GENERAL INTRODUCTION
Soil is the basis of all our sustenance. From the dawn of civilisation to this day it has exerted a tremendous influence on humanity. The relationship between the productivity of land and the prosperity of a nation has been reflected in the history of mankind whereas soil deterioration has been a primary cause in the decline of civilizations.

As with all objects of nature our concept of soils has been changing with the accumulation of knowledge about them. To the early speculative philosophers the nature of soil was veiled in mystery - something containing unknown vital self that gave life. Soil, which predominantly contains particles initially derived from the disintegration or decomposition of primary igneous rocks, is a dynamic object undergoing various changes due to continuous operation of a number of factors like climate, vegetation, relief, age and parent material. Study of soil may be undertaken from two standpoints, first as being a natural entity or body and then studied with respect to its origin, morphology and classification without any specific regard to its agricultural use. In the second place, soil may be looked upon from the standpoint of being a medium for plant growth consisting of three phase systems and having in addition a "living phase" represented by bacteria and micro-organisms. Soil is, thus, an intricate dynamic system
and to understand how a fertile soil may function requires much study.

A good or fertile soil must, therefore, provide an anchorage and aeration for plant roots, store and deliver enormous amounts of water to the growing plant and also serve as a frugal custodian of nutrient elements. Fertility of soil is its ability to produce a large amount of crop throughout a series of years. It is an expression of the present condition of soil and different factors of soil dynamics, such as climatic condition, topographical situation, the physical condition of soil, its chemical composition, the content of organic matter and the micro-organisms, each singly and in combination, contribute towards soil fertility.

It is not surprising, therefore, that thoughtful men throughout the course of human history have interested themselves deeply in the study of soil in relation to plant growth and thus have slowly built up a certain amount of knowledge for dealing with them.

Francis Bacon, Lord Verulam and Van Helmont regarded water as the "principle nourishment" of plants, the purpose of soil being to keep them upright and protect them from excessive heat or cold. J.R. Glauber, supported by
John Mayow's experiments, put forward the hypothesis that salt-petre is the "principle" of vegetation. From various publications Woodward concluded that, "vegetables are not formed of water, but of a certain peculiar terrestrial matter -- from all of which we may reasonably infer that earth, and not water, is the matter that constitutes vegetables". However, Tull in 1731 published that nitre, air, fire and earth contributed in some manner to the development of plants. The above authors were the supporters of the "salt theory" advocated by Paracelsus.

Meanwhile a new theory of plant nutrition by soil organic matter, originated by Aristotle, was supported and upheld by a group of distinguished authors of that time. Francis Home, Wallerius and Thaer discussed the true nature and importance of humus. The Earl of Dundonald stressed not only upon the role of humus but also upon the added alkaline phosphate to the list of nutritive salt.

The foundation of soil science was laid by Boussignault in France and Lawes and Gilbert in England who concentrated on establishing facts by careful experiments in field plots and pots, with chemical analysis of soils, manures and crops. Lawes and Gilbert demonstrated the striking
effects of ammonium salts as fertilizers and as early as 1846 Lawes had concluded that, "Until Chemistry has solved the great problem of uniting hydrogen with nitrogen, and can furnish us with a cheap supply of ammonia, the employment of artificial fertilizers must be confined to one or two crops ". Liebig, on the other hand, was convinced that it was impossible to make significant quantities of ammonium salts, and that in any case they were unnecessary. Even in 1863 he wrote, "Though manufacturers of manures add a certain amount of ammonia to their products, this is chiefly to humour the fancy of farmers for this substance -----. This prejudice will soon disappear of it--self when farmers have learnt to make a proper use of nitrogen which nature supplies spontaneously to the land without any aid on their part ".

Following these pioneering researches which stimulated discussions and controversies by expounding new interpretations a band of workers were attracted to the problem of fertility of soil and increase in crop-production. Various theories were put forward in early times but it is now well established that out of a large number of nutrient elements nitrogen, phosphorus, potassium, calcium and organic matter - along with various other micro-elements contribute largely towards the fertility of soils.
In India where agriculture is the basic industry and nearly 70 per cent of the population live by it, the average yields of crops per acre are the lowest as compared to those obtaining in other countries of the world. The level of productivity in Indian soils has gone much below the normal due to continuous cropping accompanied by such other unchecked, injurious factors as leaching, erosion, physical, chemical and biotic factors. The immediate remedy sought to this can only be the application of adequate amounts of fertilizers, both inorganic and organic, combined with improved and systematic agricultural practices.

The chemists and agriculturists, from the time immemorial (Bernard Palissy, 1510 - 1589), were conscious of the importance of soil nitrogen in crop production. The French chemist Boussingault held the view that, "Nitrogen is the element of highest importance, which is necessary to increase and conserve in manure. The organic substances that are most advantageous for producing fertilizers are precisely those which give birth, by their decomposition, to the largest amount of nitrogenous bodies, whether soluble or volatile. But while admitting the importance, the absolute necessity even, of nitrogenous principles of fertilizers, we should not conclude that these principles are the only ones that contribute to fertilize soil."
Most of the organic nitrogen in soils probably remains in the same state of combination over a long period of the years. Nitrogen in this form, nevertheless, constitutes a reservoir for continued removals and additions in nitrogen cycle. In a given environment, the amount of nitrogen present in available form at any particular time tends to increase with the supply of nitrogen in the reservoir. It is, therefore, of concern whether the total nitrogen content is low or high or whether the current management practices in a particular instance are causing a decrease or increase.

Majority of tropical soils, to which Indian soils are no exception, are poor in nitrogen content. From the results of analysis of Indian soils, J.A. Voelcker\textsuperscript{285} concludes that with the exception of black cotton soils, Indian soils are generally deficient, both in organic matter and nitrogen. The Royal Commission on Agriculture in India\textsuperscript{9} also states, "Of principle food materials in which the soils of India are deficient, by far the most important is nitrogen and the manurial problem in India, is in the main one of nitrogen deficiency".

To overcome the deficiency of nitrogen and increase the productivity, the main line of action adopted in all
countries is to add artificial manures mainly consisting of ammonium salts to the soil. Even though the addition of these salts increases the crop production, results of experiments at agricultural stations at Rothamsted\textsuperscript{233}, Cornell\textsuperscript{298}, Kansas\textsuperscript{204}, and other places\textsuperscript{170,178} show that a good part of ammonium salts thus added is lost without being of use to the plants. Russell has obtained the following results with one Cwt. per acre of ammonium sulphate added to soil:

<table>
<thead>
<tr>
<th>Crop</th>
<th>Average Crop Yield</th>
<th>Percentage of Nitrogen Recovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat grain straw</td>
<td>4.5 Bushels, 5.0 Cwt.</td>
<td>39.0</td>
</tr>
<tr>
<td>Barley grain straw</td>
<td>6.5 Bushels, 6.5 Cwt.</td>
<td>47.5</td>
</tr>
<tr>
<td>Oats grain straw</td>
<td>7.0 Bushels, 6.0 Cwt.</td>
<td>46.5</td>
</tr>
<tr>
<td>Potatoes</td>
<td>20.0 Cwt.</td>
<td>50.0</td>
</tr>
<tr>
<td>Swedes</td>
<td>20.0 Cwt.</td>
<td>35.0</td>
</tr>
</tbody>
</table>

The above findings very well establish that recovery of added nitrogen is usually 40 - 50\% and nitrogen is lost from the soil. Often the loss of nitrogen from artificial manures may be more than 50 per cent as indicated by the following observation of Russell, "Crops that respond to nitrogen manuring commonly take up and fix in their mature tissue between one-third and one-half of nitrogen added as
sulphate of ammonia --- the remainder is lost to the crop, and usually to the soil, probably being washed off into the subsoil during wet weathering". The experiments of Lipman and Blair\textsuperscript{160} at California experimental station also recorded a loss of 133 lbs of nitrogen from 1600 lbs of cropped lands and 12.4 lbs from the same quantity of uncropped land. Snyder and Hummel\textsuperscript{263} in Minnesota observed a loss of 26% of nitrogen.

The above observations regarding the loss of nitrogen are not restricted to the fertilized soil alone. Virgin soils, when broken, tilled and exposed to air gradually lose a part of their nitrogen content whether cultivated or not. Megitt\textsuperscript{188} reported considerable losses of nitrogen in humid soils of Assam. Snyder's\textsuperscript{262} study of Minnesota soils and the studies of Kansas soils by Swanson\textsuperscript{269} and Gainey\textsuperscript{106} also recorded losses of nitrogen. F.E. Shutt\textsuperscript{257} has given a very clear proof of the loss of nitrogen on breaking up prairie lands of America.

All these observations lead to the conclusion that nitrogen is being continuously lost from cultivated soils to which large amounts of synthetic nitrogenous fertilizer or organic matter are added and even from the soils which are only broken and tilled for cultivation.

Various theories have been put forward to explain the
universal loss of nitrogen but none is satisfactory. Collison and Mensching\textsuperscript{54} observed that in small losses due to leaching more than 99 per cent of nitrogen leached out is in the form of nitrate, while Russell\textsuperscript{233} is doubtful about the losses due to leaching and states that other causes are responsible for the major loss of nitrogen. Lipman and Conybeare\textsuperscript{171} observed that erosion losses of nitrogen are more serious than those of other elements. Meiklejohn\textsuperscript{189}, Niklewski\textsuperscript{207}, Delwiche\textsuperscript{67}, Russell and Richards\textsuperscript{242} uphold that bacteria is the sole cause of this loss whereas N.W. Barritt\textsuperscript{19}, Williams and Sturgis\textsuperscript{297} indicate the possibility of a chemical phenomenon in such losses. Dhar and coworkers\textsuperscript{74,77,81,85} put forward a photo-oxidation theory of decomposition of nitrogenous fertilizers and manures added to the field. According to this theory loss of nitrogen has been explained to take place through the formation of an unstable intermediate compound, ammonium nitrite, in the system.

Thus, it is seen that nitrogen is being continuously lost from the soils, although the true mechanism is not fully known. If there were no natural processes by which the content of combined nitrogen in soils could be increased, at the expense of elemental nitrogen, crop production on unfertilized soils eventually would cease for lack of available nitrogen. The
fact that long-continued removal of nitrogen from unfertilized soils does not exhaust, but merely reduces the nitrogen content of the soil to a low and stable level, indicates that processes of combined nitrogen addition are in operation. Continued researches on nitrogen-economy experiments have established that the stock of combined nitrogen is due to various physical, chemical and physiological factors.

Soils may gain combined nitrogen by four generally recognized processes. They are addition in rainfall, symbiotic nitrogen fixation, non-symbiotic nitrogen fixation and fertilization.

Small amounts of nitrogen are brought down every year during rainfall. Lightning discharges unite nitrogen and oxygen to form oxides of nitrogen. The latter may decompose or unite with water and reach the soil in rain or snow. In addition, a small amount of nitrogen is added in ammoniacal and organic forms present in the atmosphere in dust and gaseous contaminations.

In 1862 Jodin demonstrated the first real biochemical evidence of the phenomenon of nitrogen fixation. Some of the micro-organisms work symbiotically with plants while others are non-symbiotic. The researches of Hellriegel
and Wilfarth\textsuperscript{126}, Schloessing and Laurent\textsuperscript{247}, the isolation of \textit{Bacillus radicicola} or \textit{B. rhizobia} by Beijerinck\textsuperscript{26} revealed the true nature of symbiotic nitrogen fixation. The most important group of non-symbiotic bacteria, Azotobacter, and particularly \textit{Azotobacter chroococum}, discovered by Beijerinck\textsuperscript{27} have been found to be quite commonly distributed in soils. Another group of non-symbiotic nitrogen fixing bacteria of the anaerobic type - \textit{Clostridium pastorianum} - was discovered by Winogradsky\textsuperscript{299} in 1893. Koch et al\textsuperscript{159} and Koch\textsuperscript{160} have described that substantial amounts of nitrogen may be fixed non-symbiotically when the supply of mineral nitrogen is deficient and the supply of carbohydrate is ample. In tropical countries like India, Azotobacter can most efficiently bring about nitrogen fixation non-symbiotically as the activity of \textit{C. pastorianum} will be inhibited due to aerobic conditions prevailing in the cultivated lands.

In order to give a satisfactory explanation for the fixation of nitrogen in tropical soils, where the climatic conditions are not so favourable for the growth of bacteria, Dhar\textsuperscript{71} put forward the photo-chemical theory. He postulates that the cellulosic substances and other carbonaceous materials undergo slow oxidation in presence of sunlight. The energy thus liberated is utilized in the fixation of atmospheric nitrogen. According to him this phenomenon takes place even
in sterile soils, thereby showing it to be independent of Bacteria. G. Bjalfve of Royal College of Sweden and G. Torestensson of Uppsala have confirmed Dhar's photo-chemical theory of the fixation of nitrogen in soils.

The solution of nitrogen problem lies in the conservation of the nitrogen compounds of the soil through the prevention of drainage losses, in the return of the nitrogen contained in the manures from the excreta of the animals which are fed on the crops that are grown, in taking advantage of the nitrogen-fixing capacities of symbiotic and non-symbiotic bacteria in soils, and in such supplemented applications of commercial nitrogen as economic conditions may warrant. Thus, the development of agriculture is largely dependent on the cheap production of nitrogen in a form available for plant food. The application of limestone, the use of potassic and phosphatic fertilizers, the ploughing under of organic matter, are known to be effective in increasing the yields of ordinary crop plants and a part of their effectiveness lies in their stimulating influence on the process of nitrogen fixation in soil.

Soil scientists have, for a long time, been emphasizing the importance of phosphates and the vital role they play in improvement and maintenance of soil fertility. The use of bones, fish, guano and pigeons dung etc., as fertilizers
is a very ancient practice. In recent years the use of different phosphatic fertilizers - superphosphate, phosphate rock, basic slag and different soluble phosphates - is steadily increasing.

Bears23, while emphasizing the importance of phosphates, states, "Within limits, phosphatic fertilizers together with potash salts and lime can be substituted for nitrogen fertilizers." Russell237 has stressed the importance of phosphates by stating, "Phosphate exhaustion was the most serious occurrence because there was no way of meeting it, and as the original supplies were not as a rule very great, it must have been acute by the end of the eighteenth century in England, for remarkable improvements were, and still are, effected all over the country by adding phosphates. Then began a process, which has gone to an increasing extent ever since, of ransacking the whole world for phosphates; at first the search was bones, even the old battle fields not being spared, -- -- phosphate applied to the soil may determine the course of history in near future." Collings52 has also stated, "Low crop yields are more often due to lack of phosphoric acid than to a lack of any other nutrient. Phosphoric acid has been called 'Master Key' to agriculture."

The phosphorus content in soils may be divided into two broad categories, organic and inorganic. The proportionate
amounts of phosphorus present in these two categories vary widely. The extreme values reported in literature for surface and samples of soils range from 3% organic to 97% inorganic on one hand to 75% organic and 25% inorganic on the other. In acidic soils, which are formed due to leaching, phosphorus is present as phosphates of aluminium and iron. With increase in calcium content and rise in pH, due to drier climate, phosphate is also present as calcium phosphate and in hydroxyapatites. The organic phosphates are mostly phytin, nucleic acid and phospholipids etc.

The total content of phosphorus in soils is relatively small. Lipman and Conybeare obtained the average value of 1240 lbs per acre in 6½ inch surface of crop land of U.S.A., which corresponds to 0.064 per cent phosphorus. Hilgard, Wrothen and other workers have reported that majority of soils in the world are deficient in their phosphorus content.

Phosphorus is one of the two elements, the other being nitrogen, the deficiency of which limits the growth of a plant. This deficiency is due to the fact that most of the compounds of phosphorus in soil are highly insoluble. The simplest solution would be to apply soluble phosphatic fertilizers but in practice it is not so. Whenever a soluble
phosphatic fertilizer is added, it usually undergoes a change in the soil. In acidic soils it is converted into iron and aluminium compounds and in alkaline soils into calcium compounds and in normal soils it is adsorbed by the clay complex.

Joffre\textsuperscript{149}, Thompson\textsuperscript{274}, Fraps\textsuperscript{100} and various other workers\textsuperscript{17,49} have reported that as the P\textsubscript{2}O\textsubscript{5} content of soil increases, there is a marked increase in its nitrogen content. Various agencies have been thought to be responsible for gain in nitrogen by soils in presence of phosphates. It has been upheld for a long time by a number of workers that the phosphates markedly accelerate the activity of Azotobacter which utilize them for building up its cells. Further, the phosphates may act as buffers in decreasing the acidity of the medium and help carbohydrate metabolism which is very necessary for amino acid synthesis by Azotobacter from the nitrate obtained by the combination of nitrogen and oxygen. Phosphates also play a very important role in nitrogen fixation and check the loss of nitrogen when nitrogenous substances are added to the soil.

According to Paul Emerson and John Barton\textsuperscript{97}, if too much attention is paid to solving nitrogen problem the forces that make potassium available are over-stained. In that case the methods for the study of soils which involve a consideration of the potassium problem become necessary. Hall\textsuperscript{117}, on finding an increase in potassium content of clover, stated, "Whatever
may be the explanation, it is found that the growth etc., is very much promoted by a free supply of potash. Mc. Intire, Plummer and Ehrenberg have brought to attention that the availability of soil potassium is lowered by the presence of calcium carbonate. They state that any unfavourable condition resulting from liming may be counterbalanced by side dressing of potash salts.

The potash content of earth's crust is 2.45% and most of the potash bearing minerals are present in sand fraction of the soil. In clay fraction potassium is largely present in the exchangeable form. The amount of potash present in the soil is influenced by the parent material from which the soil is derived.

The practical value of potash salts was not established until 1830, when commercial supplies became available from German mines and were tested on many farms. Though soils in many countries contain considerable amount of total potassium, and sometimes available, yet they respond to potassic fertilizers. Corner and Abbott were of the opinion that a lack of available potassium is the factor limiting the crop yields on the Indiana soils and that the value of straw, corn, hobs and similar materials is due to the potassium contained in them. The following table shows the weight of
lettuce and wheat grown under greenhouse conditions on black sandy loam from Cass county.248:

<table>
<thead>
<tr>
<th>Soil treatment</th>
<th>Weight of crops</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lettuce</td>
</tr>
<tr>
<td></td>
<td>Amount (lbs. per acre)</td>
</tr>
<tr>
<td>None</td>
<td>-</td>
</tr>
<tr>
<td>K₂SO₄</td>
<td>200</td>
</tr>
<tr>
<td>KCl</td>
<td>200</td>
</tr>
<tr>
<td>K₂CO₃</td>
<td>200</td>
</tr>
<tr>
<td>Wheat straw</td>
<td>2.40</td>
</tr>
<tr>
<td>Sweet clover</td>
<td>1.08</td>
</tr>
</tbody>
</table>

* Additional treatment of 200 lbs of K₂SO₄ and 500 lbs of superphosphate.

The organic fraction of soils consists of living organisms of various types, together with their decaying residues. It is derived directly or indirectly from plant tissue. A major portion of mature plant tissue may be classified into three types of compounds, namely, polysaccharides consisting of celluloses and hemicelluloses, lignin composed of carbon, hydrogen and oxygen in ring structures condensed into large
molecules, and proteins which are aggregates of amino acids that are joined by means of nitrogen bearing amino groups.

The decay of organic matter in the soil may be regarded as occurring in four, more or less distinct but orderly, steps:

(1) The starches, sugars and water soluble proteins are first attacked and broken down by organisms in soil.

(2) Next follows crude proteins, pentosans and hemicelluloses.

(3) Cellulose appears to be more resistant but still yields readily to the action of organisms.

(4) Decomposition of the oils, fats, waxes, resins and lignin is very slow. These latter materials, especially lignin, contribute largely to the production of humus.

Immediately after fresh organic matter, such as farm or green manure, is mixed with moist warm soil, active decay becomes intense and results in liberation of large quantities of carbon dioxide. In the process of oxidation the organic matter becomes oxidized to carbon dioxide and water, and is, therefore, completely lost from the soil. Due to humification, which is conservative in its effect, plant residue becomes changed into a dark coloured amorphous material, humus,
which forms the greater part of the organic matter in soils.

The amount of organic matter in soil, then, depends on the rate at which this is added to the soil, either in the form of plant residues or as organic manures, and on the relative intensity of oxidative decomposition and humification. It is expected, therefore, that there will be low organic matter where plant growth is scanty, as in deserts and sand dunes, or where oxidative decomposition is favoured by warmth and aeration, as in culturable soils of the tropics. On the other hand, bad aeration due to water logging, or acidity may encourage the conserving process of humification, and under such conditions organic matter as humus tends to accumulate.

The extent to which soil organic matter affects plants is a question of long standing. Whitney\textsuperscript{92} thought effects due to organic matter were of major importance and proposed the "organic toxin" theory. Bottomley\textsuperscript{15} observed that plants in water cultures grew better when he added an extract of "bacterized peat" than when he supplied only inorganic nutrients. In the light of the present knowledge that plants can be grown satisfactorily in solution cultures containing inorganic salts only, it appears that at least a part of beneficial effect of the organic extract results from the presence in it of some mineral substance required by plants,
or from its interaction with the mineral substances already present in the solution to increase their effectiveness.

From the above remarks it is clear that though there is no evidence that any of the organic compounds in soil matter are direct nutrients of plants, yet in many natural soils high yields can be secured if there is an adequate supply of suitable organic matter. John B. Abbot of Vermont has stated, "If all accumulated wisdom of a hundred generations of master farmers were boiled down to just three sentences, one of these sentences certainly would be: provide for regular and frequent replenishment of the supply of organic matter in the soil." Results of experiments at Askov, Rothamsted, New Jersey, Norfolk and many other places show that crop production by a mixture of artificials and farmyard manure, dung or straw, is better than that obtained by artificials alone.

The role of organic matter in governing the nitrogen status of soils has been an important one. Hendrick has observed a marked depletion of soil humus by the addition of artificial nitrogenous fertilizers. Crowther, Russell, Dhar and many others have shown that organic matter when added to soil brings about nitrogen fixation. Several other workers have shown that application of organic matter with inorganic nitrogenous fertilizers retards denitrification process. Addition of organic matter to soils,
especially alkaline ones, lowers the soil pH and consequently increases the availability of phosphates, improves physical texture and colloidal properties and enriches the soil in its humus content and trace elements.

From the foregoing pages it is evident that the fertility of the soil is not a wasting asset like the reserves of coal or oil-field but it should be maintained and enriched to an adequate level by the addition of nitrogenous, phosphatic and potassic fertilizers together with organic substances.

Various nitrogenous fertilizers like ammonium sulphate, urea, ammonium sulphate-nitrate etc., are being used in this country. Recently as number of trials carried out at various places\textsuperscript{8,51,52,121,260} have shown that ammonium chloride is as efficient a source of nitrogen as sulphate of ammonia for various crops like cotton, rice, potato, tobacco etc.

Indian resources of gypsum are limited and as such the production of ammonium sulphate is beset with limitations while ammonium chloride can be cheaply manufactured by utilizing the industrial chlorine obtained as a bye-product in the electrolytic alkali plants and soda-ash industry. In India, however, there have hardly been any systematic trials in past regarding its use as a fertilizer though Raychaudhary and Ghosh\textsuperscript{227}, Desai\textsuperscript{68}, Sinha\textsuperscript{259} and Vachhani\textsuperscript{279} observed that addition of ammonium chloride can be beneficial to paddy, maize and other crops.
The use of different types of oil cakes, a residue left over when oil has been extracted from oil-bearing seeds, as a manure is well known in India. These are quick-acting concentrated organic fertilizers containing large quantities of nitrogen. Oil cakes have given good results with almost every crop and have been found to be as effective as some of the artificial nitrogenous fertilizers on equal nitrogen basis. Their use has also been recommended for the reclamation of alkali soils. Decomposition of these oil cakes and many other cellulosic substances needs a detailed study to give a clear insight into the problem of nitrogen fixation in soils.

Crowther has stated, "There is no ideal balance of fertilizers for any one crop, soil or region --- . In actual soils two entirely different mixtures may be required for a single crop on adjacent fields if these happen to have different types of soil or have received different agricultural treatments recently". This statement and various other experimental observations show that the physical and chemical characters of soils vary from place to place, being dependent on a number of factors such as climatic condition and temperature of the place, and hence it is not possible for any one or even a band of workers to find a suitable composition of artificial fertilizer and organic matter which will be efficient for all
soils in general. This is particularly true for Indian soils because of large variations in temperature and other climatic conditions due to vastness of the country. It is, therefore, very essential that thorough analysis and assay of the soils of a particular place must be made first, followed by manural experiments. The results of these experiments only, will enable one to recommend the use of a particular composition of fertilizer and organic matter to the farmers of that locality.

I have, therefore, taken up a systematic study of the effect of ammonium chloride, sodium phosphate (Na$_2$HPO$_4$), potassium sulphate, alone and in combination with 'rantil' or niger-seed (Guizotia abyssinica Cass) oil cake and cellulose acetate on the physico-chemical properties of Saugor soil.

The soil samples, collected from cultivated fields, were completely analysed and a representative sample of these soils was selected, due to its proximity from the chemical laboratories, for further studies. Different sets of soil containing 0.5% of each of the above mentioned substances, alone and in combinations, were taken in glass jars and regularly exposed to sunlight for about eight hours every day. The moisture content was kept constant at approximately 20% by regular addition of distilled water. The mixtures were stirred on alternate days to facilitate aeration. Every month soil
samples were taken out for the estimation of ammoniacal nitrogen, nitrate-nitrogen, total nitrogen, organic carbon and also values of exchangeable cations, pH and conductivity.

The productivity of a soil is, however, not determined solely by its content of nutrients but crops often do not show any increase in yield as one would expect from the apparent deficiencies in soil. Therefore, the results of exposure studies have been verified by performing pot experiments and observing the effect of above mentioned substances on the growth of tomato (Lycopersicum esculentum) plant and brinjal or egg-plant (Solanum melongena).

The present work is, thus, an attempt to elucidate the effect of inorganic and cellulosic substances on the physico-chemical properties of soil and their effect on plant growth.

The results have been recorded in four chapters:

CHAPTER I consists of nitrogen transformations in soil in the presence of ammonium chloride, sodium phosphate and potassium sulphate along with oil cake and cellulose acetate.

CHAPTER II deals with variations in conductivity and pH of
soil on the addition of ammonium chloride, sodium phosphate and potassium sulphate along with oil cake and cellulose acetate.

CHAPTER III describes the influence of ammonium chloride, sodium phosphate and potassium sulphate along with oil cake and cellulose acetate on exchangeable cations in soil.

CHAPTER IV presents the study of the effect of ammonium chloride, sodium phosphate and potassium sulphate along with oil cake and cellulose acetate on the growth of tomato plant (Lycopersicum esculentum) and brinjal or egg-plant (Solanum melongena).

The details are recorded in the following pages.