INTRODUCTION

The blanket of air enveloping the Earth, moderates the Earth's temperature. This blanket is made up of almost entirely by two major gases, the nitrogen and oxygen with some minor gases, such as water vapour, carbon dioxide, nitrogen oxide, methane, rare gases etc. Annual average temperature of the earth remains almost constant because the incoming heat is balanced by the outgoing heat. However, the earth will exhibit rapid cooling in the absence of the atmosphere. The rapid cooling is prevented because some of the minor atmospheric gases, including those of natural origin and some produced by human activities, are relatively transparent to incoming short-wave radiations from the sun, but are opaque to longer wave length infrared radiation arising from the Earth's surface and lower atmosphere. This mechanism of control has been termed the "green house effect", since it is similar to the processes which occur in a green house where the glass envelope acts like a compressed atmosphere. The heat balance of earth is now changing. The amount of outgoing heat is slightly lesser than the incoming heat causing increase in the temperature of the atmosphere, a phenomenon called the "global warming" (Whilmore, 1991).

The term "Green House Effect" was first coined by J. Fourier in 1827. (In : Sharma and Kaur, 1994-95, p 110) Global warming or green house effect is caused by the increase in concentration of a number of minor gases in the earth's atmosphere which are increasing at an alarming rate in recent decades. These gases include water vapour, carbon dioxide, methane, nitrogen oxides, carbon monoxide, sulphur dioxide, ozone and chlorofluorocarbons. Together they are known as green house gases. Out of all these gases, Carbon dioxide is the most important green house gas accounting for 50-60% of the global warming.

These green house gases have various sources of their origin. Methane is mostly produced by anaerobic decomposition of biological materials. It is released from swampy rice fields, landfills and from the guts of cud-chewing cattle and wood eating termites. Nitrogen
Oxides are the pollutants spewed out of automobile exhausts and smokestacks of power plants. Sulphur dioxide is released by the combustion and decomposition of sulphur containing substances. Carbon monoxide is not generally considered a greenhouse gas. But it influences the oxidising capacity of the atmosphere and contributes to an increase in the concentration of CH₄ and N₂O. Incomplete combustion and slow smouldering of gasses generates CO. Ozone occurs only in traces at the ground level. Chlorofluorocarbons (CFCs) are used in refrigerators, air conditioners, foam-packing, solvents and aerosols. Their concentration is increasing by more than 5% annually.

The greenhouse effect is likely to result in rise in atmospheric temperature because of which there would be melting of Arctic and Antarctic ice caps leading to a rise in sea level. There are various estimates on the rise in sea level ranging from one meter to three metres depending upon the extent of the rise in atmospheric temperature.

Balling Jr of Arizona State University has recently suggested that the increase in surface air temperature in desertified regions caused by change in land cover characteristics is sufficient to significantly "contaminate" the global mean temperature record (Kelly and Hulme, 1993).

The possible impacts of a climate change, alone, particularly higher temperatures, are generally expected to reduce production. Increase of CO₂ in the atmosphere can enhance plant growth in a number of ways: it can increase the rate of photosynthesis, leading to greater leaf expansion and a larger canopy and it can reduce water losses from plants. Due to doubling of CO₂ there would be 10-15% increase in dry matter production (Parry et al., 1990). Higher levels of atmospheric CO₂ will lead to increased efficiency of water use by reducing transpiration rates.

Changes in weather could affect agriculture through changes in the length of the growing season, changes in crop yields and geographical shifts in agricultural potential. Agricultural potential at mid-latitudes generally decreases towards the poles, due to smaller
thermal inputs, so the same increases of temperature will have greater relative effects on crop potential at higher latitudes than at lower latitudes. In addition, because the size of CO₂-induced temperature increases is likely to be greater at higher latitudes, substantial effects on crop potential can be anticipated in far northern regions. Agricultural production is affected by numerous ways by climate change, soil erosion, salinization, nutrient loss, changing the pests and diseases (Parry et al., 1990).

The C₄ grassland dominated from 30,000 to 8,000 yr BP, but was replaced around 8,000 yr BP by a C₃ dominated flora (probably desert shrubland). This C₄ to C₃ shift was caused by an increase in atmospheric CO₂ concentration from 200 - 280 p.p.m. v. during the late Quaternary (Boutton et al., 1994).

A change in atmospheric CO₂ from 200 to 280 p.p.m. v. significantly increases photosynthesis, water use efficiency and biomass production of C₃ species at the leaf and whole plant levels. However, even at the present CO₂ concentration of 350 p.p.m. v. C₄ species still have quantum yields, photosynthetic rates and water use efficiencies comparable to or greater than those of coexisting C₃ plants. Some C₄ species also show enhanced carbon and water relations and increased growth with increasing CO₂. In addition, net photosynthesis by C₃ plants is reduced 25-40% by photorespiration under present atmospheric CO₂ and O₂ concentrations. This reduction may have been greater during the late Quaternary when the CO₂/O₂ was lower than at present. Thus, although carbon and water relations of C₃ plants may have improved as CO₂ increased from 200 to 280 p.p.m. v. during the late Quaternary, ecophysiological evidence does not suggest this increase in CO₂ would have shifted competitive interactions to promote replacement of C₄ grassland by C₃ desert shrubland (Boutton et al., 1994).

Atmospheric CO₂ is only one of many environmental factors that can influence plant communities, and direct effects of CO₂ on leaf and whole plant ecophysiology may be poor predictors of community, ecosystem or a regional vegetation composition and dynamics.
Crop productivity (both the quantity and quality of the output) in any location depends on a complex combination of climate, biophysical factors and management.

Temperature frequently plays a dominant role in the distribution and development of insect pests, therefore any increase in temperature will have a significant effect on such pests and their interaction with agricultural crops. A number of important effects of global warming on insect pests have already been identified. These include: increase in the rate of development and the number of the generation produced per year, extension of the geographical range beyond the margins of distribution, earlier establishment of pest populations in the growing seasons and an increase in the risk of invasion by migrant and exotic species. Many of these factors could lead to increase in pest density and damage. Shifts in agricultural potential which could enable the production of new crops in regions may also encourage the introduction of pest species (Parry et al., 1990).

The Earth's average surface temperature was higher in 1995 than any other year on record, possibly a sign of global warming.

According to Jones's preliminary data, which he compiled with the U.K.'s meteorological office in Bracknell, the 1995 global temperature was 0.04°C higher than of 1990 (Kerr, 1995). An analysis of data collected at 2,000 meteorological stations around the globe found. 1990 was the warmest year in records dating back to 1880 with temperature averaging 15.4°C. That represent a 0.25°C rise in average global temperature from 1989 and an increase of 4.10°C over the average from 1951 to 1980. The warmest year before 1990 was 1988 when temperature averaged 15.3°C. The record certainly is a supporting evidence for global warming. Global temperature would increase by about one degree celsius by 2025 and three degree celsius by 2100. The world would be warmer by two degree celsius by 2030 and that could vary between 1.4°C and 2.8°C. The rise would be about 4°C in hundred years but could be between 2.6°C and 5.8°C.

According to scientists specialising in environmental studies, the eighties turn
out to be the earth’s warmest decade since meteorological records began in the mid nineteenth century. Since 1900, average temperature have risen by about 0.5°C. Climatologists predict that by mid way through the next century temperature may rise as much as 4°C. They found 1989 was 0.23°C above the 1951 to 1980 average, while 1988 was 0.31°C higher, the hottest years of the eighties.

Global warming is likely to disrupt circulation patterns in the atmosphere and oceans, which play a key role in determining climate. With the changes in global temperature, there will be changes in precipitation. At latitudes and high mid latitudes (i.e. over 45°N and S) rainfall may increase by 5% in summer and possibly up to 15% in winter (Jager, 1988). At lower mid latitudes (30°-40° N and S) summer rainfall is likely to become very limited and winter rainfall may decrease by about 5-10%. At low latitudes (0°-30° N and S) rainfall is expected to be enhanced by about 5-10%. Increase in potential evapotranspiration can be expected to accompany the increase in temperature.

The profound effect that weather can have on agricultural crops can be seen in the common year to year fluctuations in yields. Frosts, excess rain, high temperatures during ear growth or grain growth, cool temperatures during the growing period, drought during grain filling and wet weather at harvest will all affect the yield adversely. Thus, any change in climate which alters the frequency, intensity or timing of such events could have a substantial effect on agriculture.

Heavy metals are the metals having a density at least five times higher to that of water. Generally metals having density more than 6 gm cm³ and atomic number more than 23 are regarded as heavy metals. Their common features in relation to biological life is that in excess quantities they are poisonous and cause death. They contaminate the environment (Misra and Mani, 1992).

Soil is a major store house for nutrients, including the heavy metals. Most heavy metals occur naturally in soil as rare elements, but, Heavy metals as pollutants have attracted
a great deal of attention after the much talked about Minamata and Itai-Itai diseases. Toxic levels of metals in soil may be caused by agricultural manufacturing, ore processing, smelting, mining, refining operations and waste disposal practices, etc. These processings can cause the dispersion and deposition of large quantities of trace metals into surrounding due to indirect or direct discharge into environment. Metal emission from the combustion of fossil fuels are also a major source of air borne metals. The burning of lead fuels contributes significantly to urban lead deposition. About 10% of the chemicals approved for use as insecticides and fungicides in the U.K. are based on compounds which contain some heavy metals (Mitchell, 1964). The continued use of lead arsenate as an insecticide has also given rise to increased concentrations of Pb in the surface soils (Brewer, 1966 and Chisholm, 1972). Large quantities of fertilizers are regularly added to the soil. The compounds used to supply these elements contain trace amounts of heavy metals as impurities which, after continued fertilizer application, may significantly increase their content in the soil. Certain phosphatic fertilizers frequently contain trace amount of Cd (Swaine, 1962). Many trace metals are discharged into the environment through effluent as well as the dumping and leaching of sludges.

Agricultural soils may become enriched with trace metals from plant-residues, phosphatic fertilizers, specific herbicides and fungicides and through the use of sewage effluent or sludge as a plant nutrient source (Misra and Mani, 1992).

Heavy metals are known to form stable complexes or chelates with a variety of compounds, the average stability of which is, electronegativity of metals. Interactions of metals are of equal importance as deficiency and toxicity in the physiology of plants. Interaction between chemical elements may be both antagonistic and synergistic. Their imbalanced reactions may cause a real chemical stress in plants. Interaction may result interference with normal metabolic function of another nutrient when plants absorbs large amount of unavailable nutrient and its concentration in the plant reaches excessive or toxic levels. It interferes with normal metabolic function of another nutrients (Misra and Mani, 1992).
Toxic heavy metals are present at less than 0.01% level in the earth's crust, but human activities add up to the natural background levels of these elements. The fate of a heavy metal added to a soil are controlled by a complex set of chemical reactions and by a number of physical and biological processes acting within the soil. Although in some respects the chemical behaviour of different metals may be similar, but there is no overall uniformity. Their initial mobility after addition to soils will largely depend on the form in which the heavy metals are added, this in turn, depends on their source. A high concentration of heavy metals in soils will not only reduce the plant growth but will also affect the availability of other essential element to plants. Following is a brief introduction about the heavy metals taken for present studies.

Acute and chronic copper intoxication is not a significant problem today, largely because present-day manufacturing processes and uses of copper have reduced its potential as a major environmental contaminant. Copper comprises about 0.007% of the earth’s crust. Some copper occurs as native copper, while some occurs as sulfide ores. Copper is widely used in alloys, and is also widely used in copper wire, sheet and strip and in standard electrolytic copper. The major portion of the world’s production of copper is utilized by the electrical industries in generators, light bulbs, telephones and telegraphs, light and power lines and other rods and wires (Shamberger, 1979).

Copper is essential to plants, for the synthesis of chlorophyll and for the functioning of certain enzymes. Yet at slightly higher levels, it can be more toxic to plants than any other heavy metal except Hg. Copper is present in several enzymes or proteins involved in oxidation and reduction. Two notable examples are cytochrome oxidase, a respiratory enzymes in mitochondria and plastocynin, a chloroplast protein. Copper is absorbed both as the divalent Cu^{2+} (Cuprous) ion in aerated soils or as the monovalent Cuprous ion in wet soils with little oxygen (Misra and Mani, 1992). Plants are rarely
deficient in copper, mainly because they need so little of it, and it is sufficiently available in nearly all soils (Espein, 1972). The available and total status of copper in soils of Raipur Tahsil ranged between 0.6 to 7.7 mg kg⁻¹ and 32.1 to 48.6 mg kg⁻¹, respectively.

The principal ore of zinc is sphalerite (largely ZnS). Zinc is present in the earth's crust at a level of about 50 ppm. The main uses of zinc are in the manufacture of galvanized iron, bronze, paint (white), rubber, glazes, enamel, glass, paper and as a wood preservative (ZnO₂, fungicidal action). Zinc is also contained in medicinal preparations of insulin and in zinc bacitracin. The total exposure to zinc is increased through the widespread use of zinc undecylenate (preparations for athletes foot) and zinc pyridinethione in antidandruff shampoos.

Zinc has a ubiquitous distribution and is an essential trace element. Zinc is present in a number of metalloenzymes, including carbonic anhydrase, carboxypeptidase, alcohol dehydrogenase, glutamic dehydrogenase, lactic dehydrogenase and alkaline phosphatase. About 100 years ago, Raulin (1869) showed that zinc was essential in the nutrition of Aspergillus niger. In 1926, zinc was found to be essential for the higher forms of plant life (Sommer and Lipman, 1926).

Foods vary greatly in zinc content. White sugar, pome and citrus fruits are among the lowest in zinc content (less than 1 ppm). Wheat germ and bran (40 - 120 ppm) and oysters, which may contain over 1000 ppm Zn, are among the richest source of EDTA and are used in some canned food to reduce deterioration from heavy metals and may affect zinc availability.

As early as 1939, zinc was found to be a constituent of the enzyme carbonic anhydrase. Zinc is involved in a wide range of metabolic activities and is vitally concerned with RNA and protein synthesis and metabolism in plants and microorganisms. Zinc is absorbed as divalent (Zn²⁺) ion probably often from zinc chelates. Disorders caused by zinc deficiency include "little leaf" and "roselle" of apples, resulting from growth reduction of young leaves and stem internodes. Leaf margins are often distorted and puckered in appearance. Intervenial
chlorosis often occur in leaves of maize, sorghum, beans and fruit trees, suggesting that zinc participates in chlorophyll formation or prevents chlorophyll destruction. The retardation of stem growth in its absence might result partly from its apparent requirement to produce a growth hormone, indoleacetic acid (auxin) (Steward, 1963). Many enzymes contain tightly bound zinc essential for their function, considering all the organisms, more than eighty such enzymes are known (Vallee, 1972).

The available, and total status of zinc in the soils of this region lie in the range of 0.2 to 5.5 mg kg⁻¹, and 19.0 to 40.0 mg kg⁻¹.

Nickel occurs in the earth's crust at a level of about 80 ppm. The main uses of nickel are in electronics, coins, steel alloys, batteries, food processing, stainless steel etc. Nickel is also used as a catalyst in the hydrogenation of fats and oils. Nickel is a constituent of urban air, possibly as a result of fossil fuel combustion, with incinerators contributing to the nickel content in the atmosphere. The average concentration in U.S. urban air was found to 0.034 µg/m³ (Vittorio and Wright, 1963). Nickel is not a normal constituent of water, while some nickel is found as a contaminant from food processing (gelatin and baking powder), and relatively large amounts occur naturally in vegetables like legumes and grains.

Nickel is widespread in its occurrence and is distributed widely in foods. Vegetable material contains much nickel than material from animal origin. Estimates of from 0.15 to 0.35 ppm. Nickel have been made for fruits, tubers and grains. Some items high in nickel are tea (7.6 ppm) and buckwheat seed.

Nickel activates several enzyme systems including arginase (Hellerman & Perkins, 1935), acetyl coenzyme A synthetase (Speck, 1949), carboxylase (Webster, 1965), trypsin (Sugai, 1944) and phosphoglucomutase (Ray, 1969).

The available, and total level of Ni in soils of this region were varied from 0.1 to 13.8 mg kg⁻¹ and 10.5 to 50.4 mg kg⁻¹, respectively.
Common sources of lead (Pb) in the environment are Pb-based pigments in paints, Pb-containing pesticides, discarded wet cell batteries, etc. Some organic forms of Pb, especially tetraalkylleads, are used as gasoline antiknock agents. Lead in gasoline, accounting for 20% of Pb used by mankind, is responsible for about 98% of the pollution problems caused by Pb. Inorganic lead is less toxic to aquatic plants than copper. Leafy vegetables are likely to absorb more lead, whereas fruiting crops. It is not wise to grow carrots, turnips, beetroot and sprouts in cities, especially near the main roads and highways because of lead contamination from vehicular exhausts (Misra and Mani, 1992).