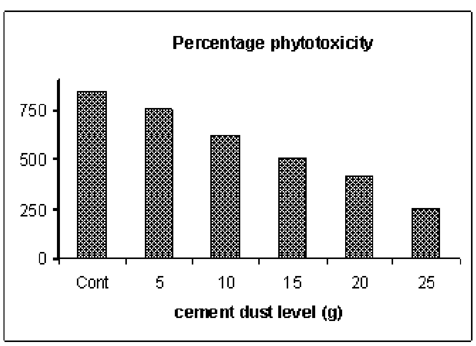

Fig.7. Effect of cement dust pollution on percentage phytotoxicity of groundnut

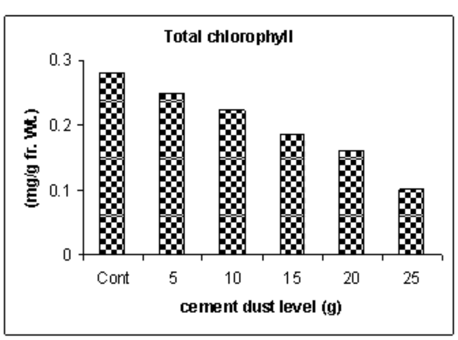

Fig.8. Effect of cement dust pollution on total chlorophyll content of groundnut

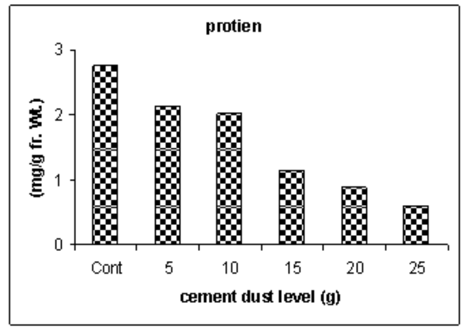

Fig.9. Effect of cement dust pollution on protein content of groundnut

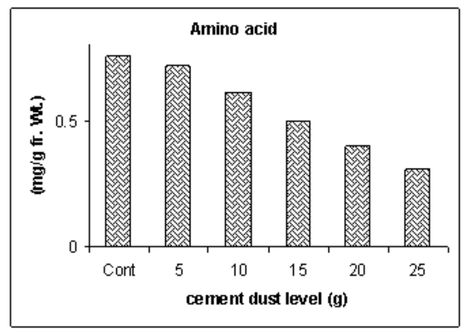

Fig.10. Effect of cement dust pollution on amino acid content of groundnut

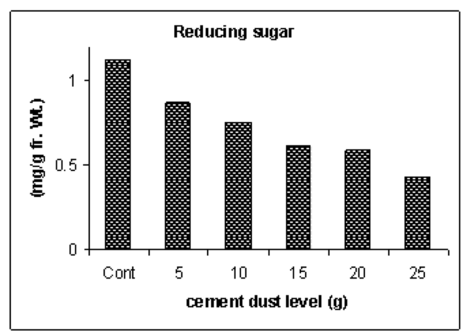

Fig.11. Effect of cement dust pollution on reducing sugar of groundnut

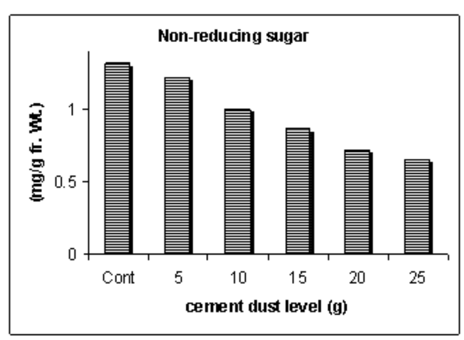

Fig.12. Effect of cement dust pollution on nonreducing sugar of groundnut

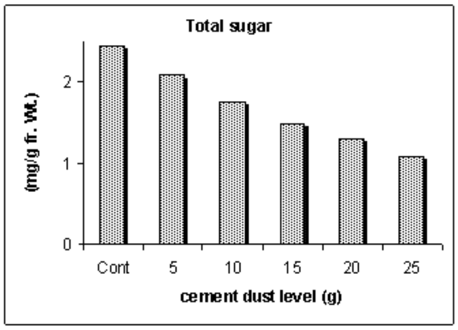

Fig.13. Effect of cement dust pollution on total sugar of groundnut

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