CHAPTER - 4

A STUDY ON EFFECT OF SOIL POLLUTION ON AGRICULTURE AND ITS ERADICATION BY USE OF FERTILIZERS
4.1 Concept of Fertilizer

4.2 Effect of cement dust pollution on agriculture

4.3 Experimental

4.4 Result and Discussion

References
Plant need for their growth sixteen elements, namely carbon, hydrogen, oxygen, potassium, phosphorus, nitrogen, calcium, magnesium, sulphur, zinc, boron, copper, manganese, Molybdenum, chlorine and iron. Out of these three namely carbon, hydrogen and oxygen are obtained from air and water and are called natural nutrients. Nitrogen, phosphorus and potassium are consumed in large quantities by the plants for their growth and these are called primary nutrients. Calcium, magnesium and sulphur, which are found to a small extent in all soils, are called secondary nutrients. Remaining elements are needed by the plants in minute amounts and so these are called micronutrients.¹

There are three important factors, which affect the fertility of a soil, these are:

(1) The amount of fix nitrogen.

(2) Nitrogen, phosphorus, potassium and other mineral salts.

(3) pH value of the soil.

Natural weathering of the minerals in the soil usually provide enough of these elements needed by plants. In a virgin soil supporting a native vegetation, there is no loss of plant food, but the supply of nitrogen, phosphorus, potassium and calcium is insufficient for frequent repetition of the same crops and the soil becomes less productive, and the supply of above nutrients is provided in the form of their compounds to make the soil reproductive. For this purpose both natural and chemical or artificial fertilizers are used.

4.1 CONCEPT OF FERTILIZERS:

Every compound containing nitrogen, phosphorus or calcium etc. can not be used as a fertilizer, the chief requisite of a fertilizer are:²

(1) The element present in the compound must be easily available to the plant.
(2) The substance must be soluble in water.

(3) It should be stable, so that it may be made available to the plant for a long time.

(4) It should not be very costly.

(5) It should maintain the pH of the soil near about 7 to 8.

(6) It should not be a poison for the plant.

(7) It should not be hygroscopic.

Thus fertilizers are those substances, which must be added to the soil, in order to remove the deficiency of essential elements, required for plant growth.

Fertilizer usually classified according to their mode of operation on the soil. 3

**Direct fertilizer**: Those fertilizers, which are directly absorbed by the plants from the soil, are called direct fertilizer, ex. nitrates, super phosphates and ammonium.

**Indirect fertilizer**: These are certain substances which do not act as a fertilizer, but help fertilization indirectly in keeping the soil's pH value suitable for plant growth.

**Complete fertilizer**: Those fertilizer which provide all the essential elements such as nitrogen, phosphorus, potassium etc. required for plant growth.

**Incomplete fertilizer**: Those fertilizer which contain, only one or two needed elements, are known as incomplete fertilizers. Thus ammonium phosphate, potassium nitrate etc. are incomplete fertilizer.

**Mixed fertilizer**: These fertilizers are prepared by mixing appropriate quantities of ammonium salts, superphosphate, potassium salts etc. They supply more than one essential elements to the soil. NPK belong to this class.
Although it is generally agreed that fertilizers come in three physical forms (liquid, solid and gas), there are actually only two classes of fertilizers: liquid and solid. Anhydrous ammonia (NH₃) is a gas, but it is classified as a liquid because it is a liquid under pressure.

The term liquid fertilizer applies to anhydrous ammonia, aqua ammonia, N solutions and liquid mixed fertilizers. Liquid NPK fertilizers are also known as fluid fertilizer. They include true solutions which require no agitation and suspensions or slurry type mixtures of N, P and K, which require constant stirring to keep the solids suspended in the solution.

The use of ammonium nitrate has decreased greatly in recent years, although it is a very good source of N. Crop responses to liquid and dry fertilizer are similar, provided the same amounts of plant nutrients are applied and the same placement and water soluble P materials are compared.

Reactions of these materials in soils are similar. When placed in the soil, dry fertilizers absorb water and undergo chemical reactions similar to liquid fertilizer. Price per unit of plant nutrients, application costs, potential for leaching, ease of handling and customer service are the prime factors to consider when buying fertilizers.

**Characteristics and Uses**: ⁴

There are several properties of fertilizers and principles of fertilizer application which users should become familiar with. One important property of fertilizers is water solubility. Nearly all N fertilizers are completely water soluble. Because of their high water solubility, granule size and band placement are generally not important.

The two most common forms of N in fertilizers are ammonium (NH₄⁺) and nitrate (NO₃⁻). Under conditions of good plant growth, NH₄⁺ is rapidly converted to NO₃⁻ by bacteria. Both forms can be taken up and utilized by plants. However, crops such as tobacco, potatoes and
tomatoes prefer nitrate as their source of N. Because nitrate is much more mobile than ammonium, ammonium forms of N are recommended when the application is made prior to the time of greatest need. This practice minimizes potential loss by leaching.

Most phosphate fertilizers are highly water soluble. Phosphate water solubility is very important for early plant growth. Thus, it is important for banded starter fertilizers to contain highly soluble forms of P (less than 2 ppm in soil solution) but concentrations as high as 100,000 ppm have been measured in the fertilizer band. During cool and wet conditions when plant growth is slow and the root system is shallow, band placement of P fertilizers becomes extremely important.

Broadcast applications usually contact less than 2% of the total soil volume. Consequently, water solubility is of little importance where P fertilizers are broadcast.

Phosphorus availability in the band is generally improved by the addition of N to the P starter and by increasing the granule size. Large granules contact less soil per unit of P than small granules. Thus, initial P fixation is lower, and availability is improved.

Most potassium fertilizers are highly water soluble. Like NH$_4^+$, K$^+$ is held in the soil by clay and organic matter. Unlike NH$_4^+$, however, K is not converted to a more mobile form. Potassium stays relatively close to the initial point of application. Leaching of K is not generally a problem, except on very sandy or gravelly soils, due to insufficient cation exchange bonds are much weaker. Because K is not subject to the same fixation reactions as P, water solubility is not considered important. Potassium can be fixed in the crystal lattice of some clay minerals; however, high K-fixing soils are not extensive. Consequently, banding K is only important where soil tests for K are extremely low.
(1) **Nitrogen Fertilizers**:

Anhydrous ammonia (82% N) is a liquid under high pressure and must be injected at least six inches deep into a moist soil because it becomes a gas once it is released from the tank. In soil, ammonia reacts with water to form the ammonium (NH₄⁺) ion, which is held on clay and organic matter. Anhydrous ammonia is generally the cheapest source of N; however, the method of application is less convenient and requires more power to apply than most other liquid or dry materials.

Nitrogen solutions (28 to 32% N) are a mixture of urea and ammonium nitrate in water. The solution has no ammonia vapor pressure and is generally sprayed or dribbled on the soil surface. Under certain conditions, however, N loss due to ammonia volatilization may be serious. If the conversion of urea to ammonia in the liquid fertilizer takes place on the surface, some ammonia can be lost by volatilization. The remainder of the ammonia may react with water on the surface to produce an alkaline condition, which also promotes volatile ammonia loss.

The most favorable conditions for volatile N loss from surface-applied urea (solid or liquid) are alkaline soils, warm temperatures, intermediate relative humidity (50 to 90%) and sandy soils with low organic matter content and low cation exchange capacities.

One-inch of rain will normally move surface applied N solutions deep enough into the soil to prevent ammonia volatilization. Nitrogen solutions should not be applied in the fall, because one-fourth of the N is in nitrate form and is subject to loss by leaching or denitrification. Surface application of N solutions to heavy residues, which occur in no-till systems, has been shown to reduce its effectiveness when compared to N that is incorporated or knifed-in. Nitrogen can be temporarily tied up in residues and unavailable to the crop until the residues decompose.
Aqua ammonia (21% N) is a liquid under low pressure and must be incorporated into the soil to prevent the loss of free ammonia to the atmosphere. It is possible to lose all of the free ammonia if it is not incorporated. Aqua ammonia has advantages over anhydrous ammonia: placement need not be as deep, and high-pressure applicators are not required.

Urea (46% N) is the most widely used dry N fertilizer. Once applied to the soil, urea is converted to ammonia which reacts with water to form ammonium within two to three days (faster under warm conditions). Some volatilization of ammonia can occur when urea is surface applied. Volatile ammonia loss from early spring topdressing of urea on wheat or pasture is seldom a problem. However, avoid topdressing of urea on pastures during summer months because of the potential for greater ammonia losses.

Ammonium nitrate (33% N) is decreasing in popularity because of storage problems associated with fire and explosive hazards. It is an excellent material for many purposes; however, one-half of the N is in nitrate form, which makes it immediately susceptible to potential leaching and denitrification losses after application. Calcium ammonium nitrate is a mixture of ammonium nitrate and crushed limestone. Neither of these materials should be used for fall application.

Ammonium sulfate (21% N) availability has increased in recent years primarily because it is a byproduct of some industries. All of the N is in the ammonium form. It is a good material for high pH soils (pH>7.0) and can be used where sulfur deficiency is suspected. If applied to alkaline or calcium soils, it should also be incorporated to eliminate potential ammonia volatilization losses. It has the disadvantage of being the most acidifying form of N fertilizer which requires more limestone to neutralize the acidity formed by the N fertilizer. The cost of ammonium sulfate is usually greater than urea because of its lower analysis and higher transportation costs.
Calcium nitrate (16% N) contains all of its N in the nitrate form, which is highly susceptible to leaching and denitrification losses as soon as it is applied. Potassium nitrate (13% N) is used as both a K source and a N source. All of the N is in the nitrate form and is subject to leaching and denitrification as soon as it is added to soil. It is used primarily in the fruit and vegetable industry as readily available sources of N and K. Sodium nitrate (16% N) contains all of its N in the nitrate form and is similar to potassium nitrate and calcium nitrate in its reaction in soils. It is used primarily in the vegetable industry when a readily available source of nitrate N is desired.

(2) Phosphate Fertilizers:

Rock phosphate supply sufficient P for good crop growth where soils are moderately acid and where decomposing organic matter is abundant. On fields with high soil tests for P, broadcasting rock phosphate to replace crop removal may be acceptable, but rock phosphate is not acceptable for a starter fertilizer because of its low water solubility.

Today, rock phosphate is generally processed before it is used as a fertilizer. Normal superphosphate (20% P₂O₅), also referred to as ordinary superphosphate, is no longer used in large quantities. Because of its lower analysis and high transportation costs, it has been replaced by concentrated superphosphate (46% P₂O₅) and the ammonium phosphates. One of the advantages of normal superphosphate was its significant sulfur content. As consumption of this material has slowly decreased, concerns over the need for sulfur have come primarily from the fertilizer industry.

Currently, sulfur from the atmosphere is keeping pace with crop removal. Concentrated superphosphate (46% P₂O₅), also known as triple superphosphate, is being used in direct application as well as in granulated processes and in bulk blending with other materials.
Consumption has decreased in recent years due to the competitiveness of diammonium phosphate (18-46-0) and monammonium phosphate (11-48-0). These materials have better storage properties and are more desirable for bulk blending, particularly where N is required in the final product.

Diammonium phosphate (18-46-0) is a dry material being used extensively for bulk blending and for direct application where soils do not need K or where K is broadcast. It has the advantage of being highly water soluble, having a high analysis and often a price advantage. Diammonium phosphate has an acid effect upon the soil similar to anhydrous ammonia. Because of the high ammonia content, this material can cause germination injury if used in direct contact with the seed.

Monoammonium phosphate (11-48-0) is a dry material being used for bulk blending or direct applications. Monoammonium phosphate has a lower ammonia content and may be less injurious to germinating seeds than diammonium phosphate. The general agronomic effects of diammonium and monoammonium phosphates are equal for most soils. Polyphosphates differ slightly from the more common orthophosphate fertilizers.

Nearly all of the liquid fertilizers containing P are of the polyphosphate type. Polyphosphates are composed of a series of orthophosphate molecules connected by the process of dehydration (removal of water). Commercial ammonium polyphosphates are usually a mixture of ortho- and polyphosphate. With prolonged storage, polyphosphates will hydrolyze to orthophosphates. Solutions of ammonium polyphosphate most commonly made are 10-34-0 and 11-37-0.

The most common dry polyphosphate is 13-52-0. In the soil, polyphosphate converts to orthophosphate by hydrolysis (adding on water). The time required for hydrolysis to occur varies with soil
conditions. In some cases, 50% of the polyphosphate hydrolyzes to orthophosphate within two weeks. Under cool, dry conditions, hydrolysis may take longer. Some claims have been that polyphosphates will make certain unavailable micronutrients in the soil more available for plant uptake. Due to the rather rapid conversion of polyphosphates to orthophosphates in the soil, it is not likely that such complexes would be available for any significant length of time.

The efficiency of polyphosphates is considered to be equal to, but not better than, the orthophosphates with more than 80 percent water solubility.

(3) Potassium Fertilizers:

Potassium Chloride (60 to 62% K₂O), also referred to as muriate of potash, is the major source of K used. Nearly two-thirds is used for direct application, and the remainder is used in granulating processes or bulk blending of mixed fertilizers. It is available in four particle sizes: fine, standard, coarse and granular. The fine-size material is used primarily for liquid suspensions. Standard, coarse and granular sizes are used for granulating processes, bulk blending and direct application.

Potash varies in color from pink or red to white depending on the mining and recovery process used. White potash, sometimes referred to as soluble potash, is usually higher in analysis and is used primarily for making liquid starter fertilizers. Potassium sulfate (50% K₂O), also referred to as sulfate of potash, is used to a limited extent on crops such as tobacco, potatoes and a few vegetable crops where chloride from potassium chloride might be undesirable. Potassium sulfate may also be source of sulfur when sulfur is required. Potassium magnesium sulfate (22% K₂O), also known as sulfate of potash magnesia, is used for both direct application and in bulk blending, particularly where magnesium is needed. If may also be used as a source of sulfur.
Potassium hydroxide, also known as caustic potash, is used to a limited extent in the production of liquid mixed fertilizers. The present cost of producing potassium hydroxide has limited its use in the fertilizer industry, even though it is a very desirable product due to high solubility and low salt index. Potassium nitrate (44% K₂O), also known as nitrate of potash, is being used in on high value crops such as celery, tomatoes, potatoes, leafy vegetables and a few fruit crops. It has a low salt index and provides nitrate N which may be desirable for these specialty crops. Production costs have limited general use for most agronomic field crops.

4.2 EFFECT OF CEMENT DUST POLLUTION ON AGRICULTURE:

Pollutant is a product of the activities of man. As man started manufacturing chemicals and metals generating power developing faster means of transportation and crowding the problem of pollution become inevitable. Pollutants contaminate air, water and soil and affect human health in direct or indirect way.

Cement dust is a common air pollutant in the vicinity of cement factories and around construction sites, it is a mixture of Ca, K, Si and Na oxides. The cement with particles from 0.1 to 100 μm in size forms a thick impervious crust understudy. The cement dust emanating from the factory settles on surface of the soil and vegetation, affecting a large area especially in northeast direction of the factory. The fall out of cement dust in the area has led to change in the soil characteristics and in plant structure and function. These changes reflect an irrepairable habitat degradation.

The habitat transformation of a cement crust on the soil surface and by changes in porosity water holding capacity, pH organic carbon and exchangeable Ca²⁺ and K⁺ ions in the soil.

The plant growing under these transformed conditions of air and soil due to cement dust pollution suffer metabolic stresses, leading to large scale plant deformation and production losses.
Several ecological studies made with respect to industrial and other human activities. The cement dust emanating from the factory settles on surface of soil and vegetation affecting a large area especially northeast direction of the factory, causes changes in soil characteristics and plant structure and functions.

This following review has a focus on the main grain and legume crops grown in the study area, these are Wheat, gram, zea mays, soybean, and rice.

Singh and Rao (1978) found that the dusted plants showed stunted growth, accompanied with reduction in lengths of their shot, root and earm and in number of tillers. leaves, ear and grains per spike. Changes in mineral contents of dusted plants were also observed.⁵

Singh and Rao (1981) and Singh (1983) studied on wheat plant polluted by cement dust and found dusted plants underwent considerable reduction in all parameters under the stress of cement dust pollution, indicating the existence of linear relationship between pollutant dose and plant response. They suggest that air pollutant influence the pattern of mineral accumulation in wheat plants. under the influence of cement dust pollution, accumulation of of N and P in plants decline whereas that of K and Ca was enhanced. Changes in mineral accumulation were more pronounced in plants subjected to cement dust at flowering stage, that at pre and post flowering stages. They also studied that grain obtained from affected sites showed quantitative and qualitative deterioration.⁶,⁷

Raj and Singh (1989) showed the effect of the leaf extract of wheat treated seperately with NH₃ SO₂ and cement dust on the mycelial growth of fungi, the growth of most of the test fungi was significantly stimulated by leaf extracts obtained from all the treated and controlled plant, however the stimulation was generally highest in case of NH₃ and lowest in case of SO₂ treated plants. The variation in nutrient level in leaf extract collected from the untreated and the treated plants seem to be cause for differential effect of dust.⁸
Effect of cement dust on yields of wheat plant is also determined by Anda (1987) and found the reduction in fertility, yield loss in wheat crop. Singh and Rai (1989) found that the percent frequency and number of colonies cm\(^2\) leaf area of all the test fungi decreased significantly at the higher doses of cement dust during both pre and post inoculation treatment. However the population of some fungi increased at low dose only.\(^9,10\)

Borka et al. (1981) studied on the metabolic process of wheat cultivars and found changes in physiological process due to exposure to cement dust, continuous deposition of cement dust adversely affected the physiological condition of the plant, including a malformation of the spikes. Gyula (1984) also studied on growth metabolism and found that yield of wheat highly affected by cement dust.\(^11,12\)

Dhindwal et al. (1992) conducted an experiment to evaluate the effect of P levels on growth parameters, yield and chemical composition of wheat in normal naturally polluted and spiked soils, and found increase in these parameters in polluted and spiked soils, the dry matter accumulation and leaf area was higher in normal soil than that of polluted and spiked soils.\(^13\)

Chatter (1991) observed effect on enzymatic activities in the leaves of Triticum aestivum and found that activities of the three enzymes increase with the increase on the concentration of cement dust. The activity was highest in all three enzymes at metaration and lowest in control one. They also observed that cement dust affect plant height, girth, leaf number, leaf area, spike length and dry weight also.\(^14\)

Ayer et al. (1991) and Tripathi and Sahu (1997) studied the effect of air pollution on growth performance of wheat plant and found that some results about biomass accumulation biochemical changes and grain yield in plants growing in the vicinity of polluted area.\(^15,16\)

Darley (1966) studied the effect of cement dust on vegetation and reported considerable reduction in agriculture production, primarily affecting fertilization and starch production.\(^17\)
Borka (1981) found that in maize plant continuous dust pollution reduced plant height, the initial small degree of pollution had a positive effect on the growth rate of the leaf blade, but the cement crust has a negative effect. The intensity of respiration and the catalase activity in leaves, polluted for a long time, decreased. The dust layer stuck the leaves and blocked the stomata in the form of cement plugs causing disturbances in plants and in the heat and water regimes of the plants. fertilization was adversely affected by cement dust. they also found that a low degree of cement pollution did not reduce the dry weight, but it significantly decreased ear production.  

Pandey and Simba (1990) found chloroplast damaging by cement dust pollution. The found that dust pollution cause decrease in number of grains per cod, weight and volume of 1000 grains, moisture content, total ash, crude fiber content and colorific value.

Shah et al. (1989) found lowering of leaf area and biomass of polluted plants. They also recorded the changes in chlorophyll content, chlorophyll a was reducing and chlorophyll b was higher. Stomata were clogged and moisture content was lower, and external appearance of the plant was like unhealthy.

Prasad and Subramanian (1991) noted the effect of cement dust pollution on Ajanus cajan, and found no visible symptoms of injuries, however stomatal clogging and reduction in growth, phytomass and net primary production. levels of chlorophyll a soluble proteins, sugar, starch, amino acids and phenols were found decreasing, while amount of chlorophyll b was found inreasing. Prasad and Mohan (1992) worked on ultrastructural responses of Cajanus cajan and found increments in free proline, free amino acids, soluble proteins, soluble starch, phenol and soluble sugars. The level of nitrogen in nodules also changed significantly.

Vijaiwargia and Pandey (1986) studied on the effect of cement dust pollution on growth and yield of soyabea and a decline was observed in
growth parameters, which resulted in reduced yield. Growth of embryonic
axis of germination of pea seeds was significantly inhibited by a low as 0.25
mm. elongation or radicle was also severely affected than that of plumule.\textsuperscript{23}

Borka (1986) studied the growth development and metabolic
processes and yield of peas under the influence of cement dust polluted soil
and found depreciation in all the parameters.\textsuperscript{24}

Morpho-bio-chemical changes due to cement dust pollution in
mustard studied by Uma \textit{et al.} (1994), who found reduction in levels of
phytomass, chlorophyll a, total chlorophyll besides the reduction in
metabolites like starch, protein, aminoacids and sugars of \textit{Brassica juncea},
growth of which was influenced by cement dust.\textsuperscript{25}

Detrimental effects due to inhibition of growth during periods of
insufficient precipitation studied by Lairand \textit{et al.} (1978) and Iqubal \textit{et al.}
(1978) who recorded a significant reduction in plant growth with the
application of cement dust, and found reduction in leaf area.\textsuperscript{26,27}

Krishnamurthy \textit{et al.} (1986) found reduction in photosynthetic
oxygen evaluation, in plants of \textit{Brassica compastris}, treated with cement
dust, which showed a consistent reduction in growth photosynthetic
pigments, yield and oil content.\textsuperscript{28}

Shukla \textit{et al.} (1990) recorded change in petal morphology in plants
of \textit{Brassica compastris}, treated with cement dust, cement dust absorbed
moisture from petal surface causing water loss and subsequent loosening of
the arrangement of papillae lead to damage of flower petals, cause alter in
the quality of flower, thus causing serious losses in floriculture. Same
findings were obtained on the plant of \textit{Brassica compastris} by Agrawal \textit{et al.}
(1992) and Mishra \textit{et al.} (1994).\textsuperscript{29,30,31}

Prasad and Inamdar (1990) observed reduction in chlorophyll,
protein, starch and phytomass content and yield of ground nut. The polluted
plants showed an increase in lipid content. Satao \textit{et al.} (1994) found the
same results.\textsuperscript{32,33}
4.3 EXPERIMENTAL:

In view of these reports, an attempt have been made in present study to assess the effect of cement dust on the production of crops in polluted soil and effect of amendment of different fertilizers in polluted soil by assessing the growth of wheat and gram crops which are grown abundantly in this area been taken for the further experiments.

**Methodology:**

Soil samples were collected from the different distances from cement industry area. After analyzing the soil samples, the major quantity of soil been dugged up from a depth of 6 inches and brought them to the lab and experimental field. Germination of seeds and growth patterns of have been studied by pot experiments method.

5 kg. of each Soil sample collected from various locations of cement dust polluted area has been taken and after crushing and sieving mixed with a kg. of sand and place into earthen pots. 50 seeds of wheat and 20 seeds of gram were sown in these pots.

For experiments of parameter relating to distance, soil samples from different distances were taken separately, and in case of fertilizers effect on soil, all the soil samples mixed in equal quantity and after mixing them properly, 5 kgs. sample taken out to mix 1 kg. of sand, mixed properly and placed in earthen pots for further experiments.

For assessing effect of fertilizers, after a period of initial 15 days different quantity of fertilizers were added to soil, this was repeated five times for a experimental span. Watering of plants was done after every alternate day in early stage and every 3rd day in later stage.

4.4 RESULT AND DISCUSSION:

Experiments on the effect (i) distance from pollution source on fertility of the soil and (ii) effect of fertilizers on cement dust polluted soil were done on the wheat and gram crops with the help of pot experiments. Each
experiment has been done in five sets. Parameters of percentage germination, plant height, dry weight of 1 gm. plant, no. of seeds per plant and yield per plant were taken to measure the effect of distance and of fertilisers on soil.

Growth of seeds of wheat crop in polluted soil sample collected from various distances from Diamond cement factory was observed by sowing 50 seeds in each pot of experiment sets, results of the observations are given in Table 4.1. Results clearly showed percentage germination was minimum in the soil sample collected from 0.5 km. away from factory, where it was 68.4% only, while in soil collected from 5th km. gave 89.6% germination. (Fig. 4.1) All other parameters also showed the same pattern in relation to distance. The plant height was 38 cm., when the soil was from 0.5 km. and 49 cm., when soil was from 5 km. from factory. Dry weight was per gram of plant was 0.142 gm. and 0.283 gm. in the soil from 0.5 and 5.0 kms. respectively. No. of seeds were also found increasing with the increase in distance, was 18.86 per plant and 23.01 per plant and total yield per plant was 2.258 and 0.5 gm. in the soil from 0.5 and 5.0 kms. respectively. (Fig. 4.2 and 4.3 and Photograph No. 4.1)

Results on the effect of cement dust polluted soil on the germination growth and yield of gram are given in Table 4.2. The seeds of gram also showed lowest germination 62.31% in nearby soil samples and 84.75% in the soil sample which was 5 km. away from soil. Plant height was found ranging 21.7 to 26.5 cm. in increasing order. Same trends were found in case of dry weight of per gram plant, which was 0.281 and 0.446 and yield per plant, which was 20.16 and 31.42 in the soils from a 0.5 and 5.0 km. distance respectively. (Photograph No. 4.2)

These results are in agreement with Rao (1971), Dubey et al. (1982) and singh (1979). The habitat transformation is affected by formation of a cement crust on the soil surface and by changes in porosity, water holding capacity, pH, organic carbon and exchangeable Ca++ and K+ in the soil. These all parameters have cumulative effect on the properties of the soil, which ultimately affect the growth and reproduction pattern of a plant.34,35,36 (Photograph No. 4.3 and 4.4)
To recover the fertility of soil and its capacity to nourish the plants, amendment of external source of fertilizers is highly needed in polluted soil, which helps to rejuvenate the soil for proper functioning.

Keeping above in mind further experiments were performed with chemical and natural fertilizers.

Results on the growth of crops in fertilizer ammended polluted soils are given in Table 4.3 for wheat and Table 4.4 for gram crop. It is clear from the data that mixture of Nitrogen, Potassium and Phosphorus fertilizer (NPK) does not support the soil properly to give increase in growth yield of wheat. Crop of wheat showed maximum increment in all six parameters in the polluted soil mixed with P fertilizer, on the other hand when phosphorus mix in soil with a combination of N fertilizer did not support the growth up to that extent. Interestingly compost fertilizer supported the crop much better than the P fertilizer. (Fig. 4.4 and Photograph No. 4.5)

In case of Gram crop results were not found same as that of crop of wheat. In gram phosphorus fertilizer did not support very well when ammended alone. But when when phosphorus fertilizer alongwith N fertilizer, it gave better increments of parameters, but the effect of a combination of all three fertilizer (NPK) gave the best support for fertility of soil. Natural fertilizer compost and khali supported the growth in extraordinary manner. (Fig. 4.5 and 4.6)

With a view, in light of, these results that the phosphorus fertilizer supported the polluted soil to grow both of above crops very well, further experiments were done with ammendment of different quantity of phosphorus fertilizer in polluted soil. Results of which are given in Table 4.5 and Table 4.6.

Results clearly indicate that in wheat crop combination of N and P fertilizer suppressed all the parameters, and P fertilizer when ammended singly supported the growth and yield upto a mark extent. (Fig. 4.7) But in case of gram, P fertilizer supported the growth in a curved manner. Up to 2.0 grams of fertilizer, all the parameters were found in ascending order, but
descending orders were found, as quantities added in higher amounts. It was a combination of N&P fertilizer, which supported the growth of gram crop very better. (Fig. 4.8 and Photograph No. 4.6 and 4.7 and 4.8)

Phosphate fertilizer is a form of soluble phosphorus, when phosphorus is applied to polluted soil, the granules of mono calcium phosphate absorb water from surrounding soil and formed a acidic solution (\(H_2PO_4^-\)). This solution reacts with soil mineral dissolving large amount of \(Ca^{++}\), \(Al^{+++}\), \(Mg^{++}\) and \(Fe^{++}\). Some of these are subsequently precipitated as new compounds with low solubilities (Fig. 4.9). The mobility of phosphate is reducing resulting in its availability of plants. This conversion of water soluble phosphate after reacting with soil constituents and converting into insoluble phosphate is known as fixation thus only 15% to 20% absorption of phosphate take place.

Phosphate fertilizer makes polluted soil supporting plant growth much better than other fertilizer, because that cement dust deposited on the soil removed away phosphorus as soluble phosphate ion and become available for the plant growth by sorption.

It can be suggested that Phosphorus along with nitrogen fertiliser gives better growth to leguminous plant (like gram), because addition of phosphate fertilizer with nitrogen fertilizer increase the nodules proliferations over the roots, because they help in nutrition of bacteria responsible for nodules formation and it helps in fixation of nitrogen.
Table (4.1): Growth of seeds of wheat crop in polluted soil samples collected from various distances of diamond cement factory

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Distance from factory (km.)</th>
<th>No. of seeds sown</th>
<th>percentage germination</th>
<th>Plant height (cm.)</th>
<th>Dry weight of per gram plant (gm.)</th>
<th>No. of seeds per plant</th>
<th>Weight of yield per plant (gm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0.5</td>
<td>50</td>
<td>68.4</td>
<td>38</td>
<td>0.142</td>
<td>18.86</td>
<td>1.715</td>
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<tr>
<td>2.</td>
<td>1.0</td>
<td>50</td>
<td>69.2</td>
<td>37</td>
<td>0.150</td>
<td>19.05</td>
<td>1.769</td>
</tr>
<tr>
<td>3.</td>
<td>1.5</td>
<td>50</td>
<td>74.4</td>
<td>41</td>
<td>0.152</td>
<td>19.55</td>
<td>1.831</td>
</tr>
<tr>
<td>4.</td>
<td>2.0</td>
<td>50</td>
<td>75.6</td>
<td>45</td>
<td>0.148</td>
<td>19.49</td>
<td>1.929</td>
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<tr>
<td>5.</td>
<td>2.5</td>
<td>50</td>
<td>74.8</td>
<td>44</td>
<td>0.162</td>
<td>19.82</td>
<td>1.907</td>
</tr>
<tr>
<td>6.</td>
<td>3.0</td>
<td>50</td>
<td>81.2</td>
<td>46</td>
<td>0.184</td>
<td>20.79</td>
<td>1.954</td>
</tr>
<tr>
<td>7.</td>
<td>3.5</td>
<td>50</td>
<td>82.8</td>
<td>45</td>
<td>0.192</td>
<td>21.05</td>
<td>2.071</td>
</tr>
<tr>
<td>8.</td>
<td>4.0</td>
<td>50</td>
<td>87.2</td>
<td>47</td>
<td>0.196</td>
<td>21.46</td>
<td>2.174</td>
</tr>
<tr>
<td>9.</td>
<td>4.5</td>
<td>50</td>
<td>87.2</td>
<td>51</td>
<td>0.222</td>
<td>22.48</td>
<td>2.264</td>
</tr>
<tr>
<td>10.</td>
<td>5.0</td>
<td>50</td>
<td>89.6</td>
<td>49</td>
<td>0.238</td>
<td>23.01</td>
<td>2.258</td>
</tr>
</tbody>
</table>
Table (4.2): Growth of seeds of gram crop in polluted soil samples collected from various distances of diamond cement factory

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Distance from factory (km.)</th>
<th>No. of seeds sown</th>
<th>percentage germination</th>
<th>Plant height (cm.)</th>
<th>Dry weight of per gram plant (gm.)</th>
<th>No. of seeds per plant</th>
<th>Weight of yield per plant (gm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>0.5</td>
<td>20</td>
<td>62.31</td>
<td>21.7</td>
<td>0.281</td>
<td>20.16</td>
<td>2.545</td>
</tr>
<tr>
<td>2.</td>
<td>1.0</td>
<td>20</td>
<td>64.67</td>
<td>23.4</td>
<td>0.307</td>
<td>22.49</td>
<td>2.612</td>
</tr>
<tr>
<td>3.</td>
<td>1.5</td>
<td>20</td>
<td>65.38</td>
<td>23.2</td>
<td>0.319</td>
<td>23.62</td>
<td>2.827</td>
</tr>
<tr>
<td>4.</td>
<td>2.0</td>
<td>20</td>
<td>66.84</td>
<td>24.5</td>
<td>0.342</td>
<td>23.51</td>
<td>2.914</td>
</tr>
<tr>
<td>5.</td>
<td>2.5</td>
<td>20</td>
<td>71.53</td>
<td>24.3</td>
<td>0.316</td>
<td>25.61</td>
<td>3.022</td>
</tr>
<tr>
<td>6.</td>
<td>3.0</td>
<td>20</td>
<td>74.19</td>
<td>25.4</td>
<td>0.355</td>
<td>25.80</td>
<td>3.156</td>
</tr>
<tr>
<td>7.</td>
<td>3.5</td>
<td>20</td>
<td>75.76</td>
<td>25.6</td>
<td>0.361</td>
<td>26.57</td>
<td>3.672</td>
</tr>
<tr>
<td>8.</td>
<td>4.0</td>
<td>20</td>
<td>78.54</td>
<td>23.5</td>
<td>0.417</td>
<td>29.74</td>
<td>3.954</td>
</tr>
<tr>
<td>9.</td>
<td>4.5</td>
<td>20</td>
<td>84.29</td>
<td>27.2</td>
<td>0.435</td>
<td>30.08</td>
<td>3.846</td>
</tr>
<tr>
<td>10.</td>
<td>5.0</td>
<td>20</td>
<td>84.75</td>
<td>26.5</td>
<td>0.446</td>
<td>31.42</td>
<td>4.067</td>
</tr>
</tbody>
</table>
Table (4.3): Growth of seeds of wheat crop in polluted soil sample amended with different fertilizers.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Type of Fertilizer</th>
<th>Qty. of fertilizer</th>
<th>No. of seeds sown</th>
<th>percentage germination</th>
<th>Plant height (cm.)</th>
<th>Dry weight of per gm. plant (gm.)</th>
<th>No. of seeds per plant</th>
<th>Weight of yield per plant (gm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>10 gm.</td>
<td>50</td>
<td>59.3</td>
<td>43</td>
<td>0.144</td>
<td>21.63</td>
<td>1.914</td>
</tr>
<tr>
<td>2</td>
<td>NPK</td>
<td>10 gm.</td>
<td>50</td>
<td>67.1</td>
<td>49</td>
<td>0.147</td>
<td>23.06</td>
<td>1.983</td>
</tr>
<tr>
<td>3</td>
<td>N</td>
<td>10 gm.</td>
<td>50</td>
<td>67.8</td>
<td>42</td>
<td>0.150</td>
<td>24.65</td>
<td>2.119</td>
</tr>
<tr>
<td>4</td>
<td>NP</td>
<td>10 gm.</td>
<td>50</td>
<td>78.3</td>
<td>44</td>
<td>0.153</td>
<td>24.27</td>
<td>2.087</td>
</tr>
<tr>
<td>5</td>
<td>P</td>
<td>10 gm.</td>
<td>50</td>
<td>83.5</td>
<td>54</td>
<td>0.156</td>
<td>25.04</td>
<td>2.316</td>
</tr>
<tr>
<td>6</td>
<td>K</td>
<td>10 gm.</td>
<td>50</td>
<td>73.4</td>
<td>50</td>
<td>0.141</td>
<td>22.41</td>
<td>1.946</td>
</tr>
<tr>
<td>7</td>
<td>NK</td>
<td>10 gm.</td>
<td>50</td>
<td>72.1</td>
<td>46</td>
<td>0.148</td>
<td>21.74</td>
<td>1.951</td>
</tr>
<tr>
<td>8</td>
<td>Compost</td>
<td>10 gm.</td>
<td>50</td>
<td>85.6</td>
<td>55</td>
<td>0.162</td>
<td>24.96</td>
<td>2.090</td>
</tr>
<tr>
<td>9</td>
<td>Khali (Mustard)</td>
<td>10 gm.</td>
<td>50</td>
<td>73.7</td>
<td>51</td>
<td>0.152</td>
<td>24.18</td>
<td>2.079</td>
</tr>
</tbody>
</table>
Table (4.4) : Growth of seeds of gram crop in polluted soil sample amended with different fertilizers.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Type of Fertilizer</th>
<th>Qty. of fertilizer</th>
<th>No. of seeds sown</th>
<th>percentage germination</th>
<th>Plant height (cm.)</th>
<th>Dry weight of per gram plant (gm.)</th>
<th>No. of seeds per plant</th>
<th>Weight of yield per plant (gm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Control</td>
<td>10gm.</td>
<td>20</td>
<td>74.32</td>
<td>25.7</td>
<td>0.341</td>
<td>25.74</td>
<td>3.044</td>
</tr>
<tr>
<td>2.</td>
<td>NPK</td>
<td>10 gm.</td>
<td>20</td>
<td>82.69</td>
<td>24.9</td>
<td>0.385</td>
<td>27.53</td>
<td>3.247</td>
</tr>
<tr>
<td>3.</td>
<td>N</td>
<td>10 gm.</td>
<td>20</td>
<td>75.82</td>
<td>26.2</td>
<td>0.419</td>
<td>29.15</td>
<td>3.181</td>
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<tr>
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<td>NP</td>
<td>10 gm.</td>
<td>20</td>
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<td>26.4</td>
<td>0.462</td>
<td>31.58</td>
<td>3.469</td>
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<tr>
<td>5.</td>
<td>P</td>
<td>10 gm.</td>
<td>20</td>
<td>77.52</td>
<td>25.6</td>
<td>0.369</td>
<td>26.81</td>
<td>3.212</td>
</tr>
<tr>
<td>6.</td>
<td>K</td>
<td>10 gm.</td>
<td>20</td>
<td>79.56</td>
<td>25.9</td>
<td>0.362</td>
<td>25.38</td>
<td>3.253</td>
</tr>
<tr>
<td>7.</td>
<td>NK</td>
<td>10 gm.</td>
<td>20</td>
<td>80.36</td>
<td>26.1</td>
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<td>29.35</td>
<td>3.225</td>
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<tr>
<td>8.</td>
<td>Compost</td>
<td>10 gm.</td>
<td>20</td>
<td>86.54</td>
<td>26.3</td>
<td>0.391</td>
<td>30.75</td>
<td>3.413</td>
</tr>
<tr>
<td>9.</td>
<td>Khali (Mustard)</td>
<td>10 gm.</td>
<td>20</td>
<td>85.39</td>
<td>26.0</td>
<td>0.379</td>
<td>29.84</td>
<td>3.382</td>
</tr>
</tbody>
</table>
Table (4.5) : Effect of different quantity of super phosphate on the growth of wheat crop grown in cement dust polluted soil

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Quantity of seeds (gms.)</th>
<th>Quty. of fertilisers (gm.)</th>
<th>Name of fertiliser used</th>
<th>Height of plant (cm.)</th>
<th>Yield (gm.)</th>
<th>No. of trees</th>
<th>No. of seeds per plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1st month</td>
<td>2nd month</td>
<td>3rd month</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>2</td>
<td>Nil</td>
<td>None</td>
<td>14.5</td>
<td>30.8</td>
<td>46.5</td>
<td>4.430</td>
</tr>
<tr>
<td>2.</td>
<td>2</td>
<td>0.5+0.5 N</td>
<td>P&amp;N</td>
<td>17.1</td>
<td>32.3</td>
<td>45.2</td>
<td>3.500</td>
</tr>
<tr>
<td>3.</td>
<td>2</td>
<td>1.0</td>
<td>P</td>
<td>16.8</td>
<td>36.5</td>
<td>54.3</td>
<td>5.750</td>
</tr>
<tr>
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<td>2</td>
<td>1.5</td>
<td>P</td>
<td>16.5</td>
<td>35.4</td>
<td>50.7</td>
<td>5.530</td>
</tr>
<tr>
<td>5.</td>
<td>2</td>
<td>2.0</td>
<td>P</td>
<td>16.0</td>
<td>30.7</td>
<td>48.6</td>
<td>5.600</td>
</tr>
<tr>
<td>6.</td>
<td>2</td>
<td>2.5</td>
<td>P</td>
<td>17.5</td>
<td>38.5</td>
<td>51.2</td>
<td>4.6500</td>
</tr>
<tr>
<td>7.</td>
<td>2</td>
<td>3.0</td>
<td>P</td>
<td>22.5</td>
<td>42.1</td>
<td>57.2</td>
<td>9.500</td>
</tr>
<tr>
<td>8.</td>
<td>2</td>
<td>3.5</td>
<td>P</td>
<td>22.5</td>
<td>42.3</td>
<td>57.1</td>
<td>9.512</td>
</tr>
</tbody>
</table>
Table (4.6): Effect of different quantity of super phosphate on the growth of gram crop grown in cement dust polluted soil

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Quantity of seeds (gms.)</th>
<th>Quantity of fertilisers (gm.)</th>
<th>Name of fertiliser used</th>
<th>Height of plant (cm.)</th>
<th>Yield (gm.)</th>
<th>No. of trees</th>
<th>No. of seeds/plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1st month</td>
<td>2nd month</td>
<td>3rd month</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>2</td>
<td>Nil</td>
<td>None</td>
<td>7.3</td>
<td>14.9</td>
<td>23.4</td>
<td>27.61</td>
</tr>
<tr>
<td>2.</td>
<td>2</td>
<td>0.5+0.5</td>
<td>N&amp;P</td>
<td>8.1</td>
<td>15.5</td>
<td>26.9</td>
<td>33.79</td>
</tr>
<tr>
<td>3.</td>
<td>2</td>
<td>1.0</td>
<td>P</td>
<td>7.4</td>
<td>14.5</td>
<td>24.1</td>
<td>28.53</td>
</tr>
<tr>
<td>4.</td>
<td>2</td>
<td>1.5</td>
<td>P</td>
<td>8.3</td>
<td>13.5</td>
<td>24.7</td>
<td>32.33</td>
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<tr>
<td>5.</td>
<td>2</td>
<td>2.0</td>
<td>P</td>
<td>8.1</td>
<td>17.5</td>
<td>25.8</td>
<td>33.81</td>
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<tr>
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<td>2</td>
<td>2.5</td>
<td>P</td>
<td>7.2</td>
<td>14.0</td>
<td>25.2</td>
<td>30.58</td>
</tr>
<tr>
<td>7.</td>
<td>2</td>
<td>3.0</td>
<td>P</td>
<td>69</td>
<td>13.8</td>
<td>24.8</td>
<td>29.85</td>
</tr>
</tbody>
</table>
Fig. 4.1: Percentage germination of different crops in cement dust polluted soil collected from various distances.

- Wheat
- Gram

Distance (km)

Percentage

0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5 5.0
Fig. 4.2: Seed production of different crops in cement dust polluted soil collected from various distances.
Fig. 4.3: Yield of different crops in cement dust polluted soil collected from various distances.
Fig. 4.4: Percentage germination of different crops in cement dust polluted soil amended with various fertilizers.
Fig. 4.5: Seed production of different crops in cement dust polluted soil amended with various fertilizers.
Fig. 4.6: Yield of different crops in cement dust polluted amended with various fertilizers
Fig. 4.7: Effect of different quantity of super phosphate on the yield of wheat crop grown in cement dust polluted soil.
Fig. 4.8: Effect of different quantity of super phosphate on the yield of gram crop grown in cement dust polluted soil.
Fig. 4.9: Action of superphosphate in soil.
Photo. (4.1): Pot experiment showing the growth of wheat crop grown in different cement dust polluted soil samples collected at various distances.

Photo. (4.2): Pot experiment showing the growth of gram crop grown in different cement dust polluted soil samples collected at various distances.
Photo. (4.3): Photograph showing growth of wheat crop in a field near Diamond Cement Factory, Narsingarh plant. (2.0 Km.)

Photo. (4.4): Photograph showing growth of gram crop in a field near Diamond Cement Factory, Narsingarh plant. (2.0 Km.)
Photo. (4.5): Photograph showing growth of wheat in cement dust polluted soil amended with different fertilizer.

Photo. (4.6): A typical view of growth of wheat in cement dust polluted soil amended with compost and Khali.
Photo. (4.7): Photograph growth of wheat in cement dust polluted soil amended with different quantity of phosphate fertilizer.

Photo. (4.8): Photograph growth of gram in cement dust polluted soil amended with different quantity of phosphate fertilizer.
REFERENCES


