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RHIZOBIAL IMMUNITY THROUGH GREEN MANURE: AN ENHANCED INOCULATED TECHNIQUE FOR ORGANIC FERTILIZERS PROCESSING

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Abstract: **It has been proved that there is a definite increase in the total nitrogen content of legumes when inoculated with specific bacterial culture of the right type and efficiency. Inoculation is the process of mixing the most appropriate Bactria with benefits are derived from the symbiotic association green manure crops have the ability to fix gaseous nitrogen from the air with the oid of rhizobia which live in the nodutes on the roots of the begume plants. Therefore, it becomes necessary to inoculate the legume seeds with beneficial strains of proper root nodule bacteria.**

Keywords: **nitrogen, green manure, plants, necessary, bacteria.**

1. INTRODUCTION

The leguminous green manure crops have the ability to fix gaseous nitrogen from the air with the aid of rhizobia which live in nodules on the roots of the legume plants. The bacteria live symbiotically in nodules , with the plants providing food and energy for the organisms which , in turn , benefit the host plant by fixing nitrogen from the air . Consequent on this symbiotic relationship the leguminous plants succeed in enriching the soil nitrogen status only in the presence of proper nodule bacteria . As many soils do not contain the appropriate strains of bacteria , it becomes necessary to inoculate the legume seeds with the specific strains of rhizobia in order to ensure better growth of the host plant and effective nitrogen fixation by the nodule organisms . Without Rhizobium bacteria , the leguminous green manure crops may deplete the soil of nitrogen like any other non - leguminous plants instead of replenishing the soil nitrogen store . Among the root nodule bacteria (rhizobia) , there are several types and strains which are specific for different legumes . For best results , appropriate strains of Rhizobium bacteria for each legume should be present . It may be that poor and ineffective forms of many of the strains of rhizobia are present in normal soils . They may produce nodules that provide little or no nitrogen .Therefore, it becomes necessary to inoculate the legume seeds with beneficial strains of proper root nodule bacteria .

The process of nitrogen fixation begins as soon as or shortly after the formation of nodules , and continues as long as the nodules remain firm and healthy . The maximum nitrogen fixation is found to take place at the flowering stage of the host plant . The percentage of nitrogen progressively decreases as the seed formation proceeds and the nitrogen percentage in the nodules approximates to that of the root by the time the seed is ripened .

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1.1. Conditions for fixation of nitrogen

- The presence of appropriate strains of rhizobia in the soil
- The level of moisture in the soil
- The initial nitrogen level in the soil
- The presence of other available plant nutrients in the soil
- The pH of the soil pH 5 to 9 is conducive for N fixation)
- The stage of growth and conditions of the green manure crop

When the soil is rich in nitrogen , the root nodule bacteria do not fix nitrogen from air but feed on the soil nitrogen . The legumes , then . act just like any other non - leguminous crops . Under such circumstances, it would be advantageous to grow cereals along with legumes in the ratio of 1 : 3 so that the cereals would be depleting the soil of its nitrogen and the legume would thrive on the atmospheric nitrogen. The requirements for successful nitrogen fixation are proper inoculation with efficient strains of bacteria , adequate supply of available phosphate , lime and moisture , good drainage and a neutral soil reaction .

1.2. Bacterial inoculation of legumes

It has been proved that there is a definite increase in the total nitrogen content of legumes when inoculated with specific bacterial culture of the right type and efficiency . Inoculation is the process of mixing the most appropriate bacteria with seeds at sowing time 50 that maximum benefits are derived from the symbiotic association of plant and bacteria . Inoculation is generally done by treating the specific pure cultures with seeds by using gum or rice kanji . The following indications normally reflect the need for rhizobial inoculation When the growth of a recent crop of legume is poor When the recently grown legume crop had sparse nodulation on the tap root and upper side roots with widely scattered small nodules on the lower regions of root system . When legume is being grown on land that is poor due to lack of care or unfavourable natural conditions . The uses of inoculation could be summed up as follows : It prevents nitrogen starvation It lessens the dependence of legumes on soil nitrogen It improves the quality of crop It increases crop yield It ensures a nitrogen rich leguminous green manure crop.

2. MATERIALS & METHODS

2.1. STAGE OF INCOPRORATION

When the green manure crops are grown and incorporated in the same field , the best stage of incorporation is the flowering stage bringing in the green plants grown elsewhere , no definite stage can be fixed as the green leaf manuring controlled by many other factors . But it can be said that the plants used for green leaf manuring should be incorporated into the soil before they mature or be incorporated as they will very easily decompose leaving little attain the woody nature Plants of very young nature also should not residue in the soil . Woody plants will decompose very slowly. Hence , the best stage for incorporation of plants is either at the flowering il crop do not , then , umstames in 1 of its rogen proper ply of stage or before they attain the woody texture .

2.2. TIME OF INCORPORATION

The success of green manuring depends on the correct time of Trampling green matter into the soil and giving sufficient interval before sowing or planting the crop . The manure , being a bulky one is usually applied as basal dressing before the main erop is raised in fruits and some plantation erops like tea and coffee , green manure is the field . In our country , except for some perennial crops like coconut , applied as basal dressing . After incorporation , sufficient time is allowed for decomposition to take place and only after this , the main crop is sown or planted . However , the time will vary according to the erop and other agronomic practices followed . For example , for sugarcane , sunnhemp is grown along with the main sugarcane crop and the green manure crop is incorporated after about 40 to 50 days growth at the time of earthing up . In the case of plantation crops , green manure grown in the same field or brought from outside is incorporated for the decomposition.

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2.3. METHOD OF APPLICATION OF GREEN MANURE

The method of application varies from place to place depending upon other agronomic practices followed . In the case of green manuring , when plants are grown in the same field where they are to be incorporated , the plants are cut at the proper stage to the ground level , placed in the furrows and covered by the next furrow . With the availability of labour saving implements like green manure trampler , the plants are trampled by working the implement and later on levelling the field . This practice is possible where rice is transplanted . In broadcast crop , a suitable modification is necessary and usually the green manure erop is incorporated during the first weeding . In the case of green leaf manuring , the plants brought from outside source are spread over the field and trampled in by the use of implements or by human labour . In some cases, as in the green manuring of sugarcane , the incorporation is done during intercultivation operation.

2.4. DECOMPOSITION OF GREEN MANURE

The green manure applied to soil undergoes a series of chemical changes and only after these biochemical changes the nutrients contained in the plants become available and the humus is synthesized .Hence , as in the case of any other bulky organic manure , the nutrients become available slowly and steadily for a prolonged period of time . The green matter applied to the soil is acted upon by many types of microorganisms such as bacteria, fungi, actinomycetes and macroorganisms like protozoa , worms and insect larvae and several intermediate and end products are formed during the decomposition . The type of decomposition and the products formed are found to be controlled by the following important factors:

(1) Organisms present: The type and nature of microorganisms whether fungi or bacteria, aerobic or anaerobic, autotrophic or heterotrophic organisms, will decide the type of decomposition .

(2) Temperature: Optimum temperature of about 30-35 ° C is necessary for the normal decomposition processes and the rate of decomposition will be modified at low or high temperature.

(3) Aeration: The various stages of the decomposition process are decided by the presence or absence of air. Hence, there is aerobic decomposition in the presence of air and anaerobic decomposition in the absence of air.

(4) Moisture supply: The moisture content of the green matter and the soil decide the rate and type of decomposition . Optimum moisture is necessary for the normal rate of decomposition. In low moisture supply, decomposition will be slowed down .

(5) Soil factors: The various physical, chemical and biological properties of the soil will influence the rate and type of decomposition. In general, decomposition will be rapid in a fertile soil than in a non - fertile soil.

(6) Nature of green manure: the composition of the green manure, its age, maturity and C/N ratio will also influence the rate and type of decomposition. The young plants will decompose more rapidly than well-matured plants. Simularly plants having greater amount of mitrogen will decompose more rapidly than those having higher content of carbon compounds. Putting all the above influencing factors together, the decomposition can be broadly studied under two categories,

i) Aerobic decomposition

ii) Anareobic decomposition or putrification.

2.5. Aerobic Decomposition

The plant material incorporated into the soil is made up numerous compounds. But , for studying the decomposition processes the various compounds can be roughly brought under three groups (1) Carbon compounds consisting of carbohydrates, fats, oils, organie acids, lignin and other cyclic organic compounds, (2) Nitrogen compounds consisting of proteins , amino acids and other non - protein nitrogenous substances and (3) Mineral salts .

In this process of decomposition the most important deciding factor is the aeration in the soil and sufficient quantity of air is always necessary for the normal rate of aerobic decomposition.

2.6. Changes in the carbon compounds

The various carbon compounds are attacked by the organisms and all of them are found to be converted finally to carbon dioxide and water . For example , if glucose is attacked by the aerobic bacteria , carbon dioxide and water are produced .

$$C_6H_{12}O_6 + 6O_2 \xrightarrow{\text{BACTERIA}} 6\,CO_2 + 6\,H_2O + \text{ENERGY}$$

In the same way , if starch , cellulose , and hemicellulose are they will be converted finally to carbon dioxide and water This conversion is found to be performed by a group of bacteria , fung and actinomycetes capable of living only under aerated condition material require sufficient quantity of energy and nutrients . They find sufficient energy from the of carbohydrates but jerom the decomposition there may be insufficiency of nitrogen and phosphorus and in such of potas the o to mo Sum final comp solut the 1 protemierpres form of d aera and biological and type of in a fertile f the green nce the rate npose more ng greater ose having sufficient quantities of nutrients and hence the rate of decomposition of carbonaceous material will be carbondioxide and water but this conversion is not so quick and simple as seen from the reaction .

2.7. Changes in nitrogen compounds

Proteins constitute the major nitrogenous compounds in the plant material. When protein undergoes decomposition, it is firsthydrolysed by proteolytic enzymes produced by microorganisms to further acted upon and ammonia is formed. The ammonia produced does not accumulate in the soil except under anaerobic condition, but under aerobic conditions, it is rapidly oxidized by the nitrifying bacteria to nitrate. Some of the ammonia may also be consumed by the microorganisms . In addition to the protein the other nitrogenous compounds like urea, purine bases, lecithin, choline, cyanamide , alkaloids etc. , are decomposed by a great variety of microorganisms .

CHANGES IN NITROGEN COMPOUNDS

Proteins – (Hydrolysis –Polypetides – (Aminization) – Amino acids

PAPLIDES AND PEPTONES

Amino acid–(Ammonification)–Ammonia–(Nitrification)–Nitrite–Nitrate

Therefore , in the aerobic decomposition , the steps are aminization , ammonification and nitrification and the end product is nitrate , though there is some utilization of nitrogen by the microorganisms to synthesize their body protein .

2.8. Changes in the mineral constituents

The various mineral constituents like those of phosphorus , potassium , calcium , magnesium , etc. which are found in the plant in the organic form and to some extent in inorganic form are converted to more soluble forms and they become readily available to the plant . Summarizing the aerobic decomposition, the carbon compounds are finally converted to carbon dioxide and water, the nitrogen compounds finally to nitrates , the mineral constituents into more soluble forms and there is synthesis of humus . Humus is nothing but the ligno - protein complex formed by the combination of the microbial protein and the lignin present in plants. Lignin is resistant to microbial decomposition and in the presence of microbial protein present in the body of the microorganisms they unite together forming the more persistent material called humus . This is the type of decomposition taking place when green manure is applied to aerated soils (garden lands and dry lands) .

2.9. Anaerobic Decomposition

This is found to take place in soils which are poorly aerated or under waterlogged conditions. Under these circumstances only the organisms capable of thriving in the absence of oxygen will developand they will decompose the various constituents present in the are attacked and converted to methane , organic acids , alcohols and .

(a) Changes to carbon compounds: The various compounds bacteria and fungi, lactic acid , alcohol , butyric acid and fumaric acid carbon dioxide . For example, if glucose is attacked by anaerobic plant bod. to re edutng by us le , S. are produced.

$C_6H_{12}O_6$ BACTERIA ——————> $2C_3H_6O_3$(Lactic acid)

$C_6H_{12}O_6$ BACTERIA ——————> $2C_2H_5OH$ (Ethyl Alcohol)+2 CO_2

$C_6H_{12}O_6$ FUNGI ——————> $C_3H_6O_3 + C_2H_5OH + CO_2$

$2\ C_2H_5HO$ ————> $C_2H_40 + 2\ CH_4$

Hence, all the non-nitrogenous compounds are finally found to be converted to the above mentioned products.

(b) Changes in the nitrogenous compounds : Here also the proteins , on hydrolysis by the various hydrolytic enzymes produced by the various microorganisms , are converted to polypeptides , peptides and peptones and finally to amino acids . The amino acids are further converted to ammonia and along with the ammonia, various amines and mercaptans are also produced and these are responsible for the putrefactive odour .Hence , the anaerobic decomposition is also sometimes referred to a putrefaction . The end product is ammonia but in some cases , it may be further converted to gaseous nitrogen which may be lost to the atmosphere .

Proteins and other nitrogenous compounds

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Hydrolysis byenzymes produced by bacteria

|

Polypeptides, peptides, peptones

|

Hydrolysis

|

Amino acids

|

Ammonifying bacteria

|

Ammonia

|

Gaseous nitrogen

With regard to mineral constituents , they are converted into more soluble forms as in the case of aerobic decomposition . So in the anaerobic decomposition , the carbon compounds are converted to methane , carbon dioxide and organic acids , the nitrogen compounds humus to some extent.

3. DISCUSSION

3.1. Carbon Nitrogen Ratio on Decomposition Process

Carbon nitrogen ratio is the relative proportion by weight of organic carbon to nitrogen , in the soil or any organic matter . The number obtained by dividing the percentage of organic carbon by the ratio.

Carbon - nitrogen ratio is of fundamental and practical importance in understanding the mineralisation of the organic matter . It is a well established fact that the C : N ratio exerts a marked influence upon the mineralisation of carbon or nitrogen of the green matter , both under aerobic and anaerobic conditions . Only green matter with C : N ratio of 30 : 1 or lower will decompose in the normal manner . Materials with a very wide ratio do not decompose rapidly as the nitrogen contained in the green matter is not sufficient for the microbial activity and materials with very narrow ratio decompose more rapidly as excess nitrogen is available for the microbial activity . This is due to the fact that the various micro organisms taking part in the decomposition process require carbon for their energy and nitrogen for the synthesis of their protoplasm . Hence in the presence of more carbon (wide C : N ratio) more energy giving material will be available for the microorganisms and thus the increased activity of the organisms will utilize all the nitrogen . Once the available nitrogen is exhausted , the microorganisms will become inactive and decomposition rate will be retarded . In contrast , when proportionate amounts of both carbon and nitrogen are available , mineralisation will proceed in a normal way .

Mature plants have a very wide C : N ratio of 50 : 1 . In such cases , the carbon , when mineralized , gives out energy which is utilized by the various microorganisms . With the availability of more energy , the organisms utilize all the available nitrogen present in the soil and plant material . Thus the entire nitrogen will be left to be mineralized and the wide ratio in the beginning will be narrowed down and when this type of green matter is added to the soil , it will be acted only by the carbon mineralizing organisme . When green in incos therefor not only yielding climbing fallow de the poin other far not likeleropping manure model . TV manure (Crotolar 3.16 LIMI Thou not being limitations a Nona green Non - ay Allotme crop is matter with very narrow ratio , below 20 : 1 , is applied to the soils , theavailability of nitrogen will be more due to greater mineralization ratio will be brought to about 10 : 1 , which is said to be an equilibrium ed into in the ted to pounds cion of Green Manuring - A Basic Component of Organic Farming 9 50 9 ght of . The by the (C N) nitrogen . However , in all cases of plant materials , finally the Ox stage . Succulent and leafy portions of green manure , when applied decompose very quickly in about a week time) , and behave alineske inorganic fertilizer . In contrast , when matured and woody piante are used , much time is taken for the decomposition , and the nutrients are released very slowly as in the case of other bulky organic manures . Thus , the C : N ratio is an useful indicator by which the decomposition process , the release of nutrients and other biochemical reactions connected with mineralisation can be well understood .

3.2. FARMER ACCEPTANCE OF GREEN MANURING

If green manure crops are not associated with a direct increase in income , farmers are not likely to be interested in them . It is therefore , important that green manuring raises the farmer's income not only indirectly by improving soil fertility but also directly , (e.g. by yielding by - products of economic importance such as fuel , stakes for climbing plants , food , fodder and local medicines) . All forms of sown fallow demand a great deal of labour . Even more important can be the point in time when this labour is needed . If this coincides with other farm activities that cannot be delayed and improved fallow is not likely to be accepted by the farmers . Where forms of alley cropping are practised , farmers often prefer to plant the green manure crops in a looser configuration than the recommended model . Two leguminous plants which show great promise as green manure are velvet bean (Mucunapruriens) and sunnhemp (Crotolariajuncea , C. ochroleuca)

3.3. LIMITATIONS IN RAISING GREEN MANURE CROPS

Though there are several advantages of green manuring , it is not being practised on a large scale by the farmers due to certain limitations

- Non - availability of water resources may restrict raising of green manure crops .
- Non - availability of good quality seeds poses a problem ,
- Allotment of 6-8 weeks exclusively for growing a green manure crop is not preferred by farmers in intensive cropping system.
- In North India , where rice is grown after a wheat crop , the farmers are not not able to carry out field operations in the peak summer months of May and June .
- As the benefits of green manuring are not as spectacular as those usually derives from direct application of inorganic fertilisers , farmers are not convinced about the usefulness of green manuring .
- Sensitivity of certain leguminous green manure crops to photoperiodism is a constraint .
- Vegetative growth is retarded by early flowering during a short , dry season , resulting in less biomass production .
- A green manure crop may compete for time , labour and water , the cost of which must be balanced against the cost of inorganic fertilisers
- Poor germination of certain green manure seeds is also a problem.
- Incorporation of green manure crops under certain situations may be difficult and costly.

4. RESULT

4.1. CONCLUSIONS

- Green manuring represents a cheap and effective way of improving the soil fertility as long as water conditions permit and green manuring is not advisable where water is a limiting factor since the succeeding crop will suffer due to dearth of water .

- For a green manure crop , a legure is preferable as it adds atmospheric nitrogen which is a distinct addition to the soil .
- It acts as a good amendment for the reclamation of problem soil.
- Young green leaves can be incorporated immediately after planting but older crops has to be buried 4-8 weeks ahead of the planting.
- The optimum dose of green manure is from 4000-6000 kg per hectare.
- Green manures should be buried in the proper stage of their growth i.e. , at flowering stage which coincides at the 8th week as it contains maximum nitrogen and less of carbon .
- Optimum depth of trying green manure is at 10-15 cm .
- Green manuring , in conjunction with artificials , especially with phosphate , increases the yields economically.
- It has the potential to improve the low fertility status of soil .
- A considerable reduction in the investment on fertiliser , the cost of which is increasing , could be achieved by green manuring.
- Green manuring can be an important component of low external input sustainable agriculture (LEISA) without sacrificing the level of productivity .

4.2. FUTURE NEEDS

- Surveying the green manure species available for different cropping patterns in the world.
- Classifying green manure species into use categories (e.g.grain green manure , non - grain green manure , including forage green manure and leafy green manure)
- Determining optimum methods for establishing green manure crops at the absolute minimum cost for land preparation (e.g. , zero tillage planting , intercropping with a cash crop)
- Collecting and testing the types of incorporation equipment currently used by farmers ; examining their utility in different environments (e.g. the Philippines slicer , the Burmese trampler) .
- Investigating methods to produce and store green manure seed at the farm level ; developing national seed programmes to protect quantity and quality of seed (eg . , China subsidizes seed producers) ; determining effective scarification practices to increase field germination.
- Identifying cultivars that are genetically resistant / tolerant to pests and diseases.
- Using cellulolytic microbial cultures to green manure .
- Maintaining legume - rhizobialgermplasm and identify legumes species - specific rhizobia for acid , saline and alkali solls .
- Identifying fast - growing , high leaf - yielding tree species for different agroclimatic environments ; studying the cropping behaviour of tree legumes .
- Documenting labour requirements and costs in green manure BIO production ; defining labour limitations for different areas .
- Providing a linkage from research to extension programmes in areas identified as having potential to economically benefit from green manure use ; conducting on - farm cropping pattern trials ; involving the community social organisations in controlling such factors as discriminant live stock grazing , forestry programmes could popularize green leaf manure yielding tree species .

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