International Journal of Agriculture and Plant Science
www.agriculturejournal.in
Online ISSN: 2664-7664, Print ISSN: 2664-7656
Received: 14-06-2025, Accepted: 14-07-2025, Published: 29-07-2025
Volume 7, Issue 4, 2025, Page No. 56-62

Effect of plant nutrient sources on availability of N, P, & K in soil

Shubham Chauhan[1], Kedar Nath Rai[3], Trilok Nath Rai[2], Sanjeev Kumar Rai[1], Jyoti Rai[4]
[1] Department of Soil Science & Agricultural Chemistry, Kamla Nehru Institute of Physical and Social Sciences, Sultanpur, Uttar Pradesh, India
[2] Department of Soil Science & Agricultural Chemistry, Krishi Vigyan Kendra (ICAR-CSSRI), Dhikunni, Sandila, Hardoi, Uttar Pradesh, India
[3] Associate Professor and Head, Department of Soil Science & Agricultural Chemistry, Kamla Nehru Institute of Physical and Social Sciences, Sultanpur, Uttar Pradesh, India
[4] Department of Botany, from A.P.S, University, Rewa, Madhya Pradesh, India

Abstract
An investigation was carried out to study the "Effect of Plant Nutrient Sources on availability of N, P, & K in soil" under incubation in the Department of Soil Science and Agricultural Chemistry, KNIPSS, Sultanpur, Uttar-pradesh. The experiment was laid out in Completely Randomized Block Design with twelve treatments replicated three times. N, P, K were applied through urea, single super phosphate and muriate of potash, respectively. While the total amount of organics was applied 15 days before incubation study. The effect of recommended doses of fertilizers in addition to organic manures of different sources equivalent N ha^{-1} and with their sole treatments on available soil nitrogen under incubation have shown significant variations over control (T_1) at each of 0, 30, 60, 90 and 120 days of incubation. Among the integrated treatments (T_3 to T_7). Recommended doses of NPK and additionl kg N ha^{-1} through digested sludge (T_6) was found inferior than other. However, the highest values were recorded in T_4 followed by T_7 which were significantly superior over all the treatments. There was increasing trend of available N in each treatment at each period of incubation. However, slower increase in values of respective treatments was observed at 120 DAI. At this day of incubation, all the integrated treatments have shown good health of soil in terms of higher values of available-N compare to rest of the treatments considering all the treatments at all the period of incubation, T_4 and T_7 (among the integrated treatments) and T_9 and T_{12} (among the alone organic treatment) have shown superiority with providing available nitrogen. The treatments of RDF only (T_2) was also effective and has shown higher values than the organic treatments but it was significantly lesser effective than the integrated treatments at each of the incubation period. At par values was found in the treatments of T_5, T_6 and T_{10}, T_{12} respectively within integrated approaches and alone treatments of PM and DS at all the periods of incubation. Application of organics alone increase the available P and K content in soil under different days of incubation study over application of chemical fertilizer (T_2), control (T_1) and in combined use (T_3 to T_7); the maximum being recorded in the treatments receiving 100% N through P.M (T_{10}) and FYM (T_8), respectively as P and K (mg kg^{-1}. soil) at 120 days of incubation. At different days of incubation most of the treatments were shown at par with each other within the integrated and alone treatments of organics except T_{10} in the case of P and T_8 in the case of K. the available P and K content of soil under incubation study.

Keywords: Organic sources, inorganic sources, changes in available N, P & K under incubation study

Introduction

Soil is a non-renewable resource upon which mankind depends for survival. Historically, the rise of great civilizations has been linked to the quality of soil and the availability of water. Equally, the demise of such civilizations is often attributed to mismanagement of soil and land in its broadest sense. Crop productivity and soil fertility are thus synonymous. In today's overcrowded world, the challenge to feed and clothe the burgeoning populations of developing countries is a daunting task. Yields have to be increased from existing land areas; adding fertility to the soil to satisfy the demands of higher-yielding crops is essential. Soils vary greatly in their capacity to grow crops without fertilizer; even the richest soils experience declining yields without man's intervention. In essence, soil is not always a perfect medium for growing plants; it is, however, the only one that is available. Soils vary greatly throughout the world; they have inherent weakness, primarily deficiencies in nutrients that are essential to growing crops. Even when adequately supplied in the early stages of land cultivation, the nutrient-supplying capacity invariably diminishes with time. Most soils are deficient in nitrogen (N); it is transient in nature, and plants need a lot of it. In many cases, phosphorus (P) is just as critical; soil chemical reactions reduce the effectiveness of P fertilizers. The soils of the West Asia and North Africa region are generally well supplied with potassium (K), and usually don't need fertilization, especially for low-yielding rainfed crops. In recent years, there is a growing realization has grown that other elements, e.g., micronutrients, are deficient in some areas of the region.

Routine application of organic sources and inorganic fertilizers are an essential components of soil management in arable crop production systems. Organic matter inputs, such as farm yard manure, green manure or straw, either alone or in combination with mineral fertilizers held the potential to sustain or improve the soil ecological basis of crop production such as nutrient availability, water holding capacity and soil structure, etc. soil microorganisms are the major protagonists of organic matter decomposition and nutrient turn-over in arable soils. It has been frequently reported that soil microbial activity is an important aspect of soil quality (Santhy, P.; Velusamy, M.S.; Murugappan, V. and Selvi, D. 1999) [11].

Materials and Methods

Incubation study was conducted on the soils collected from the Agricultural Research Farm. 500 g processed soil was filled in suitable plastic containers. Prior to filling required quantity of organic manures and inorganic fertilizers were added in soil as per treatment. Low quantity of fertilizers were dissolved in water for a treatment and equal amount of solution was distributed in respective replications to make the replication homogenous. The treated soil was brought to about 60 per cent of W.H.C. and then incubated at $30^0C \pm 1$ in B.O.D. Periodic evaporation loss was recouped after every three day. Soil samples were collected and analyzed at different days after incubation (DAI).

Location and Climate

The research farm is located at North end of the Sultanpur. This district falls under semi-arid to sub-humid climatic belt having hot summer and cold winter.

In Indian agroecological zone, the area falls under V-eastern plain zone. The temperature begins to rise from middle of February and reaches its maximum by the end of May or middle of June. May and June are the hottest months. However, the coldest period lies between the last week of December and first week of January. The normal period for onset of monsoon in the region is third week of June which lasts upto the end of September or sometimes in the first week of October. The areas occasionally experience some showers of winter cyclonic rains during December to February. The normal annual rainfall of this region is about 1100 mm. In terms of percentage of total rainfall, about 84% is received from June to September, 0.7% from October to December, 6% from January to February and 9.30% from March to May as premonsoon rain. The mean relative humidity of this region is about 68% with maximum of 82% and minimum of 30% during July to September and April to early June, respectively.

The soils of Sultanpur region formed due to deposition of alluvium by river Gomati and have predominance of illite, quartz and feldspar minerals. Illitic minerals are partly inherited from micas which are predominant in the sand and silt fractions. Quartz and feldspar in the soil are supposed to be inherited from the parent materials. Most of the soils of this division have been classified in the soil order of Inceptisol (Udic, Ustochrept).

The soil, used for incubation was collected from the A-1 block of the Research Farm. The soils of this site fall under Inceptisol with low, medium and high fertility status of nitrogen, phosphorus and potassium. The details of physico-chemical and biological properties of the experimental soil have been discussed in the chapters of result and discussion.

The city of Sultanpur (which gives its name to the district) lies in latitude 26 degree 15 minutes north and longitude 82 degree 05 minutes east on the right bank of Gomti about 61 km south of Faizabad, 42 km north of Pratapgarh and 138 km south-east of Lucknow (Figure 1). It is on the branch line of Lucknow-Jaunpur section of the Northern Railway (broad guage) passing through Sultanpur, Jafrabad and Jaunpur. Another branch line of the same railway connects it with Faizabad and Allahabad. Metalled road connects it Faizabad, Shahganj (district Jaunpur), Jaunpur, Pratapgarh, Raebareli and Lucknow. District road connects Sultanpur with Amethi.

The original town was situated on the left bank of the Gomti. It is said to have been founded by Kusa, son of Ram, and to have been named after him Kusapura or Kusabhavanpur. This ancient city has been identified by General Cunnigham with the Kusapur mentioned by Hiuentsang, the Chinese traveller. He states that there was in his time a dilapidated stupa of Ashoka and that Buddha taught here for six months. There are Buddhist remains still visible at Mahmoodpur, a village, 8 km distant to the north-west of Sultanpur. The town subsequently fell into the hands of Bhars, who retained it until it was taken from them by Musalmans in the 12th century. About seven hundred and fifty years ago, it is said, two brothers, Sayid Muhammad and Sayid Ala-ud-Din, horse dealer by profession, visited eastern Avadh and offered some horses for sale to Bhar Chieftains of Kusabhavanpur, who seized the horses and put the two brothers to death. This came to the ear of Ala-ud-Din Khilji, who would not allow such an outrage to pass unpunished. Gathering a mighty force, therefore, he set out for Kusabhavanpur and took revenge by killing most of the Bhars by strategem adopted after a long drawn seige. Kusabhavanpur was reduced to ashes and the town of Sultanpur, so called from the rank of the victor, rose upon its ruins. This town was finally raised to the ground during the military operations connected with the reoccupation of the province in consequence of the inhabitants having been concerned in the murder of British officers at the outbreak of the freedom struggle of 1857.

Before annexation a military station and cantonement were established on the right bank of the river in a village then known as Girghit but more commonly called by officials Sultanpur or Chhaoni Sarkar and by the rustic population Kampu or the Camp. The present town of the Sultanpur has been developed at this site. In this city there are two parks, one maintained by Soldiers', Sailers' and Airmen's board and other privately maintained known as Chimanlal Park. A library called Vinayak Mehta library, aided by Municipal Board is the only library in the city. It is run by the Vinayak Mehta Library Trust Association and contains over 10,000 books.

In Chowk there is a clock tower. On the bank of Gomti is Sitakund, where Sita bathed as she accompanied her husband (the Loard Rama) on his exile. Bathing fairs are held there in Chaitra and Kartika. In civil lines opposite the collectorate is a church known as Christ Church which was opened and consecrated on the 16th November 1869. Next to the church, on the south side, stands Victoria Manzil, built in commemoration of the first jubilee of Queen Victoria. Now its is called as Sunder Lal Memorial Hall and it houses the office of the Municipal Board. A stadium, named as Pant stadium has been built in the city in 1954-55.

There is 955 mm of seasonal rainfall and 12.5 to 45.5°C for mean annual minimum and maximum temperatures, respectively. It is an alluvial soil. For the Sultanpur, September to January is considered the monocropping season (main season). Although farmers also produce horticultural crops, pulses, and oil crops, the sultanpur district is highly suited for the production of cereals.

According to the Central Statistical Agency's population projection, as cited in the district's total population by 2011 was projected to be 2431490 (1226650 males and 1204840 females).

Soil Topography

The surface is generally level, being broken only by ravines in the neighborhood of the rivers. The central portion is highly cultivated; while in the south are widespread arid plains and swampy marshes. Minor streams are the Kandu, Pili, Tengha and Nandhia. Apart from this, the Garbhiya Nala, Mazui Nala, Jamurya Nala, and Bhat Village Karkharva, Sobha Mahona etc. are lakes. The land of Sultanpur district is generally plane except some regions around the Gomti River which drains almost the whole district. However, the southern part of Sultanpur drains towards Sai River flowing through the Pratapgarh district.

Climate

The climate of this district is characterized by a hot summer and a pleasant cold season. The climate is semi-arid with very hot summer and equally cold winter season. During the summer months i.e. May-June, the maximum temperature goes beyond 44 degree Celsius and in winter months of December & January, it is around 3-4 degree Celsius. Winds are generally light to moderate with some strengthening during later part of the summer and monsoon season. Winds are mostly from the east or south-east during the period from May to September. The average annual rain fall is about 900 to 1000 mm and confined mainly during July to September. The rainfall in general increases from the south-west towards the north-east and about 80-85 per cent of the annual rainfall is received during the south-west monsoon months June to September, July being the rainiest month. Hail and Dust Storms are observed only during March to June.

Soil

Alluvial soils generally cover the major portion of the district. They have developed an alluvium deposited by the Gomti and its tributaries. The soils are neutral to moderately alkaline and calcareous and have sometimes, well developed clay accumulation in the sub-soils. The large areas of barren waste are striking characteristics of the district. Tahsil Sultanpur has the greatest area of such land. Most of this area is of a very unproductive nature and consists of wide usar plains, which are especially noticeable in the south and the east of district. Nothing grows on such land, not even grass. Most of the land affected by soil erosion in the district lies in the water sheds of the rivers Gomti, Mangar, Majhai and Sai.

Land use Pattern

The mainstay of the population is still agriculture and more than 90 percent of families have excess number of persons engaging themselves in agricultural related activities. Out of the total geographical area, about 67% is devoted to Agriculture. The culturable and non-culturable waste land contributes 14.85 % and 18.21 % respectively. The main occupation of the people is agriculture, the crop pattern was all alike on the usual pattern of harvesting two crops rabi and kharif. But zaid crop are also found in this district.

Agro-Ecological Situations

As per the survey of the district, it has been observed that agro-ecological situations are directly correlated with physiographic situations, land quality and availability of irrigation facilities of the area. Broadly, the farming situations have been divided into four i.e. productive plain, sodic, ravenous and waterlogged conditions. The first three conditions, are further divided into two i.e. irrigated and rain fed. The waterlogged areas are temporarily or permanently submerged in nature. Bore well is the major source of irrigation (48.5%) followed by canal (38.65%) and public tube wells (9.17%).

Crop and cropping pattern

The agriculture of the district does not differ much from that of neighbouring districts. The main harvests of the district are known by the usual names kharif (autumn) and the rabi (spring) crops. The kharif crops are sown in the beginning of hot weather and reaped after cessation of the rains; the rabi crops are sown in October–November and reaped in March-April. The zaid or intermediate harvest which reaped before the summer rains is not of great importance in the district. Among the kharif crops paddy is the most important in point of the area under it. Other kharif crops are arhar, maize, urd and mung. The rabi crops consists of wheat, barley, gram and pea grown.

Rice is the most important crop of kharif and accounts for 34.78% of the total cropped area. The degree of dominance is comparatively less in the north-western part than the south-western part of the district. The next most important cereal crop is wheat which occupies nearly 25% area of the total cropped area and well distributed all over the district. Other crops like barley and millets occupied 4% and 5% of the gross cropped area respectively. Pluses cover only 15% of the total gross cropped area. Gram is the most important crop and accounts for 18% followed by pigeon pea (3.19%), field pea and lentil. Mustard is the main oil crop grown in rabi, mixed with gram, pea, wheat and lentil. Sugarcane is cultivated as cash crop and occupies only 1.82% of the total gross cropped area. Cultivation of horticulture crops, specially the vegetables are mainly restricted to traditional families except potato, onion and sweet potato which are widely grown by majority of the farmers in the district. Potato occupies only 1.23% of the total gross cropped area followed by onion, sweet potato and other vegetables. Among the fruit crops Mango occupies a maximum area (15,517 ha) followed by guava (81 ha), aonla and jackfruit.

The cultivators of the district had the services of seed godowns, fertilizer depots, rural godowns, insecticide depots, seed farm, cold storages and agriculture service centre. For storage of crops there were many warehousing godowns, among which some were managed by Food Corporation of India and State Warehousing and by State government.

Live stocks and fisheries

Animal husbandry is yet another sector which supports economy after agriculture. The domestic animal of local variety is found in the district. The cattle bovines, buffaloes, sheep, goats (he and she), pigs, poultry birds are the other animals. The condition of live- stock is worst in problem areas due to shortage of feed, fodder and occurrence of diseases. Nowadays, poultry farming has become important in the district with increasing demand of poultry products. Animal Husbandry departments make arrangement for supply of fowls to those interested in poultry farming.

The district has an immense potential for fresh water fisheries through large system of rivers and inland water bodies. Gomati River is an important source of fishes which covers a length of 207 km in the district. There are 5,636 ponds with water spread area of about 4,500 ha. The most prized species are the Anwari or Mullet and Rohu which are found in abundance in the Gomti. Majority of the fisherman population is concentrated in the village along the bank of Gomati River. Catching and selling of fishes is the main source of their livelihood. Housewives are mainly involved in rope making from Saccharum species which grows widely in the ravine areas.

The Need

As a whole, district is characterized by typical socio-economic and agro ecological situation. The majority of the farming community falls under marginal and small categories with fragmented holding scattered at different locations and poor resources. The soil condition of the district is inherently productive but a good proportion of land is beset with productive hazards as stated earlier.

Thus, there is a constant need for vertical as well as horizontal improvement of agriculture production in an integrated manner to uplift the socio-economic condition of the farming community. The majority of farming community suffers with a number of problems such as low level of knowledge, poor credit facility, input support, poor condition of soil, fragmented holdings and unemployment. Keeping in view the above, the following thrust area have been prioritizing and taken into consideration for improvement of agriculture development in the district.

Fig 1. Map of the study area.

Organic Materials Used as Nutrient Sources

a. Farm yard Manure (FYM)
   It was obtained from the Dairy Farm of Banaras Hindu University.
b. Carpet-waste (CW)
   District Bhadohi in U.P. is well known for manufacturing of quality carpets. Many waste materials come out during the processing of carpet threads. These waste materials are known as carpet waste which is infact creating environmental problem. However, it is having nutritional value particularly in terms of nitrogen value and is useful as organic source of nutrients. Carpet waste was collected from the carpet industries of district Bhadohi.
c. Press mud (PM)
   Press-mud was collected from Aurai sugar mill district Mirzapur, U.P.
d. Digested sludge (DS)
   Digested sludge was collected from sewage treatment plant (STP), Dinapur near DLW, Varanasi.
e. Poultry-manure (PyM)
   Poultry manure was collected from Satau Mahua, Varanasi.
f. Fertilizer sources
   For nitrogen, phosphorus and potash urea, single super phosphate and potassium chloride were used for the supply of N, P and K respectively.

Table 1: Details of Treatment: The treatments used have been presented

T_1	**:**	**Control (Natural farming)**
T_2	:	100 % of NPK (N: P2O5:K2O) 130: 75: 70 kg ha^{-1}
T_3	:	100% of NPK + 6 tonne ha^{-1} FYM (equivalent to 30 kg N) + Halo mix
T_4	:	100% of NPK + 255 kg CW ha^{-1} (equivalent to 30 kg N) + Halo mix
T_5	:	100% of NPK + 3.0 tonne PM ha^{-1} (equivalent to 30 kg N) + Halo mix
T_6	:	100% of NPK +3.0 tonne DS ha^{-1} (equivalent to 30 kg N) + Halo mix
T_7	:	100% of NPK + 1.2 tonne PyM ha^{-1} (equivalent to 30 kg N) + Halo mix
T_8	:	130 kg N as FYM + Halo mix + P: K (75: 70) kg ha^{-1}
T_9	:	130 kg N as CW + Halo mix + P: K (75: 70) kg ha^{-1}
T_{10}	:	130 kg N as PM + Halo mix + P: K (75: 70) kg ha^{-1}
T_{11}	:	130 kg N as DS + Halo mix + P: K (75: 70) kg ha^{-1}
T_{12}	:	130 kg N as PyM + Halo mix + P: K (75: 70) kg ha^{-1}

Table 2: Method used for soil pysico-chemical analysis the methods used along with references for soil analysis have been presente

Parameter	Method used	References
Soil texture	Hydrometer method	Bouyoucos (1927) [2]
W.H.C. (%)	Keen box	Black *et al*. (1966) [1]
B.D. (Mg m^{-3})	Pycnometer	Black *et al*. (1966) [1]
P.D. (Mg m^{-3})	Pycnometer	Black *et al*. (1966) [1]
C.E.C. [c. mole (p^+) kg^{-1} soil)]	Centrifuge method	Jackson (1973) [5]
pH (1:2.5 soil water suspension)	Glass electrode pH meter	Jackson (1973) [5]
EC (1:2.5 soil water suspension)	Conductivity bridge	Jackson (1973) [5]
Organic carbon (g kg^{-1})	Chromic acid digestion	Walkley and Black's (1934) [13]

Available – N (mg kg^{-1})	Alkaline permanganate method	Subbiah and Asija (1956)
Available – P (mg kg^{-1})	Olsen's method	Wattanabe and Olsen (1965)
Available – K (mg kg^{-1})	Flame photometer (Ammonium acetate extract)	Jackson (1973) [5]

Statistical Analysis

All the experimental data of soil, plant and soil microorganism were statistically analysed to drawn conclusion of significance by using the method as prescribed by Panse and Sukhatme (1967) [9]. The test of significance was carried out at 5% level of significance by referring to 'F' table value. Critical differences were worked out for the effects which were significant.

Results & discussion

Physico-chemical characteristics of Soils

The physico-chemical characteristics of the initial soil samples collected from KNIPSS, Sultanpur block of Agricultural Research Farm for incubation study have been reported in table 3. The soils of this area belong to the soil order Inceptisol.

Table 3: Physico-chemical properties of Initial soil.

Soil Properties	Values
Texture of the soil	Sandy loam
Bulk density (Mg m-^{3})	1.35
Particle density (Mg m-^{3})	1.92
Water holding capacity (%)	43.20
pH	7.25
E.C. (dSm^{-1})	0.032
O.C. (g kg^{-1})	4.7
C.E.C. [cmol (p^{+}) kg^{-1} soil]	9.45
Available N (mg kg^{-1})	85.34
Available Olsen's P (mg kg^{-1})	6.31
Available K (mg kg^{-1})	70.41

Incubation study

Effect of organic and inorganic sources of nutrients on available N, P and K in the soil during incubation study

Results pertaining to effect of recommended doses of fertilizers in addition to organic manures of different sources equivalent and with their sole treatments on available N, P and K (Table 4, 5 and 6) in the soil have indicated significant variation over control at each of 0,30, 60,90 and 120 DAI. The available N varied lowest in control to maximum in T_4 (N ha^{-1} through C.W.) at zero days of incubation among the integrated treatments (T_3 to T_4) T_6 was found inferior than others. Fast increase in available–N was observed at 30-days after incubation due to integrated treatments where, highest value has been found in T_4 followed by T_7 significantly superior over all the treatments in the case of organic treatments the highest was again due to 100% N through C.W. T_9 there was increasing trend of available-N in each treatment at each period of incubation. However, slower increase in values of respective treatment were observed at 120 DAI. At this period of incubation, all the integrated treatments have shown good health of soil in terms of higher values of available –N compare to rest of the treatments, considering all the treatment at all of the period of incubation, addition of carpet-waste and poultry-manure were found more effective in providing higher amount of nitrogen in integrated as well as organic treatment the treatment of only RDF (T_2) was also effective and has shown higher value than the organic treatment but it was significantly lesser effective than the integrated treatments at each of the incubation period.

The available phosphorus was varying from control to 100% N through P.M (T_{10}) at zero days of incubation. Here, all the integrated treatment was showing at par and comparative values of phosphorus with the treatment of RDF (T_2) highest rate of increase in available – P as above was observed due to organic treatments of (100% N as P.M.) had shown maximum and significantly higher followed by T_8 and T_{12}. All the treatments were showing sharp increase in available phosphorus upto 60- DAI and after that the rate of increasing its availability declined compare to previous DAI. Similarly, all the integrated and organic treatment have shown significant increase over the control and RDF (T_2) at each period of incubation. The treatment of P.M. was found quite effective in releasing P with maximum value at 30, 60, 90, and 120 DAI, respectively followed by the similar performance of T_{10} and T_8 also.

The available potassium was varying from control (T_1) to maximum in T_8 at zero days of incubation. There was significant increase in available potassium by all the integrated treatments either of RDF or organic approaches over the control at each of the incubation period. Three treatments *viz*. T_3, T_6 and T_7 of the integrated approaches were found more effective in releasing potassium significantly. Among the organic treatments T_8 (100% N through FYM) was found quite effective in releasing highest quantity of potassium at 0 to 120-DAI. The values were significantly higher over each treatment in respect of incubation period. The other treatments like T_{12} (100% N through PyM) and T_{11} were also found effective.

In the present study, there was general trend of sharp increase in available nitrogen, phosphorus and potassium content under enriched soil with organic and inorganic sources of nutrients incubated for longer periods might be attributed due to different factors like increase in microbial population and enzymatic activity capable to break-down of organic source supplied through various treatments. In the case of T_4 (100% NPK + N ha^{-1} through C.W.) maximum available–N was due to high content of N and fast decomposition of carpet waste, because of its narrow C: N ratio, the available –P was maximum in T_{10} (100% N through press- mud) due to higher supply of phosphorus through press – mud than other treatment. The available potassium maximum in T_8 (100% N through FYM) was due to higher K supply from farm yard manure. The increase in available N, P and K (mg kg^{-1} soil) by the all treatments was in the range of upto 30 to 35 % , 50 to 55%,65to 75% and 75to 80% at 30, 60, 90, and 120 days after incubation, respectively over the zero days of incubation, application of organic sources as in treatments of T_8 to T_{12} were showing lesser available – N and higher available – P and K compare to integrated treatment of RDF plus organic sources equivalent of N ha^{-1} (T_3 to T_7) in different DAI. Higher available–N was due to addition of amide form of N through urea in integrated treatments. Reverse to that organic treatments, having no application of urea, were showing comparatively lower N and higher rate of available P and K. Organic sources were also containing phosphorus and potassium. Therefore, after mineralization, organic sources were releasing variable amounts of these elements in respective treatments depending upon content and rate of mineralization (Jagtap *et.al.*; 2007) [6].

Organic manures are helpful in reduction of phosphorus and potassium fixation in the soil. Therefore, enhanced P and K availability was observed in the treatments of organic manures. Besides that, humic and fulvic acids are added in the soil through decomposition of organic matter which play and important role in liberating fixed–K because of their chelating power (Santhy *et.al.* 1999) [11]. These compounds are capable to penetrating in the intermiceller spaces of expanding type of clays and reach the specific sorption sites for potassium where the reacts or compete for the sites with K. Consequently, fixed K is released. The other factors like organic anions, liberated during decomposition of organic matter, make complexes or chelate with magnesium and calcium ions which ultimately prevent them for reacting with phosphate. The addition of phosphorus fertilizers along with organic manures in the soil retained higher amount of saloid phosphorus, a form available for longer period due to its reduced fixation as calcium phosphate. Thus, phosphorus fixation was reduced and its availability was remaining in increasing trend (slightly) throughout the experimentation – period due to addition of organic manure. Decomposition of organic matter and release of some organic acids were might be also responsible for the enhanced solubility and availability of phosphorus.

Table 4: Periodical changes in available N (mg kg^{-1}) due to organic and inorganic sources of nutrient during incubation study

Treatments	**Available N (mg kg^{-1})**				
	Days after incubation				
	0	30	60	90	120
T_1	80.24	86.35	88.55	93.15	95.96
T_2	142.81	155.25	169.20	175.08	177.32
T_3	143.71	157.25	171.35	179.25	182.35
T_4	147.73	169.75	173.45	183.45	185.42
T_5	142.51	165.82	169.25	176.85	180.45
T_6	141.23	164.36	167.45	174.74	183.35
T_7	145.25	166.25	172.75	171.35	184.62
T_8	92.96	99.36	116.08	164.12	179.47
T_9	95.53	103.75	120.72	168.75	174.35
T_{10}	92.56	104.71	115.84	164.18	177.85
T_{11}	93.92	103.25	113.75	162.95	175.88
T_{12}	96.26	107.28	118.35	166.82	172.86
SEm±	1.16	1.15	1.44	1.25	1.20
CD(P=0.05)	2.32	2.30	2.86	2.45	2.32

Table 5: Periodical changes in available P (mg kg^{-1}) due to organic and inorganic sources of nutrient during incubation study

Treatments	**Available P (mg kg^{-1})**				
	Days after incubation				
	0	30	60	90	120
T_1	5.51	6.15	6.98	7.25	8.85
T_2	18.63	22.61	24.43	25.18	26.45
T_3	19.31	23.65	26.22	27.55	29.79
T_4	18.63	24.5	27.35	28.25	29.98
T_5	18.57	25.89	29.75	30.52	35.99
T_6	19.99	26.17	28.15	31.32	34.75
T_7	20.31	27.05	28.85	32.78	35.96
T_8	28.77	29.25	39.36	40.16	41.08
T_9	19.68	24.23	29.76	32.21	34.06
T_{10}	29.70	34.78	39.45	42.85	45.02
T_{11}	23.92	23.58	23.05	36.12	43.05
T_{12}	28.77	34.15	38.25	40.25	42.06
SEm±	0.60	0.55	0.63	0.65	0.66
CD(P=0.05)	1.20	1.14	1.32	1.54	1.66

Table 6: Periodical changes in available K (mg kg^{-1}) due to organic and inorganic sources of nutrient during incubation study

Treatments	**Available K (mg kg^{-1})**				
	Days after incubation				
	0	30	60	90	120
T_1	62.31	68.75	72.34	73.25	74.15
T_2	90.03	90.45	94.35	95.68	96.86
T_3	93.24	95.26	100.02	101.25	102.35
T_4	91.00	93.29	96.55	97.35	98.26
T_5	92.09	94.56	97.25	98.15	99.36
T_6	92.88	95.08	99.05	100.00	101.02
T_7	93.21	95.48	99.75	100.26	101.23
T_8	103.92	105.56	115.23	117.62	119.26

T_9	92.68	96.35	99.86	101.05	102.35
T_{10}	95.17	98.25	101.25	102.36	104.00
T_{11}	94.63	100.53	102.56	103.35	105.23
T_{12}	97.49	99.78	107.35	109.05	110.23
SEm±	1.03	1.12	0.98	1.05	0.95
CD(P=0.05)	2.06	2.31	2.02	2.37	1.96

Summary

The effect of recommended doses of fertilizers in addition to organic manures of different sources equivalent N ha^{-1} and with their sole treatments on available soil nitrogen under incubation have shown significant variations over control (T_1) at each of 0, 30, 60, 90 and 120 days of incubation. Among the integrated treatments (T_3 to T_7). Recommended doses of NPK and additionl kg N ha^{-1} through digested sludge (T_6) was found inferior than other. However, the highest values were recorded in T_4 followed by T_7 which were significantly superior over all the treatments. There was increasing trend of available N in each treatment at each period of incubation. However, slower increase in values of respective treatments was observed at 120 DAI. At this day of incubation, all the integrated treatments have shown good health of soil in terms of higher values of available-N compare to rest of the treatments considering all the treatments at all the period of incubation, T_4 and T_7 (among the integrated treatments) and T_9 and T_{12} (among the alone organic treatment) have shown superiority with providing available nitrogen. The treatments of RDF only (T_2) was also effective and has shown higher values than the organic treatments but it was significantly lesser effective than the integrated treatments at each of the incubation period. At par values was found in the treatments of T_5, T_6 and T_{10}, T_{12} respectively within integrated approaches and alone treatments of PM and DS at all the periods of incubation. Application of organics alone increase the available P and K content in soil under different days of incubation study over application of chemical fertilizer (T_2), control (T_1) and in combined use (T_3 to T_7); the maximum being recorded in the treatments receiving 100% N through P.M (T_{10}) and FYM (T_8), respectively as P and K (mg kg^{-1}. soil) at 120 days of incubation. At different days of incubation most of the treatments were shown at par with each other within the integrated and alone treatments of organics except T_{10} in the case of P and T_8 in the case of K. the available P and K content of soil under incubation study.

Conclusion

Application of organic manures / wastes alone treatments was found to be favourable for available nitrogen, phosphorus, potassium and organic carbon under incubation study. Application of 100 per cent nitrogen through urea along with N ha-1 through carpet waste was found to be highly effective for achieving maximum soil health. The application of recommended doses of N through farm yard manure, poultry manure, press mud and carpet waste were also found suitable for nutrient acquisition as organic sources.

Recommendations

On the basis of 120-days of incubation final recommendation for the farmers will not be justified. Nevertheless, the findings indicated that if recommended doses of N are to be applied through the organics (FYM, CW, PM, DS and PyM), there is a possibility of increase nutrient status in the soil in comparison to recommended doses of chemical fertilizer along with N ha-1 additional nitrogen through organic sources of nutrients and alone treatment of inorganic sources. However, the indications are that soil health improve in case of organic farming.

Acknowledgement

The corresponding author is thankful to Mr. Sanjeev Kumar Rai for preparation of the manuscript and also thanks to Dr. Kedar Nath Rai, who have provided financial and valuable support during research works and publications.

References

1. Black CA. (Ed.). Methods of soil analysis, Part I, II. Amer. Soc. Agronomy, Inc., Publishers, Madison, Wisconsin, USA, 1966.
2. Bouyoucos GL. Hydrometer method improved for making particle size analysis of soils. Agron. J,1927:54:464.
3. Gupta AP, Antil RS, Gupta VK. Effect of press mud zinc on the yield uptake of zinc nitrogen by corn. J. Indian Soc. Soil Sci,1986:34:810-814.
4. Indian Economy. Himalaya Publishing House, New Delhi, 2003.
5. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi, 1973.
6. Jagtap PB, Patil JD, Nimbalkar CA, Kadlag AD. Influence of integrated nutrient management on soil properties release of nutrients in a saline-sodic soil. Journal of the Indian Society of Soil Science,2007:55(2):147-156.
7. Kant S, Kumar R. Effect of gypsum, pyrite, press-mud farmyard manure on soil properties yield of rice (Oryza sativa). Indian J. Agric. Sci,1992:62(3):191-195.
8. Mukherjee SK, Biswas TD. Textbook of Soil Science; Tata McGraw Hill Publishing Company Limited, New Delhi,2000:2:55.
9. Panse VG, Sukhatme PV. Statistical methods for Agricultural Workers, ICAR, New Delhi, 1967.
10. Ram S, Chauhan RPS, Singh VP. Integrated use of organic fertilizer nitrogen in rice (Oryza sativa) under partially reclaimed sodic soil. Indian J. Agric. Sci,2000:70(2):114–116.
11. Santhy P, Velusamy MS, Murugappan V, Selvi D. Effect of inorganic fertilizers fertilizer-manure combination on soil physicochemical properties dynamics of microbial biomass in an Inceptisol. J. Indian Soc. Soil Sci,1999:47(3):479–482.
12. Subhiah BV, Asija CL. A rapid procedure for the estimation of available N in soil. Curr. Sci,1956:25:259-260.
13. Walkley A, Black CA. Estimation of organic carbon by chromic acid titration method. Soil Sci,1934:37:29-38.
14. Watanabe FS, Olsen SR. Test of an ascorbic acid method for determining phosphorous in water NaHCO3 extracts from soil. Proc. Soil Sci. Am, 1956, 667-679.
15. Yaduvanshi NPS. Effect of five years of rice-wheat cropping NPK fertilizer use with without organic green manures on soil properties crop yields in a reclaimed sodic soil. J. Indian Soc. Soil Sci,2001:49(4):714–719.