Study of Morphological and Germination Parameters of Legume Crops *Vigna Mungo* L. Treated with Cement Dust

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ABSTRACT

Field experiment was conducted with blackgram var. Vamban 3. By different levels (5, 10, 15 and 20 g m^{-2} day^{-1}) of the cement dust to investigate the effect of foliar application on plant growth. The morphological growth parameters (shoot length, root length, number of root nodules, total leaf area, fresh weight, and dry weight) of blackgram were recorded periodically. The yield parameters (number of pods, number seeds per pod, dry weight of pod, 100 seed weight and final yield) were recorded at the time of harvest. Both parameters were found to be decreased with the increasing levels of the applied cement dust.

Key Word: *Vigna mungo* L, Morphology, Root nodules, Cement dust Pollution.

INTRODUCTION

Air pollution has become a major threat to the survival of plants in the industrial areas. Air pollutants, emitted from various industries in particularly, cause damage of plant leaves, impairs plant growth, and limit productivity according to the sensitiveness of the plants to pollutants (Ulrich, 1984). Thus, pollution stress can alter plant growth and quality and the effects are often extensive (Sagar et al., 1982). Rapid urbanization and industrialization in recent years has escalated the demand for cement not only in India but worldwide. The accompanying growth of cement industries in India has consequently magnified the pollution problem. Cement industries are regarded to be highly-pollution prone, especially with regard to particulate emission. They also play a vital role in the imbalance of the environment and produces air pollution hazard.

Cement industries pollute the environment in the form of dust in the surrounding areas and their products escape during factory processing (Uma et al., 1994; Ayanbamiji and Ogundipe, 2010). Cement dusts can be emitted at every stage of the manufacturing process of the cement: extraction of the raw material, crushing, production, packaging and loading of finished cement (Bankole, 2003). Solid particles released from cement factory can have negative effects on air quality. The particles can enter into soil as dry, humid or occult deposits and can undermine its physico-chemical properties. Cement dust spread along a large area through wind, rain, etc., and are accumulated in and on plants, animals, and soil and it shows negative effects (Ayvaz, 1992). Accumulation of particulates on leaves may cause foliar injury, reduction in yield, changes in the rate of photosynthesis, transpiration, uptake and accumulation of minerals and energy in plants. In addition, it caused various diseases in humans beings such as asthma, chronic bronchisis, tuberculosis, head ache and lung cancer in human beings. The objective of this study, therefore, was to investigate the effect of cement dust application on the growth characters of *Vigna mungo* L.

MATERIALS AND METHODS

Seed material: The seeds of blackgram (Vigna mungo L. Hepper var. Vamban 3) were procured from National Pulse Research Station, Regional Research Station of Tamil Nadu Agricultural University located at Vamban, Pudukkottai district, Tamil Nadu, India. The healthy seeds were chosen and used for both laboratory and field experiments.

Germination studies

The healthy seeds of blackgram var. Vamban 3 were surface sterilized with 0.2 per cent of $HgCl_2$ for two minutes and thoroughly washed with tap water. Fifteen seeds were equispacially arranged in plastic cups (3 cm in height 12 cm width) with various amount (5, 10, 15 20, 25 and 30 g) of cement dust each mixed with 200 g soil (Raajasubramanian *et al*., 2011a&b). The control set was maintained without cement dust. Uniform irrigation was done by tap water. Three replicates were maintained for each treatment including the control. The germination percentage, seedling length, seedling fresh weight and dry weight were measured on the 7th day after old seedling. The values of vigour index and tolerance index were also calculated (Plate-I).

Germination percentage: Germination refers to the initial appearance of radicle by visual observation. The number of seeds germinated in each treatment was counted on each and every day upto 7th day after

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Received April 19, 2018, Accepted August 16, 2018

sowing. Germination percentage was calculated by using the following formula:

$$\text{Germination percentage} = \frac{\text{Total number of seeds germinated}}{\textit{Total} \text{ number of seeds sown}} \times 100$$

Seedling length (Cm/seedling): Fifteen seedlings were randomly selected on 7th day from each treatment to record the seedling length. The length, of the blackgram var. Vamban 3 seedlings was measured by using a centimeter scale and the values were recorded.

Fresh weight and dry weight (g/seedling): Fifteen seedlings were measured and their fresh weight was taken by using an electrical single pan balance. They were dried in a hot air oven at 80°C for 24 hrs and their dry weights were recorded with an electrical single pan balance and they were expressed in grms/seedling.

Vigour index: Vigour index of the seedlings was calculated by using the formula proposed by Abdul-Baki and Anderson (1973), as follows:

$$\text{Vigour index} = \text{Germination percentage} \times \text{seedling length.}$$

Tolerance index: Tolerance index of the seedlings were calculated by using the formula proposed by Turner and Marshal (1972) as follows:

$$\text{Tolerance index} = \frac{\text{Mean length of longest root in the treatment}}{\text{Mean length of longest root in the control}}$$

Field preparation:

The field was thoroughly ploughed three times before seed sowing. The entire field was irrigated with bore well water for two days before sowing. Blackgram seeds were sown with a spacing of 20 × 20 cm. Field management were employed under usual agronomical practices.

Cement dust treatment: Different amounts (5, 10, 15, and 20 g m-2 day-1) of cement dust were applied daily on the aerial parts of the experimental crops. The crops grown without cement dust were treated as the control.

Plant samples were collected randomly at various stages (15, 30, 45 and 60 DAS) of its growth and used for recording morphometrical observations like: shoot length, root length, number of root nodule, total leaf area, fresh weight, dry weight, and yield of crop plants. Five plants were selected from each treatment including control for recording various morphological parameters.

Shoot length and root length: Five plant samples were collected at 15, 30, 45 and 60 DAS to record the shoot length and root length by using cm scale.

Number of root Nodule: Five plants from each plot with intact roots were removed with the help of digging fork. The root with root nodules were carefully separated from the soil and thoroughly washed with tap water to remove the soil. Pink coloured nodules were counted as effective nodules and the number of nodules were recorded.

Total leaf area: The total leaf area was calculated by measuring the length and width of the leaf as described by Yoshida et al. (1972), as follows:

Leaf area (cm^2) = K × length × breadth

Where

K = Kemp's constant (for dicot leaves 0.66)

Fresh weight and Dry weight: The plant samples taken for morphometric studies were used for the determination of fresh weight and dry weight of plant material. They were dried in a hot air oven at 80°C for 24 hrs and their dry weight was measured by using an electrical single pan balance.

Yield Parameters

Number of pods per plant: Five plants were selected at random in each plot and the number of pods per plant was recorded.

Number of seeds per pod: The seeds were removed from the pod and the total number of seeds was counted and expressed in number of seeds per pod.

Dry weight of pods per plant: The pods were separated from the plant and their dry weights were measured by using an electrical single pan balance and it was expressed in g/plant.

Hundred Seed weight: 100 mature seeds were collected from test crop and their dry weights were recorded by using an electrical single pan balance.

Seed yield: The yield of black gram was collected from which experimental plot and expressed in kilogram per hectare.

RERSULTS

Germination studies

The effect of cement dust on germination studies of blackgram are presented in Figs 1 and 2 (Plate-I). The highest germination percentage (100), seedling length (19.36 cm/seedling), fresh weight (0.986 g/seedling), dry weight (0.349 g/seedling), vigour index (1836.0) were observed in the control plants. The lowest germination percentage (21) was recorded in 30 g cement dust treatment mixed with 200 g of soil.

The lowest seedling length (9.31cm/seedling), fresh weight (0.364 g/seedling), dry weight (0.135 g/seedling), vigour index (600.4) and tolerance index (0.59) were observed in 25 g cement dust treatment mixed with 200g soil. Germination of seeds was noticed in 30 g of cement dust mixed with 200 g of soil and there is lowest number of seedling growth was observed in this concentration, when compared to other treatments.

Field experiment

Shoot length: The effect of cement dust on shoot length of blackgram at various stages of growth is presented in Fig 3. The highest shoot length (16.685, 21.843, 28.019 and 34.802 cm/plant) was obtained at 15, 30, 45 and 60 DAS of control plant. Similarly, the lowest shoot length (5.705, 9.113, 13.142 and 20.436 cm/plant) was recorded in the 20 g m^{-2} day^{-1} of cement dusted plants at 15, 30, 45 and 60 DAS respectively.

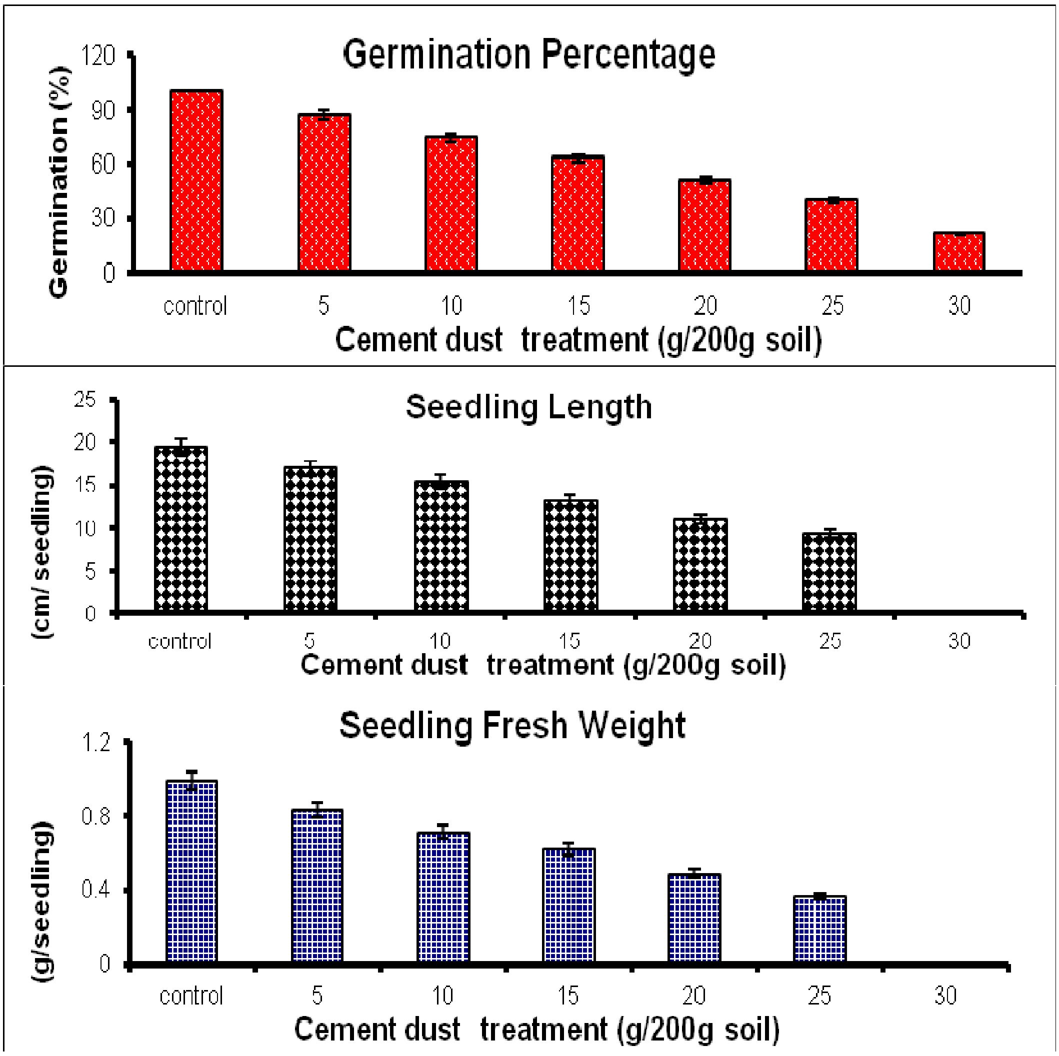

Fig. 1. Effect of cement dust on germination percentage (%), seedling length (cm/seedling) and fresh weight (g/seedlings) of blackgram seedlings

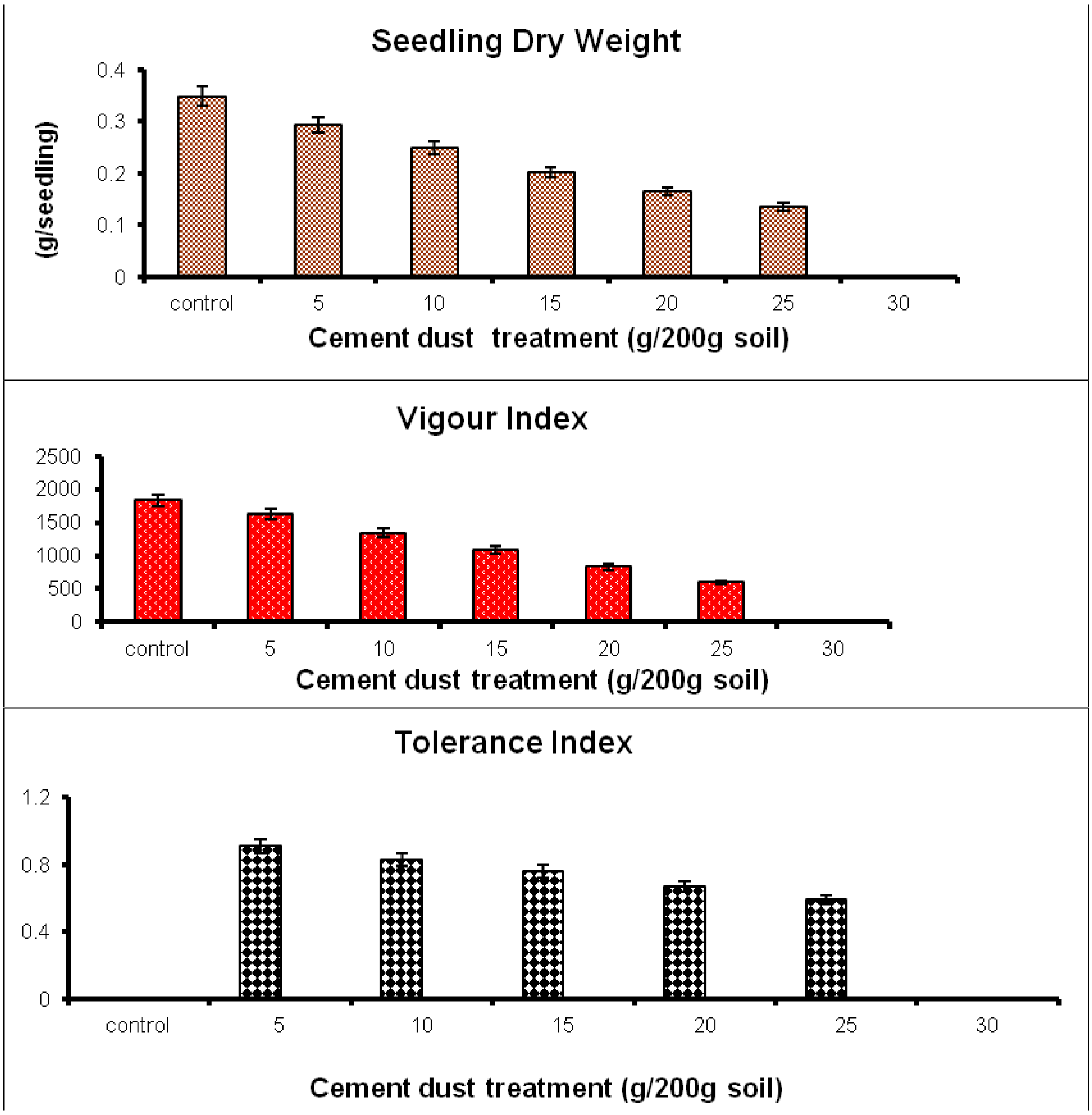

Fig. 2. Effect of cement dust on dry weight (g/seedling), vigour index and tolerance index of blackgram seedlings

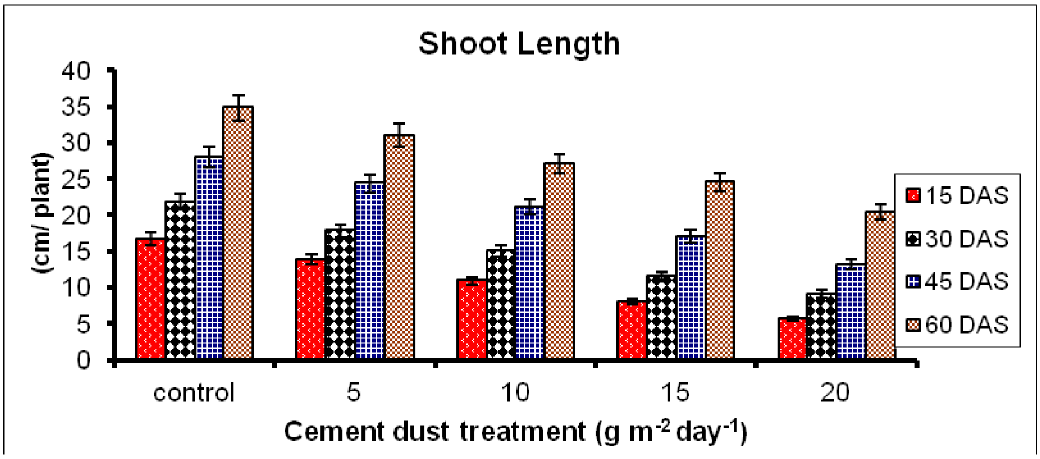

Fig. 3. Effect of cement dust on shoot length (cm/plant) of blackgram at various stages of its growth

Root length: The effect of various amount of cement dust on root length of blackgram at various stages of its growth was given in fig 4. The highest root length (10.218, 13.803, 17.791 and 21.293 cm/plant) was observed in control plants at 15, 30, 45 and 60 DAS respectively. Similarly, the lowest root length (3.511, 4.762, 8.134 and 12.652 cm/plant) was observed in 20 g m^{-2} day^{-1} cement dusted plants at 15, 30, 45 and 60 DAS respectively.

Number of root nodules: The effect of cement dust on number of root nodule of blackgram was presented in Fig 5. The highest number of root nodules (29.22, 38.32, 50.23 and 45.23 nodule/plant) was observed at 15, 30, 45 and 60 DAS in control plants. Similarly, the lowest number of root nodules (7.45, 13.28, 19.96 and 16.28 nodule/plant) was recorded in the 20 g m^{-2} day^{-1} of cement dusted plants at 15, 30, 45 and 60 DAS respectively.

Total leaf area: The effect of cement dust on total leaf area of blackgram was presented in Fig 6. The highest total leaf area (54.519, 78.323, 86.402 and 71.01cm^2/plant) was recorded in control plants. The lowest total leaf area (19.859, 29.985, 58.785 and 41.258 cm^2/plant) was observed in 20 g m^{-2} day^{-1} of cement dusted plant at 15, 30, 45 and 60 DAS respectively.

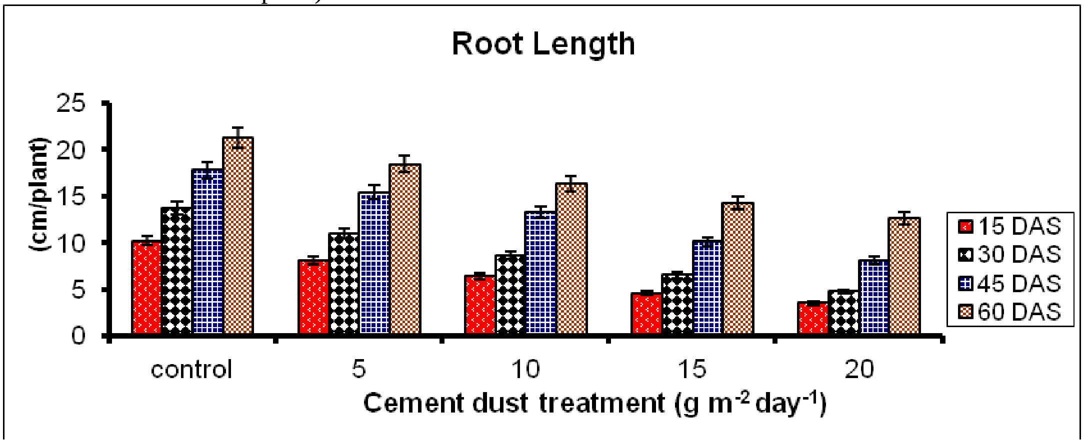

Fig. 4. Effect of cement dust on root length (cm/plant) of blackgram at various stages of its growth

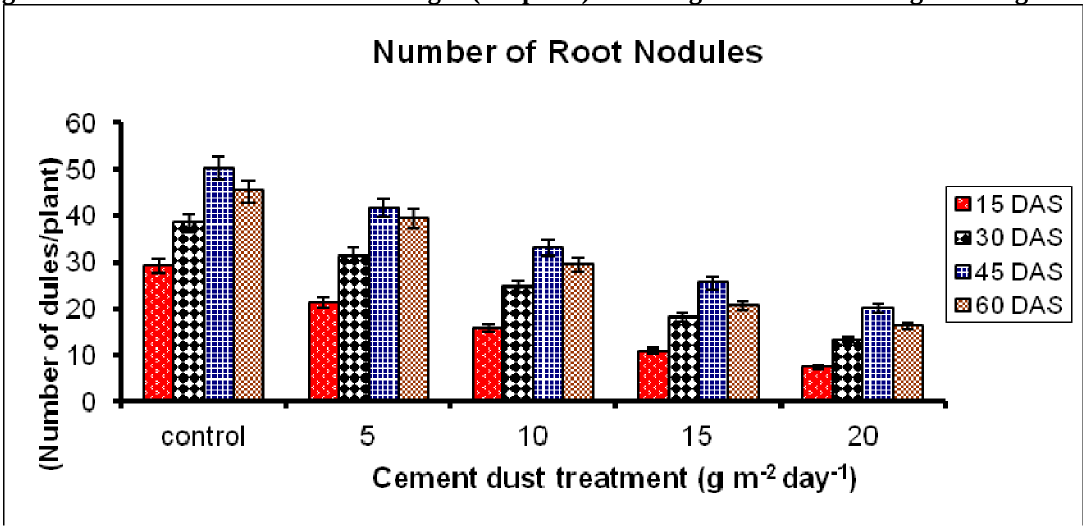

Fig.5. Effect of cement dust on number of root nodule (nodules/plant) of blackgram at various stages of its growth

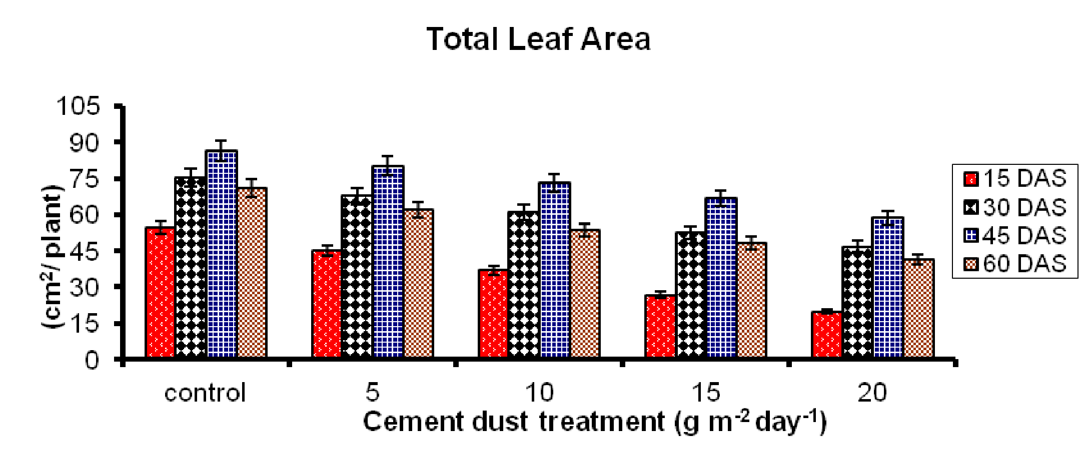

Fig. 6. Effect of cement dust on total leaf area (cm^2/plant) of blackgram at various stages of its growth

Fresh weight of shoot: The influence of cement dust on fresh weight of blackgram shoot was shown in the Fig 7. The highest fresh weight of shoot (21.951, 35.901, 49.914 and 71.241 g/plant) was observed in 15, 30, 45 and 60 DAS of control plants. The lowest fresh weight of shoot (4.974, 11.551, 17.249 and 37.174 g/plant) was observed in 20 g m-2 day-1 cement dusted plants at 15, 30, 45 and 60 DAS respectively.

Dry weight of shoot: The effect of cement dust on dry weight of blackgram shoot was recorded in Fig 8. The highest dry weight of shoot (6.773, 11.519, 14.663 and 20.337 g/plant) was recorded in control plant at 15, 30, 45 and 60 DAS respectively. The lowest dry weight of shoot (1.996, 3.564, 6.058 and 11.005 g/plant) was recorded at 15, 30, 45 and 60 DAS in 20 g m^{-2} day^{-1} cement dusted plants.

Fresh weight of root: The effect of cement dust on fresh weight of blackgram root was shown in Fig 9. The highest fresh weight of root (5.997, 9.978, 13.817 and 17.847 g/plant) was recorded in control plants. The lowest fresh weight of root (1.605, 3.089, 6.101 and 9.101 g/plant) was recorded in 20 g m^{-2} day^{-1} cement dusted plants at 15, 30, 45 and 60 DAS respectively.

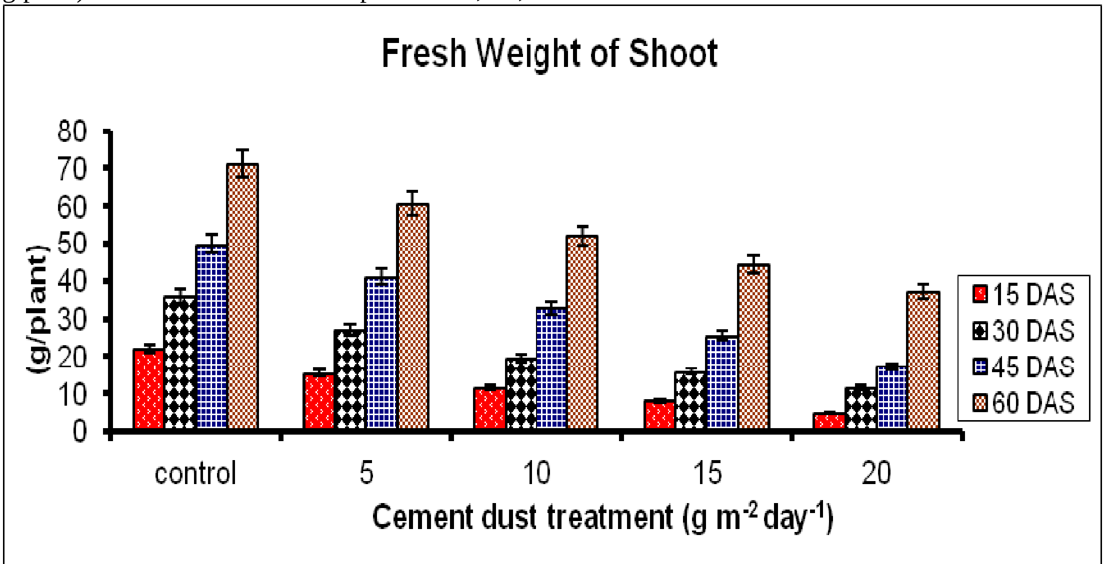

Fig.7. Effect of cement dust on fresh weight of shoot (g/plant) of blackgram at various stages of its growth

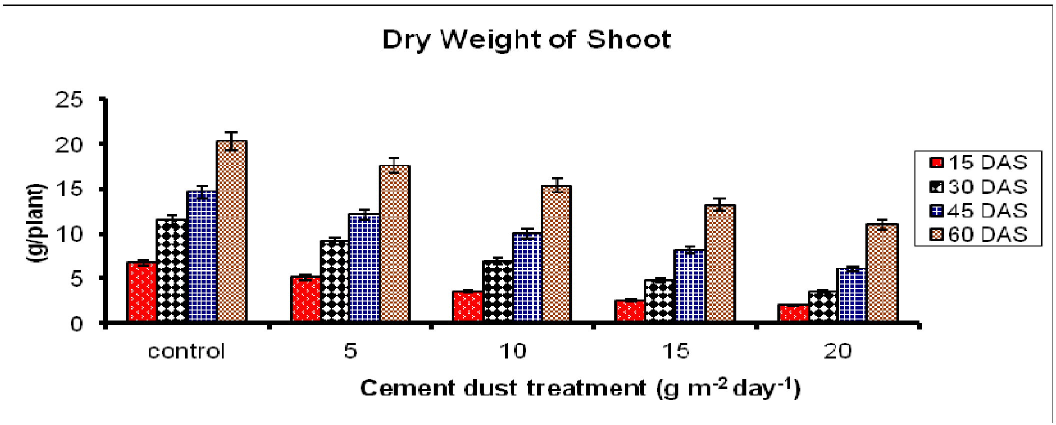

Fig. 8. Effect of cement dust on dry weight of shoot (g/plant) of blackgram at various stages of its growth

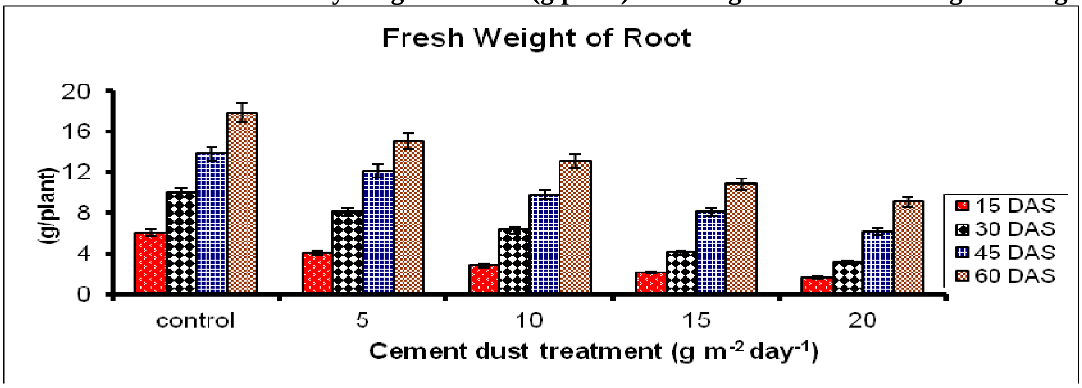

Fig.9. Effect of cement dust on fresh weight of root (g/plant) of blackgram at various stages of its growth

Dry weight of root: Influence of cement dust on dry weight of blackgram root was recorded in Fig 10. The highest dry weight of root (1.491, 2.849, 3.909 and 4.968 g/plant) occurs in 15, 30, 45 and 60 DAS of control plants respectively. The lowest dry weight of root (0.404, 0.956, 1.402 and 1.984 g/plant) was recorded in 20 g m^{-2} day^{-1} cement dusted plants at 15, 30, 45 and 60 DAS respectively.

Yield Parameters:The effect of various amount of cement dust on yield parameters of blackgram was given in Figs from 11 to 15. The highest number of pods (22.3/plant), number of seeds (10.5/pod), dry weight of pod (0.985 g^{-1} plant), 100 seed weight (7.2/g) and yield (655.2 kg^{-1} hectares) were recorded in control plants at the time of harvest. The lowest number of pods (10.9/plant), number of seeds (3.8/plant), dry weight of pod (0.431 g/plant), 100 seed weight (3.5/g) and yield (332.3 kg/hectare) were recorded in 20 g m^{-2} day^{-1} cement dusted plants at harvest stage

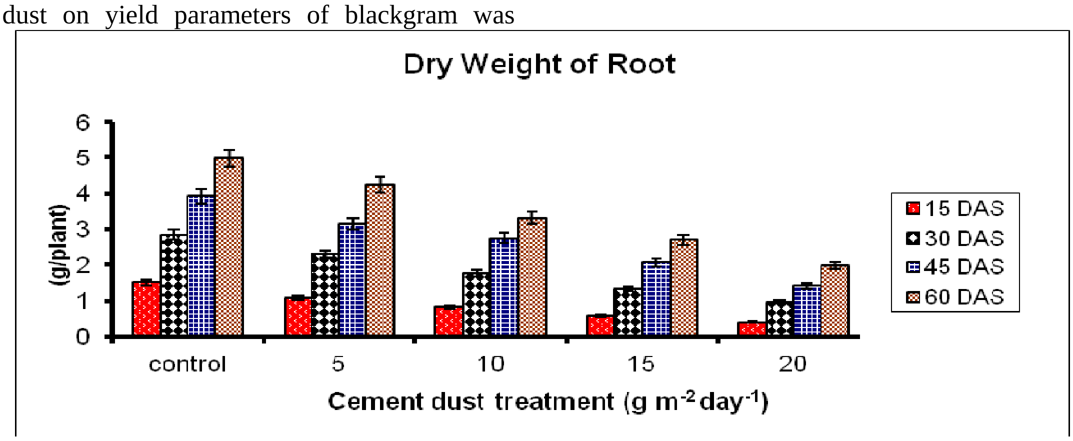

Fig. 10.Effect of cement dust on dry weight of root (g/plant) of blackgram at various stages of its growth

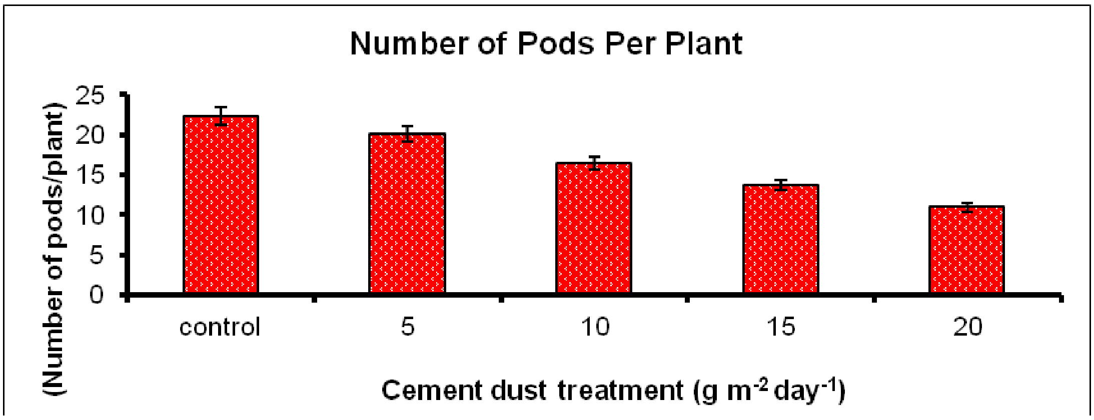

Fig. 11. Effect of cement dust on number of pods (pods/plant) of blackgram at yield stage

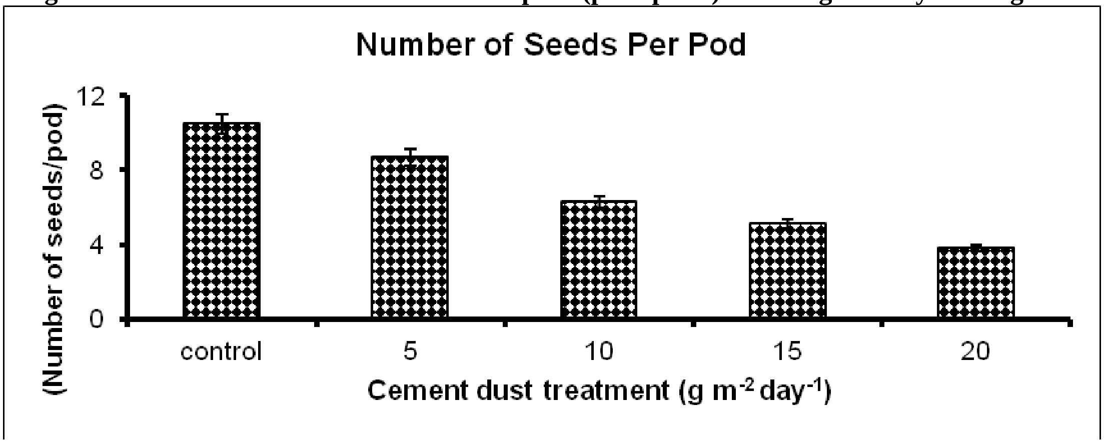

Fig. 12.Effect of cement dust on number of seeds per pod (seeds/pod) of blackgram at yield stage

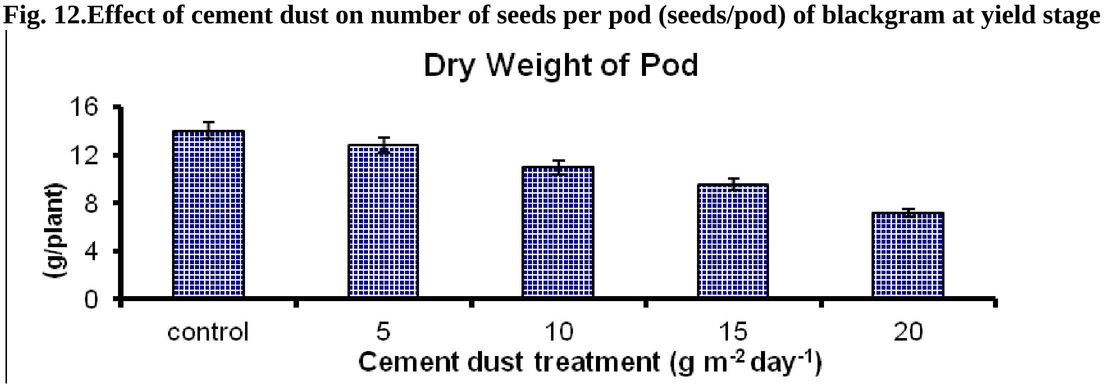

Fig.13. Effect of cement dust on dry weight of pod (g/plant) of blackgram at yield stage

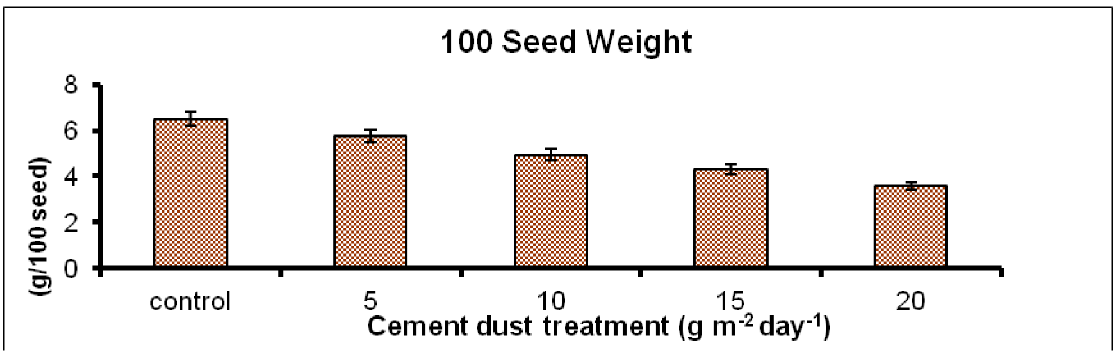

Fig. 14. Effect of cement dust on 100 seed weight (g/100 seed) of blackgram at yield stage

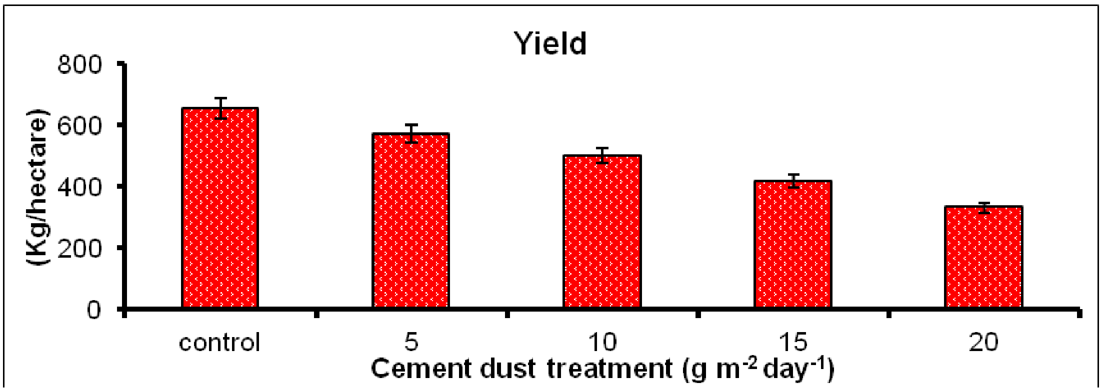

Fig. 15. Effect of cement dust on yield (kg/hectare) of blackgram at yield

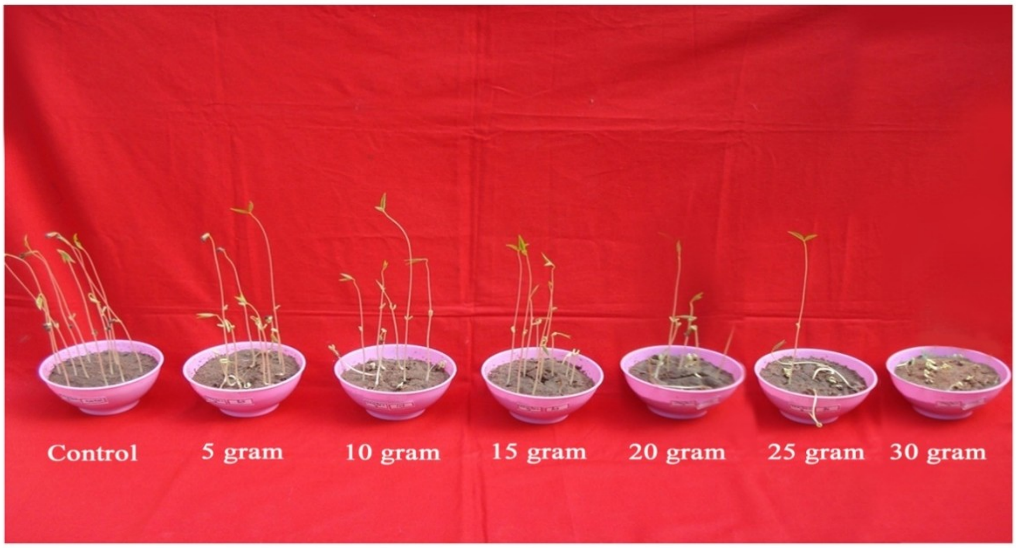

PLATE-I. Germination studies of Blackgram grown in soil mixed with various levels of cement dust

PLATE-II. Figure showing Measure of plumule and radicle in the seedling

DISCUSSION

A cement industry offers an excellent opportunity for studying the impact of dust on germination, growth and yield of agriculture crops. The reaction of plants to pollutants can be seen from changes in plant communities and from visible lesions on leaves, flowers and fruits, as well as from invisible biochemical and physiological changes. The influence of pollutants also cause stress situation that affect the whole plant metabolism.

Seed germination is one of the most important phases in the life cycle of a plant and it shows highly response to existing environment (Besma and Mounir, 2010). Seed germination and seedling growth are vital for continuation of plant life. They are extremely vulnerable to environment stress due to presence of polluting agents in the environment especially during seed hydration period. The pollutants presence in the environment affect the germination and ultimately the growth and yield of the crop.

In the present study, the germination percentage of blackgram seeds gradually decreased with the increase in the level of cement dust treatments. Reduction in germination percentage was observed at 25 g of cement dust mixed with 200 g of soil. The better germination was observed at control sets. Similar results of the gradual decrease in seed germination percentage of blackgram, sunflower and groundnut crops were reported with increased amount of cement dust (Prasad and Inamdar, 1990; Zargari and Shoar, 2008 and Raajasubramanian *et al*., 2011). The decrease in germination of seeds with increasing concentration of cement dust may be due to toxic effect of metals present in the cement dust that interfere in the normal synthesis of metabolic products (Singh and Srivastava, 2002).

In contrast to that view, Saralabai and Vivekanandan (1992) reported that the application of cement dust to the soil did not affect the seed germination of some legumes. 100% germination was observed even at 200 g of dust mixed with 1 kg of soil. The observed positive effects may be attributed to the presence of optimum level of plant growth promoting elements (N, P, Ca, Mg, Mn, Fe, S, Cu, Pb and Zn) in the cement dust. The germination of some leguminous seeds was totally affected in higher cement concentration. The time taken for plumule and radicle emergence was also delayed at increasing concentrations of the cement dust (Sundaramoorthy *et al.,* 1997).

The seedling stage is the most sensitive stage in the life of a plant and more susceptible to physical and chemical adversities. In the present study, the reduction in the root and shoot length of blackgram seedlings grown in cement dust was recorded. It was observed that the seeds germinated even in the high concentration of cement dust but their subsequent growth of seedlings was inhibited. Reduction in seedling growth with increasing concentrations of cement dust solution has also been observed in *Phaseolus vulgaris*, *Vigna* Sp., *Lycopersicum esculentum*, *Clitoria ternatea* and *Helianthus annuus* (Prasad and Inamdar, 1991; Singh, 2000; Singh and Strivastava, 2002 and Zargari and Shoar, 2008). Decrease in growth of seedling with increasing concentration of cement dust may be due to presence of toxic metals in the cement dust.

The weight of the seedling depends upon the growth behaviour of seedlings. In our present study, reduction in fresh and dry weight of seedling grown in cement dust polluted soil were recorded. Similar results of reduction in dry weight of seedling were reported in wheat (Simba, 1986), some legumes (Saralabai and Vivekanandan, 1995), *Tamarindus indicus* (Sundaramoorthy *et al*., 1997), tomato (Singh, 2000) and groundnut (Raajasubramanian *et al*., 2011). The reduced dry weight may be due to the poor growth of seedlings grown in cement dust polluted soil.

Vigour index is the value of multiplication of seedling growth with germination percentage of seeds grown in respective doses. The value shows the ability of seedling growth in polluted environment. In our study, the value of vigour index was directly proportional to the amount of cement dust applied. Similar trend of variation in vigour index values was already recorded in various crops (Raajasubramanian *et al*., 2011). The variation in these values may be due to germination behavior of blackgram seedling grown under cement dust polluted environment.

Tolerance index value is obtained by dividing the root length of cement dust treated seedling with root length of control seedlings. It showed a decreasing trend with the increasing concentration of cement dust. Similar trend of tolerance index value was reported in various crops (Sundaramoorthy *et al*., 1997 and Raajasubramanian *et al*., 2011) exposed to cement dust pollution. The variation in these values may be due to response of root growth of seedlings grown in cement dust mixed soil.

Field experiments were conducted with blackgram crop dusted with varying levels of cement dust. In this field experiment, the root length and shoot length of blackgram gradually decreased with the increase in cement dust concentration. Similarly, the highest root length and shoot length were observed in (unpolluted) control plants than the polluted (treatment) ones. Similar growth reduction results were reported in various crops such as *Hibiscus abelmoschus Cajanus cajan* (Prasad *et al.*, 1991) and sun hemp (Uma *et al*., 1994), *Vigna mungo* and *Vigna faba* (Kaushik, 1996); *Triticum sativum* and *Betal vulgaris* (Singh *et al*., 2003, 2005); some plants (Ademilua and Umebese, 2007) and groundnut (Raajasubramanian *et al*., 2011) due to the addition of cement dust. `

A thin and hard crust of cement was formed on the upper surface of leaves of cement dust sprayed plants. The crust formation reduced the rate of photosynthesis. The reduction in plant growth due to environmental pollution which cause decreased photosynthesis (Gupta and Mishra, 1994). Presence of toxic pollutants in dust might be responsible for the reduction in plant growth. Traces of toxic metals like Cr and Cd present in cement are harmful to human beings and other living beings (Iqbal and Shafig, 2001).

The heavy metals and toxic pollutants present in cement dust can play an important role in disturbing the various metabolic processes and cause the reduction in plant growth. The growth of the plant is determined by genetic constitution and also by the edaphic and weather conditions, especially temperature and water regimes. It also depends upon the dust load, the duration of its effect and the tolerance of the plants. The growth reduction in shoot and root length might be due to deacidifying ability of cement dust by neutralizing the soil pH (Gajek *et al*., 1984). The presence of Ca^{++} in the cement dust polluted soil decreased the availability of other nutrients needed for plant growth. The reduction in nitrogen content is the main causes of growth reduction in polluted plants. It may be due to reduced photosynthesis, interference with the gaseous exchange of foliage, clogging of stomata and interception in the incident light. The growth reduction may also be due to cement encrustation on the leaf surface, pigment degradation and intra or inter cellular changes in the leaves (Shukla *et al*., 1990).

Nodules are spherical or cylindrical growth formed in the roots of leguminous crops. They are formed as a result of an infection by bacteria (Streeter, 1995). They play a vital role in the process of nitrogen fixation in leguminous crops. In the present study, the reduced of nodules were recorded in blackgram, dusted with varying levels of cement dust. The nodule number is directly proportional to the amount of cement dusted blackgram crops. Similar results of decrease in the number of root nodules were reported due to cement dust in various crops such as Chickpea (Rai *et al*., 1984); Lupine (Tang *et al*., 1990); French bean (Thangarasu, 2002) and Common bean.

The reduction in number of nodules may be due to the increased deposition of cement dust in the soil that alters the soil pH. The increased soil pH has an inhibitory effect on nodulation (Paz *et al*., 1982). The poor development of root nodules may be due to poor inhalation of nitrogen fixers in cement dust polluted soil (Stratmann and Van Haut, 1966 and Lie, 1974). It may also be possibly due to the deposition of cement dust pollutants which may become toxic to the population of *Rhizobium* as suggested by Thangarasu *et al*. (2002). The decreased number of nodule was recorded in soybean. Peanut (O'Hara, 1988) and French bean (Hemantarajan and Garg, 1986) due to iron deficiency.

In general, Leaf area is an important part of the plant responsible for conversion of solar energy. It is the index of photosynthesis which reflects into the crop production. Leaf is the most sensitive and reliable part of a plant than any other part. It may act as a persistent absorber and is exploited in polluted environment. The air pollution injury brings about a reduction in the number of leaves and leaf area (Krishnamurthy *et al*., 1994). In the present study, significant reduction in leaf number and total leaf area was recorded in blackgram crop due to cement dust pollution. Similar trends of reduction in number of leaves and total leaf area were reported in maize (Parthasarathy *et al*., 1975); wheat (Singh and Rao, 1980); some legumes (Indirabhai, 1987) *Cassia carandas*, *Azadirachta indica* and *Delonix regia* (Iqbal and Shafig, 2001)**.** The harmful effects of dust deposition reduced the total leaf area due to uniform coating over the surface of the leaves, plugging of stomatal apparatus and impaired gaseous exchange (Krishnamurthy and Rajachidambaram, 1986).

The fresh and dry weight is mainly based on their growth performance of a particular crop. In our study, the reduction in fresh weight and dry weight of blackgram crop grown with cement dust were recorded. Similar results of reduced phytomass of plants were recorded in cotton (Armbrust, 1986), blackgram (Prasad and Inamdar, 1990), cotton (Satao *et al*., 1993), *Sorghum* (Chitralekha and Dhashinamoorthy, 2000) *Atriplex halimus* (Fakhry and Migahid, 2011). The phytomass of dusted plants was consistently lower than those of control plants at all stages of growth and again reduction was related to application rate of cement dust (Shukla *et al*., 1990). The decreased phytomass may be due to reduction in photosynthesis of polluted plant. The cement dust deposited on leaves reduce the available light for photosynthesis (Lerman, 1972). This may be due to reduced photosynthesis, through combination of factors such as reduced leaf area, clogging of stomata, interception of incident light due to cement encrustation on leaf surfaces, pigment degradation and inter or intracellular changes in the leaves.

The growth and yield are the most of useful criteria for determining economic damage of vegetation in polluted area. The yield parameters of blackgram such as number of pods, number of seeds/plant, 100 seed weight and yield are gradually decreased with the increase in cement concentration.

Alkaline cement dust deposition on plant leaves are known to reduce amount of light available for photosynthesis and reacting with water to form toxic solution. As a result, it reduced yield of crops without showing any visible leaf injury (Manning, 1971). Reduction in yield of rice, grape, cotton and barley was recorded when they are growing in the higher concentration of cement dust. Satao *et al*., (1993), has reported that the yield of wheat crop cultivated in field polluted with cement dust reduced and expressed in term of biological and economic yield. Shukla *et al*. (1990) reported the number of pods per plant and number of seeds per pod were found to be reduced. The characteristics of seed produced from dusted blackgram plants were markedly different from those obtained from the non-polluted site. The number and dry weight of seeds from dusted plants were significantly lower than those of control plants (Kumari and Pandey, 2011).

Inhibition of plant yield from polluted sites was always lower than control due to deposition of dust particles on the leaf surface that indirectly affects the metabolism of plants in various ways. The reduction in number of seeds was recorded in polluted area it may be due to failure of pollen germination on the dust laden stigma and failure of fertilization. The decrease in yield may be due to the poor growth of plants and their metabolism due to cement dust pollution. The heavy metals present in cement dust can play an important role in distribution the various metabolic processes.

Reduction in yield was primarily due to failure of pollen germination and fertilization on the dust – coated stigmatic surfaces. The reduction in production of flowers, pods and seeds were recorded in *Brassica campestris* and *Brassica oleracea* exposed to cement dust pollution for longer period (Shukla *et al*., 1990 and Zargar *et al*., 1999) respectively.

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