The Role of Nitrogen Fertiliser in Agriculture

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Abstract

Nitrogen is an important constituent of protein and protoplasm. And essential for the growth of plants. Its shortage leads to chlorosis (yellow of leaves) and stoppage of growth. Its excess adversely effect the quality of fruit. Its presence in moderate doses is essential for plant growth and fruiting. it is usually deficient in soils. Nitrogen given to plants in the forms organic manure and artificial fertilisers. It is also present in the air but plants can not directly avail of it. The lithosphere and atmospheric content of molecular nitrogen are 18 x 10^{15} and 3.8 x 10^{15} tones . In plant nitrogen lost through leaching, erosion or escape of ammonia or elemental N into the atmosphere.

Function of nitrogen (Ref.9)

It is a part of protein, important constituent of protoplasm, enzymes, the biological catalytic agents which speed up life processes. Nitrogen is also present as a part of nucleoprotein , amino acids, amines, amino sugar, polypeptides and other organic compounds in plants. In order to prepare a food for plant, plant required chlorophyll, energy of sunlight to form carbohydrates and fats from CO_2 and water and nitrogenous compounds. Nitrogen constitutes about 5-6% of soil organic matter by weight. Nitrogen is added to the soil both symbiotic and non-symbiotic fixation from the atmosphere.

Natural source of N in the soil. (Ref.3)

Nitrogen increases the area of the leaf, while potassium increases its efficiency.

The maximum up-take of nutrients occurs during the period of most active growth.

Ammonium sulfate and sodium nitrate their responses of various crops are different.

Ammonium salts in the soil dissolves and take part in cation exchange with soil colloid particle. A proportion of ammonium ions displace from the colloids an equivalent amount of calcium, magnesium and potassium ions, which are absorbed by growing plant. If soil conditions are good the nitrifying organisms will oxidize the ammonium to nitric acid, then immediately dissolve calcium to nitric acid, and then immediately dissolve calcium compounds to produce calcium nitrate. is largely not absorbed directly by the plant is largely absorb by the soil colloids then convert to nitrate.

"X" represent negatively charged soil colloid particles,

$CaX + (NH_4)_2SO_4$	------cation exchange ----------.	$(NH_4)_2X + CaSO_4$.
$(NH_4)_2X$	---------nitrification---------	$2HNO_3 + H_2X$
$2HNO_3 + CaX$	--------neutralization -------	$Ca(NO_3)_2 + H_2X$.

Ammonium salt are not available to the plant until after nitrification in the soil.

Phosphate increased the effect of ammonium sulfate slightly and sodium nitrate are markedly. Sodium nitrate is better than ammonium sulfate , except in the presence of phosphorus and potassium or sodium.

Form of N utilized by plants.

In order to N absorbed by plant. The organic N into inorganic NO3-N called minarlization of N ..In which organic N present in soil by the help of soil-microrganism converted in to ammonia (ammonification) and organic N converted in to inorganic NO_3-N .The plants takes up N from the soil in the form of NO_3^- and NH_4^+ ions, urea as amino acid

The N uptake in plant is as under :

Nitrate ----------Nitrate reductase ------Nitrite--------Nitrate reductase
(NO_3) (NO_2)

Hyponitritie ----------Hyponitrite reducatse ----------Hydroxylamine
(HNO) NH_2OH

Hydroxylamine ----------Hydroxylamine reductase ----------Ammonia
(NH_2OH) (NH_2)

Nitrogen is taken up in both cationic $(NH_4)^+$ and anionic (NO_3^-) forms. Nitrogen is used as ammonium fertilizer. Ammonium up take is best low pH , also carbohydrate status of the plant effect on NH_4^+ uptake. High carbohydrate plants favor high NH_4^+ uptake through enhancement of ammonia assimilation. Ammonium ion and ammonia are inter-convertible. $NH_3(aq) + H^+ = NH_4$.Ammonium. Nitrogen shows toxicity at higher pH. Wheat , sugarbeat, rice, tolerate high NH_4-N concentration at acid to neutral pH.

$NH_3(aq)$ could freely diffuse in to it and un-couple photosynthetic photosynthetic phosphorylation.

The nitrogen forms which are readily taken up by plants are NH_4^+ and NO_3^- ions.

The inert atmospheric N_2 must be converted to either NH_3-N or NO_3-N before utilization by plants.
$N_2 + 3H_2 = 2NH_3$ ammonium fertilizer produced. The total world biological N fixation to be the order of 17.2 x 107 tones per annum.

Two types of microorganisms are involved in biological N_2 fixation are:

Free living microorganism, microorganism living symbiotically with higher plants.

Free living N-fixers are:

- Azotobacter need pH 6.5 (Beijerinckia species are aerobic) Clostridium strain
- Achromobacter.
- Pseudomonas bacteria.
- Phototsyntheitic bacteria
- Soil fungi.
- Blue-green-algae.
- All these are anaerobic.

Nitrogen fixation by legumes and under field conditions (Ref.9)

Crops	N-fixed, Kg/hec/year
Alfalfa	261
Red clover	163
Sweet clover	182
Peas	51
Soybean	63

Soil bacteria and fungi require nitrogen in their food, most of them utilize the soluble nitrogen compounds like ammonium salts and nitrate present in the soil.

Rhizobum forms colonies or nodules on the roots of leguminous plants. The plant provides the organisms with energy in the form of carbohydrate and receives some of the combined nitrogen manufactured by the organism from the atmosphere. It is this association between nitrogen-fixing bacterial and legumes, which help in maintain the soil fertility. The gain of nitrogen from good crop is about 45 Kgs per acre per annum.

Azotobacter, clostridium, the non symbiotic N fixation under orchard conditions vary from 0-55 Kg per hectare annually.

Azobacter is an organism, is a free-living soil bacteria, they are capable of fixing nitrogen, if they are provided carbohydrate material. The carbohydrate is oxidized and supply energy necessary for the fixation of the atmospheric nitrogen. This nitrogen becomes available to plants after the death and mineralisation of the cells of the free-living organisms and helps to maintain combine nitrogen in the soil.

The N-fixing bacterial are photosynthetic one are heterotropic Azobacter and fix about 90kg/ha/annum.Rhizobium species live in association with legumes are very important N2 fixers. It fixes N around 100-400 Kg/N/ha/year. The amount of N_2 fixed depend on host condition soil pH, K, Ca, P, Co, Mo, status.

Plant obtain their N either by uptake as nitrates and ammonium or by reduction of atmospheric disnitrogen in root nodules of legumes, some other plants ammonia is assimilated in the root, where nitrate reduced in root or exported in the xylem to NO_3 reduction sites in the shoot. Nitrogen which is assimilated in the root is converted in to amides , amino acids and ureides:

- **Effect of N on root growth**
  N supply causes relatively more growth of shoot than roots.(Ref.5)
- **Effect of N on Carbohydrate utilization**
  Decrease carbohydrate status under high N supply (Ref.6)
- **Effect of N on Fruit formation.**
  High N fertilization, grain/straw ratio decreases; under extreme N deficiency. N application increases grain/straw ratio.
- **Effect of N on Hardiness of plant. (Ref.7)**
  High nitrogen supply increase the winter hardiness of peach tree.
- **Effect of N on Maturity Time.**
  Heavy nitrogen application delay the maturity of fruits.

Sources of nitrogen. (Ref.2)

Ammonium nitrate and urea are the widely used source of nitrogen. The nitrogen application do increase the soil acidity and lime requirement. Low rate of application involveds low quantities of nitrogen required by the tree with large pool of soil nitrogen available.

Nitrogen in plant can be classified in to three groups:

- Inorganic fraction, in form of NO_3^- and $NH_4^{+.}$
- Low molecular weight organic fraction-contains amino acids, amides and amines,
- High molecular weight organic bipolymers, protein and nucleic acids.

Conversion of nitrate to ammonia is as under:

NO_3- -----NO_2^-------$N_2O_2^{-2}$----------NH_4OH-------NH_3
Nitrate Nitrite Hyponitrite Hydroxylamine ammonium

Nitrate reduction found both in roots and upper plant ..Nitrate reductase activity is higher in young meristematic tissue.

There are 3 forms of inorganic nitrogen in fertilizers:

- Nitrates supply NO_3^- ions.
- Ammonium salts supply NH_4^+ ions.
- Simple amides are not ionized but contain nitrogen.
- NH_2 (amide) form or forms derived from this group.

Different forms of Nitrogen.

Nitrogen is present in various forms .These are as under:

- Ammonium sulfate
- Ammonium nitrate
- Sodium nitrate
- Calcium nitrate.
- Urea .

Other forms.

- Solids (includes ammonium phosphate)
- Solutions.

All nitrates are water soluble, their action on crop depends upon the other ions in fertilizer salts, this may be potassium, sodium, calcium or ammonium.

Chilean nitrate of soda-contain 16% of nitrate-nitrogen, 26% of sodium. It is water soluble.

Chilean potash nitrate-common fertilizer contains 15% N (all as nitrate), 10%K_2O and 20% sodium.

Potassium nitrate (KNO_3) contains 13.8% N and 36.5% K (about 44% K_2O.

Calcium nitrate ($Ca(NO_3)_2,NH_4NO_3,10H_20$) which contain 15.5% N

Nitrogen materials.

Nitrogen may supplied to the soil from any one or more of the following sources.

1) Organic.

a) Natural

b) Synthetic

2) Inorganic.

1) Organic.

a) Natural organic material

These material include farmyard manure, oil-cake, dried blood, fish manure, green manure, sewage products, castor, neem and other oil cakes, these become N supplier in about week or ten days.

b) Synthetic organic nitrogen.

Material containing synthetic organic N are readily soluble in water .These are:

(i) Calcium Cyanamide.

Nitrogen combine with calcium carbide to produce calcium cyanamide.

$CaC_2 + N_2 = CaCN_2 + C$ (carbon)

This is an exothermic reaction produce at ,100C° depending upon the size of unit. Commercial product contains 60% Calcium Cyanamide; the impurities are about 20% lime (CaO), 10% Carbon, which is responsible for dark gray color and small amount of various other substances. It contains 21% N, and is 35% in pure calcium cyanamide.

The nitrogen of Calcium cyanamide is not available to plants, unless they pass in to a reaction of the carbonic acid in the soil which converts the calcium cyanamide in to cyanamide to calcium carbonate

$CaCN_2 + H_2O + CO_2 = H_2CN_2 + CaCO_3$

The cyanamide is hydrolysed to Ureas.

$H_2CN_2 + H_{2O}) = CO(NH_2)_2$

Soil bacteria convert urea rapidly in to ammonium carbonate and latter more slowly in to nitrate. Cyanamide may form a polymer called dicyano diamide, $H_4C_2N_4$ if hydrolysis to urea is impeded or if the biological conversion to urea is slow. Both cynamide and dicyanodiamide are toxic to young plants and nitrifying organisms. If it is used on soil ,it kills most of micro organism and is used as weed killer. Calcium cyanamide contains calcium hydroxide so it should not used with ammonium sulfate.

Calcium cynamide ------H_2O- ----------Urea –Hydrolysis.----------$NH_4 + CO_2$

It is $CaCN_2$ with 21-22% N is hydrolysed in soil to form urea. It is used as weed killer. Cyanamide decomposes in the soil to form ammonium nitrogen .Cynamide contain lime but it whould not make soil acidic.

(ii) Urea

It contains 46% N. Urea is highly soluble in water and readily absorbd through the leaves
It has chemical formula $CO(NH_2)_2$ it is called carbamide. In soil urea readily converted by an enzyme urease to ammonium carbonate, which is unstable and release free ammonia.
It is very soluble and until converted to ammonium compounds through hydrolysis by the enzyme urease. It is just as mobile as nitrate. Commercial urea may contain traces of an impurities (biuret) which damages germination of crops. Pure urea contains 1.5% biuret. Urea free from biuret gives good crop, but suffer two disadvantages.

Rapid decomposition in the soil or on the soil surface.
Free ammonia is formed, this reduce the efficiency of urea. This ammonia damage germinating seeds. Urea is more effective when contain nitrate.

(iii) Liquid ammonia

Liquefied ammonia is new generation of nitrogen fertilizer.

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(iv) Urea and urea-form compounds.

It is produced when heating a mixture of anhydrous ammonia and carbon dioxide at high pressure. Urea contain 46.7% Nitrogen, and is readily converted in the soil to nitrate, without leaving any harmful effects.

Biuret ($NH_2.CO.NH.CO.NH_2$) which occurs in urea as impurity is toxic to fruit crops. Urea should not contain more than 0.25% Biuret.

2) Inorganic sources.

(i) Chilean nitrate of soda or saltperes.

Its compositions is:

$NaCO_3 + 2HNO_3$ ---------- $2NaNO_3 + CO_2 + H_2O$

Sodium nitrate shows neutral effect on soil, some impurities like saltpetre or the chilean nitrate of soda is present in a granular form:

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(ii) Ammonium Salts.

All ammonium salts used as fertilizer are water soluble and nitrified quickly in slightly acidic and neutral soil to form nitrate. Their effects are as under.

Ammonium sulfate –contain 21%Nitrogen. Due to non-hydgroscopic properties, it is make easy to handle , than nitrates or urea.

Ammonium chloride Contains - 26% Nitrogen, a cheap source of by-product hydrochloric acid.

(iii) Ammonium Nitrates.

It contain ammonium and nitrate, these are water soluble.
Ammonium nitrates- contains 35%N.
Nitro-chalk-contains enough limestone and it does not make soil acidic.
Ammonium nitrate-sulfate-contains 26%N
It supplies both nitrate and ammonical N. It is dangerous in case of fire of its explosive nature. This fertilizer contains almost double the quantity of N as contained by sodium nitrate.

(iv) Calcium ammonium nitrate.

This material is obtained by mixing of ammonium nitrate with precipitated calcium carbonate.

(v) Ammonium and nitrate.

Nitrate, nitrate application if followed by rain then nitrate leaches out. In different soils both ammonium and nitrate show difference. On calcareous soil nitrates give better results than ammonium salt. Nitrate salts are safer.

(vi) Ammonia Nitrate.

Nitric acid is produced by passing ammonia from reaction, mixed with air over platinum catalyst.
$NH_3 + 2O_2$ (oxygen) = $H_2O + HNO_3$
If nitric acid is neutralized by more ammonia, ammonium nitrate is formed.
$HNO_3 + NH_3 = NH_4NO_3$
Ammonium nitrate is very attractive form of fertilizer salts it contains 35% nitrogen half as the ammonium and half as the nitrate radical. Ammonium nitrate could be used as nitro-chalk, which contain 16% nitrogen. This product is granular and easy to handle.

(vii) Ammonium Phosphate.

It is mono-ammonium phosphate ($NH_4.H_2.PO_4$) and is completely soluble in water. It contains 12.2% N and 61.7% P_2O_5.It can be manufactured by adding the correct amount of ammonia to Phosphoric acid or rock phosphate treated with sulfuric acid and ammonium sulfate, like
$Ca_3(PO_4)_2 + (NH_4)_2\ SO_4 + 2H_2SO_4 = 2NH_4.H_2PO_4 + 3CaSO_4$.
Calcium sulfate is removed by filtration and solution of ammonium phosphate is concentrated.
Di-ammonium phosphate $(NH_4)_2\ _{P2O5}$ is also manufactured and used alone or mixed with fertilizer. It is easily soluble in water, but it has higher N to P_2O_5 ratio, containing 21.2%N and 53.8%P_2O_5.

(viii) Ammonium sulfate

By-products are coal containing 1-2% Nitrogen and 0.5-4% sulfur. The sulfur is present mainly sulfide and calcium sulfate. but as a constituents of organic compounds drive from the original plants and are produced by the action of sulfur bacteria.

When coal burns nitrogen begins to come off as ammonia at a temperature of 300°C to 400°C. A substantial amount of ammonia is obtained during the gasification of cake by air and steam. Ammonia is also by-product of oil-refining and Shale-distillation plants. Crude gas from the coal is used to remove tar, hydrogen sulfide and oil. The aqueous liquor is obtained by the proves of distilled and free ammonia from ammonium salts. The liberated ammonia gas is mixed with sulfuric acid in saturator and crystal of ammonium sulfate are separated in a centrifuge. About $1/5^{th}$ of nitrogen is used to recovered 22-23 Ib. of ammonium sulfate from 1 ton of coal.
It is soluble in water and used for mixed fertilizer and top dressing material. Ammonium sulfate continuos use make the soil acidic , so lime is recommended on the soil.

(ix) Ammonium Sulfate Nitrate.

It is produced both in crystalline or granular form. It contain ammonical and nitrate.N in 3:1 ratio. Application of this salt produce acidity.

(x) Calcium Nitrate.

It is soluble in water, nitrogen in form of nitrate is immediately available to the plant. The anhydrous salts $Ca(NO_3)_2$ contain 17.1% nitrogen. Calcium nitrate is made by dissolving limestone in nitric acid. In the manufacture of soluble phosphate calcium nitrate is obtained as by –product.
Nitrate has been produced by nitrification of organic matter on higher ground and gradually transferred in solution with other salts to the lower area in height where it has crystallized under the hot dry conditions of the higher plain.
The sodium nitrate the calcite contains large quantity of Sodium chloride, little sodium iodate and substantial quantities of sulfate of sodium, potassium and magnesium .Sodium nitrate is very soluble. Sodium nitrate contains high percentage of oxygen.

(xi) Potassium Nitrate.

Several methods based upon the different solubility of sodium and potassium nitrate are employed to produce Chileans potash nitrate, Chileans potash nitrate contains various composition, it contain 10% K_2O and 15% N**.**

Other Principal sources of inorganic materials used as sources of Nitrogen.

Name of material	Compound formula	N%
Anhydrous ammonia	NH_3	82
Ammonia solution	NH_4OH	20
Ammonium sulfate	$(NH_4)_2SO_4$	20.5
Ammonium sulfate nitrate	$(NH_4)SO_4.NO_2$	26.0
Ammonium nitrate	NH_4NO_3	33.5
Ammonium Phosphate	40% $(NH_4)_2H_2PO_4$	40
Sulfate	60% $(NH_4)_2SO_4$	16
Sodium nitrate	$NaNO_3$	16
Potassium nitrate	KNO_3	13
Calcium ammonium nitrate	$NH_4NO_3 + CaCO_3$	25
Calcium cynamide	$CaCN_2$	21
Urea	NH_2CONH_3	46
Castor Pomace		5.5
Karanj cake		3.9
Mahua cake		2.5
Neem cake		5.2
Farmyard manure		0.5-1.5
Dried blood		12-14
Slaughter house waste		6-10
Meat meal		5-10

Characteristic of commonly available source of nitrogen (Ref.2)

Sources	Percent nitrogen	Pound per 1 Ib N	Acidity or Basicity (IbCaCO3)Ib of N Acidity	Acidity or Basicity ($IbCaCO_3$)Ib of N Basicity.
Ammonia , anhydrous	82	1.22	1.8	-
Ammonia, aqua	20	5.00	1.8	-
Ammonium nitrate	33.5	2.98	1.8	-
Ammonium polyphosphate	12	8.33	4.1	-
Ammonium sulfate	20.5	4.88	5.4	-
Calcium nitrate	15.5	6.45	-	1.3
Di-ammonium phosphate	16-18	5.56	4.1	-
Mono-ammonium phosphate	11	9.09	5.3	-
Potassium nitrate	13	7.69	-	2.0
Sodium nitrate	16	6.25	-	1.8
Urea	45	2.22	1.6	-
Nitrogen solution	Variable	-	-	-

Nitrogen solutions may consist of mixtures of urea plus ammonium nitrate, aqua ammonia or anhydrous ammonia.

Various forms of Nitrogen fertilizers.

- Nitro-chalk- It is a mixture of ammonium nitrate + lime.
- Nitram – Straight ammonium nitrate.
- Aqueous ammonia.
- Anhydrous ammonia
- Isobutylidene dirurea – Acts as quickly as ammonium nitrate , but it is inferior than it ammonium nitrate.
- Sulfur-coated urea- In which urea is converted to ammonia by nitrification .The organic fertilizer are more expensive than inorganic fertilizers.

Comparison of nitrogen fertilizer.

A kilo gram of nitrogen shows same effect on crop, whether used ammonium sulfate, or ammonium nitrate ,supplied alone or in a mixture with lime or as "Nitrate of soda " or "potassium nitrate .
The choice of material is based in following things:

- The price charged for 1 kg of nitrogen.
- The efficiency of each fertilizer for particular crops and soils.
- Ease of storage, handling and distribution.
- Whether the fertilizer causes loss of lime from the soil.
- In case of wheat the application of nitrogen, when the crop is heading ,gives a flour that is high in protein and superior baking quantities . Same effect on oats is also found protein content in oat increases by the use of nitrogen fertilizer. In Barley nitrogen fertilizer is carefully applied as , it need high starch for malting purpose.
- In case of root crops excess nitrogen reduces the percentage of dry matter. In case of sugar cane nitrogen fertilizer increases the sugar as well as the yield.
- In case of cereals excessive amount of nitrogen bring too much leaf, late and un-even ripening, fungus attack and lodging of weak stems.
- Some legumes plants roots contain nodules, which contain nitrogen-fixing organisms.
- In legumes N application depresses yields due to inhibition of N fixation by fertilizer N
- The N added to the soil from atmosphere through rain water and biological agencies such as N-fixing bacteria.
- Alkaline soil favor ammonia and acid conditions nitrate up-take under low pH. The application of ammonical N can alter the cation sorbing capacity of root system.
- NH_4^+ nutrition differs from NO_3^- nutrition in 3 ways:
- The demand for oxygen to the roots is increased with NH_4^+ nutrition.
- In case of NH_4^+ nutrition the competition for the absorption of other cations is increases and this may be harmful for plant growth.
- There may be indirect effects due to change in pH of the medium.

Soil acidification

- Ammonium sulfate make the soil acid. Roughly 1 Kg of ground limestone is lost for every Kg of ammonium sulfate used. So lime must be added to keep the soil neutral.
- Ammonium chloride, ammonium nitrate, ammonium phosphate, urea, anhydrous ammonia and nitrogen all make the soil acidic, because they form nitrate in the soil. If it leaches down it removes equivalent lime. Nitrate fertilizer do not make soil acidic.

Liquid nitrogen fertilizers (Ref.4)

- Anhydrous ammonia –contains 82% N
- Aqua ammonia – contain 21-29 %N
- Nitrogen soluble fertilizer . Are ammonium nitrate and urea, Ammonia about 82 %N.
- Liquid mixed fertilizer are also called gas liquor. It contain 1-4% nitrogen usually ammonium carbonate or ammonium chloride.
- Ammonia even in diluted aqueous solutions is unsuitable for top dressing grassland, it damages the crop and retards growth, and some ammonia is lost in the air.
- After new trees are planted an application of 15-25 liters per tree of water soluble fertilizer solution like 20-20-20 mixed in 500 liters of water. After leafing in the first season it should be 75-100mgs of ammonium per tree. In second season nitrogen applied at the rate of 100 g per tree, and . 20-25 Kgs of actual nitrogen per acre are sufficient. Leaf analysis of plants are used to know subsequent nitrogen requirement . (Ref.1)
- The Cheaper methods of fixing nitrogen are to be found. The soluble combination is fixing nitrogen with carbides or with hydrogen. The former leads to production of calcium cynamide and later amounts to the synthesis of ammonia. The other methods are : nitrogen may be produced from liquid air and hydrogen by electrolysis of water or both gases may be obtained from natural gas or from the gasification of cake or oil with steam.

Solutions of nitrogen compounds.

- Most commonly used are ammonium sulfate or ammonium nitrate. One method is treat super-phosphate with waste ammonia liquor to obtain ammoniated super phosphate. This way ammonia is neutralized without using sulfuric acid in the method of making by-product ammonium sulfate .Solution of urea or ammonium nitrate in a ammonia are also applied to mixed fertilizers. One such solution containing 41% Nitrogen, 65 parts ammonium nitrate and 22 parts anhydrous ammonia in 13 parts of water. For direct application to the soil ammonium nitrate solutions or liquid anhydrous ammonia is used. Anhydrous ammonia is the cheapest form of nitrogen.

Timing of Nitrogen application (Ref. 11)

- Adequate N is needed at the time of flowering and fruit set and is strongly conditioned by season .In summer application both soil and spray, resulting poor fruit quality.
- The highest rate of N application results in to doubling of tree dry weight and increasing in the dry matter percentage of all tissue.
- It is found that 1.36 kg of N annually (half from a concentrated fertilizer, half from manure) with winter cover crops results in highest yield and fruit size per tree
- Iron and Cu content rises with increase in N fertiliser. (Ref.11)

N-deficiency symptoms

- The tops, shoots, and roots of N. deficiency are stunted. The shoots are usually upright and spindly stunted..The leaves become small, and pale yellow. There is dieback of twigs and gradual defoliation, which result in thin, brushy appearance of tops, and fruit size is reduced.
- Deficiency of nitrogen revealed by paleness of color in the leaves and general stunting growth. The yellow pigment carotene, which is animal converted to vitamin A.
- Nitrogen deficiency associated with anthrocyain pigmenting. N deficiency plant mature earlier and vegetative growth phase is terminated early.
- Young leave show strong sink of N, which contain high amount of N^{15} and NH_4-N,.When nitrogen deficiency occour the older leaves feed young leaves so N deficiency symptoms first appear on old leaves. Soil N depends upon the soil type, temperature and rain fall
- The availability of N contained in the fertilizer depends upon the form of N contained by the material. Leaching is directly proportional to the degree of N in a material. So nitrate-N has greater tendency to leach than the ammonia-N
- In general, 10% increase or reduction in nitrogen application is usually reflected as 0.1% change in leaf nitrogen content. Spreading the fertilizer under the trees in a rings or bands or over the weed free strips along the tree rows is more efficient. Required $1/3^{rd}$ or ½ half the amount of material needed in broadcasting over the entire orchard floor (Ref.1)
- The enzyme nitrate reductase, molybdenum (Mo) had been found to be a constituent of enzyme so in Mo-deficent plant nitrate reduction fails to take place and plants suffer N deficiency.
- Nitrogen is a constituent of protein and chlorophyll with protein they form protoplasm, which are the active centers of metabolism, less active protein store in chlorophyll, which absorb light and carbon dioxide presence produce various carbon compounds. The dry matter of plant contains from less than 1 and more than 5% of nitrogen, but it also depend upon the stage of plant and amount of nitrogen available to it. The plant use atmospheric free nitrogen and into a combined form. This nitrogen then become available to the plants.
- Nitrogen is a constituent of protein, nucleic acid (DNA and RNA), chlorophyll, many co-enzymes ATP, NAD, alkaloids and many other classes of compounds. The major effect of nitrogen deficiency is impaired protein synthesis and growth. Its deficiency symptom is chlorosis due to reduced synthesis of chlorophyll.

- Plants take up both ammonium and nitrate ions. Soil ammonium-N converted in to nitrate by the help of microbial action.
- The oxidation of organic material in the soil produce small amount of nitrogen.
- Nitrogen fertilizer is one of the basic mineral element required by the plants to provide high yield (Ref. 12)

Health of crop .(Ref.8)

- Rhizoctonia Solani of bean plant lowered by increase N supply through organic source.
- (Ref.9.) This way the decomposition of organic matter led to high soil CO_2 concentration to which the strains of R.Solani were susceptibale)
- More nitrogen, increases the relative humidity around the plants and increase infection by airborne diseases, like mildew and rust. In apple high amount of N increase the incidence of fire blight.
- Reduction in N supply results in poor vegetative growth but increased fruitfulness.
- The atmosphere contains ammonia and oxides of nitrogen. The oxide of nitrogen are produced by degradation of the protein of the earth.
- The proportion of ammonia nitrogen tends to be greater in summer than in winter .Nitrate nitrogen is highest after thunderstorms.
- The amount of nitrogen contained in a crop reachesto between 50 and 200Ibs per acre.
- Urea spray inhibites the germination of bean rust spores and minimizes disease incidence
- Soil rich in organic matter requires less amount of nitrogen than other soils for maximizing crop production.
- Tree vigor has direct relationship with nitrogen status. The excess nitrogen in fruit crops affects fruit color, firmness and storage quality. In order to check nitrogen fertilizer requirements various factors are need to be consideres. The nitrogen requirement of mature trees can be considered to be proportional to the amount of structural wood contained in trunks, scoif fold limbs and large roots. Different soils have different capacity of fertilizer nitrogen availability. The efficiency of nitrogen in various soils varies 55-80%.
- The amount of nitrogen fertilizer requirement effect by the presence of soil moisture and competition of the ground cover for nitrogen (Ref.1)
- Sodium nitrate prevented by the application of gypsum and ammonium sulfate were eliminated by lime stone.
- Combined use of NO_3-N and ammonium-N brings better results
- $(NH_4)_2SO_4$ shows better results than NH_4NO_3 ,Ammonium-N reduces the soil pH .It interferes with uptake of some other cations especially Mg.
- For normal growth plants require from 2-55 N in their dry matter. High nitrogen fertilizer use may impair product quality.
- Soils of humid and pre-humid regions containes more N than those from the arid or semiarid areas.
- Adequate P and K levels tend to boost up the crop response to N
- (Ref..14.)

- Oxides of N are formed in the atmosphere by lightening which is washed down to the soil with the help of rainwater.
- Nitrogen concentration decrease with Ca deficiency. Addition of either N or a Ca salt increase N concentration.
- The slow release N fertilizer are : urea, formaldeyhyde ,Isobutylidene diurea etc.
- (Ref.8) .
- The nitrogenous fertilizers supply N to either NO_3^- or NH_4^+ form. The performance of crop under ammonium and nitrate nitrogen remains the same in most soils.

Conclusion.

Nitrogen is an important constituent of protein and protoplasm. Essential for growth of plants. Nitrogen in plant can be classified in to three groups:

a) Inorganic fraction, in form of NO_3^- and NH_4^+.

b) Low molecular weight organic fraction-contains amino acids, amides and amines,

c) High molecular weight organic bipolymers. Protein and nucleic acids.

d) Conversion of nitrate to ammonia is as under:
NO_3- -----NO_2^-------$N_2O_2^{-2}$----------NH_4OH-------NH_3

Inorganic nitrogen Sources

Calcium cynamide; urea; Chilean nitrate of soda or saltpets, ammonium nitrate; ammonium phosphate; ammonium sulfate; ammonium sulfate nitrate; calcium nitrate; potassium nitrate.

Ammonia, anhydrous contain 82% N; urea contains 45%N; ammonium nitrate contains 33.5% N. Nitrogen also fixed by legumes like : alfalfa; red clover; sweet clover; peas; soybean. Rhizobium and Azotobacter Clostridium are capable of fixing nitrogen and supplying atmospheric N to the plants.

Nitrogen deficiency effects on photosynthesis, so leaves turn yellow, it also effects on root growth, carbohydrate utilization, fruit firmness, hardness of plants, maturity time, diseases incidence.

In order to remove N deficiency the consideration of soil, pH and time of application is need to be considered.

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