International Journal of Agriculture and Plant Science
www.agriculturejournal.in
Online ISSN: 2664-7664, Print ISSN: 2664-7656
Received: 14-01-2024, Accepted: 06-02-2024, Published: 29-02-2024
Volume 6, Issue 1, 2024, Page No. 19-24

Influence of organic and inorganic sources of nutrients on availability of major nutrients in the soil

Kedar Nath Rai[1], TrilokNath Rai[2*], Sanjeev Kumar Rai[3], Arvind Kumar Rai[3]
[1] Associate Professor and Head, Department of Soil Science & Agricultural Chemistry, Kamla Nehru Institute of Physical and Social Sciences, Sultanpur, Uttar Pradesh, India
[2] Subject Matter Specialist, Department of Soil Science & Agricultural Chemistry, Krishi Vigyan Kendra (ICAR-CSSRI), Dhikunni, Sandila, Hardoi, Uttar Pradesh, India
[3] Research Scholar, Department of Soil Science & Agricultural Chemistry, Kamla Nehru Institute of Physical and Social Sciences, Sultanpur, Uttar Pradesh, India

Abstract
An investigation was carried out to study the "Influence of organic and inorganic sources of nutrients on availability of major nutrients in the soil" under incubation in the Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar-pradesh. The experiment were 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 were applied 14 days before incubation study. The effect of recommended doses of fertilizers in addition to organic manures of different sources equivalent to 10 kg 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 10 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 days 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 increased from 4.91 to 40.02 mg kg^{-1} and 67.31 to 114.26 mg kg^{-1} respectively under incubation study. The incorporation of FYM alone (T_8) improved the organic carbon significantly as against application of rest of the treatments over long periods of incubation at different days of intervals. Due to application of organics alone or in combinations most of the values were shows at par among them- selves except T_8 and T_3 treatment at different days of incubation. In comparison to the O.C status of soil treated with various organic N sources, the status of organic carbon significantly increased in the soil treated with 100% chemical fertilizer (T_2) and control (T_1), except T_9 and some cases in T_{12}. Among different days of incubation the maximum and minimum values of O.C were recorded at 0 and 120 days of incubation, respectively.

Keywords: Organic sources, inorganic sources, microbial population under incubation study

Introduction

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].

Since, the soil quality affects the yields of crop, attention should also be diverted to look at this aspects. For example India harvested 75.57 million tonnes of wheat during crop year 2000. Its production shall have to be around 109.0 million tonnes by the year 2020. A.D. In such an eventuality, between now and 2020 AD, production has to be increased by 40.0 to 42.0 million. Since, there is no scope for area expansion, additional production has to come from increased productivity. This implies that the current all India average yield of 2707 kg ha^{-1} has to be increased to 4200 kg ha^{-1} in next 16 years. (Indian Economy, 2003). Masanobu Fukuoka is considered as a father of Modern-day Natural Farming. Natural farming, also referred to as 'The Fukuoka Method', 'The Natural Way of Farming' or 'Do-Nothing Farming', is an ecological farming approach established by

Masanobu Fukuoka (1913–2008). Shri Subhash Palekar is an agricultural scientist who pioneered the concept of Natural Farming in the country. Palekar drew his inspiration from ancient Indian farming techniques, at the heart of which are cow dung and cow urine. *Organic Agriculture* is a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity and cycles.

Materials and Methods: The methods used along with references for soil analysis have been presented in table no.1.

Table 1: Method used for soil pysico-chemical analysis

Parameter	Method used	References
Soil texture	Hydrometer method	Bouyoucos (1927)
W.H.C. (%)	Keen box	Black *et al*. (1966)
B.D. (Mg m-^{3})	Pycnometer	Black *et al*. (1966)
P.D. (Mg m-^{3})	Pycnometer	Black *et al*. (1966)
C.E.C. [c.mole (p^+) kg^{-1} soil)]	Centrifuge method	Jackson (1973)
pH (1:2.5 soil water suspension)	Glass electrode pH meter	Jackson (1973)
EC (1:2.5 soil water suspension)	Conductivity bridge	Jackson (1973)
Organic carbon (g kg^{-1})	Chromic acid digestion	Walkley and Black's (1934)
Available – N (mg kg^{-1})	Alkaline permanganate method	Subbiah and Asija (1956)
Available – P (mg kg^{-1})	Olsen's method	Wattanabe and Olsen (1956)
Available – K (mg kg^{-1})	Flame photometer (Ammonium acetate extract)	Jackson (1973)

Details of Treatment: The treatments used have been presented in table no.2.

Table 2

T_1	**:**	**Control**
T_2	:	Full dose of NPK (N:P_2O_5:K_2O) 120 : 60 : 60
T_3	:	Full dose of NPK + 2 tonne ha^{-1} FYM (equivalent to 10 kg N)
T_4	:	Full dose of NPK + 85 kg CW ha^{-1} (equivalent to 10 kg N)
T_5	:	Full dose of NPK + 1 tonne PM ha^{-1} (equivalent to 10 kg N)
T_6	:	Full dose of NPK + 1 tonne DS ha^{-1} (equivalent to 10 kg N)
T_7	:	Full dose of NPK + 0.4 tonne PyM ha^{-1} (equivalent to 10 kg N)
T_8	:	120 kg N as FYM (24 tonne ha^{-1}) + PK
T_9	:	120 kg N as CW (1 tonne ha^{-1}) + PK
T_{10}	:	120 kg N as PM (12 tonne ha^{-1}) + PK
T_{11}	:	120 kg N as DS (12 tonne ha^{-1}) + PK
T_{12}	:	120 N as PyM (5 tonne ha^{-1}) + PK

Statistical Analysis

All the experimental data of soil 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 and discussion

Physico-chemical characteristics of Soils: The soils of Agricultural Research Farm area belong to the soil order Inceptisol. Analysis of physico-chemical properties shows that soil was sandy loam in texture with water holding capacity 46.5%, neutral in reaction (pH 7.2) and EC 0.04 dSm^{-1}. The CEC of the soils was 15.50 c.mol (p^+) kg^{-1} soil. The content of organic carbon and total N, P,K of the soils was 5.5g kg^{-1}, 0.048%, 0.031% and 0.038%, respectively. The content of available N, P and K was 79.24, 4.91 and 63.31 mg kg^{-1}, respectively which fall under low category of soil fertility. Available mincronutrients, Zn, Mn, Cu and Fe were found sufficient. The changes in the above properties have been discussed experiment wise.

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 to 10 kg N ha^{-1} and with their sole treatments on available N, P and K in the soil have show significant variation over control at each of 0,30. 60. 90 and 120 DAI. The available N varied from 79.24 mg kg^{-1} in control to maximum 137.73 mg kg^{-1} due to T_4 (100% NPK + 10 kg 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 110.72 mg N kg^{-1} 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 (fig.1a and 1b).

The available phosphorus (fig 2a and 2b) was varying from 4.91 in control to 26.70 mg kg^{-1} in the case of 100% N through P.M (T_{10}) at zero days of incubation. Here, all the integrated treatment were 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} for (24.77 and 24.77 mg P kg^{-1} soil respectively). 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 of 29.78, 38.45, 39.85. and 40.02 mg kg^{-1} soil at 30, 60, 90, and

120 DAI, respectively followed by the similar performance of T_{10} and T_8 also.

The available potassium (fig 3a and 3b) was varying from 67.31 mg kg^{-1} soil in control (T_1) to maximum 98.92 mg kg^{-1} 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 value obtained by this treatment was 98.68, 102.65, 110.23, 112.62 and 114.26 mg kg^{-1} soil respectively, at 0,30,60,90, and 120-DAI. The above 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 with values of 110.23 and 105.23 mg kg^{-1} soil, respectively.

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 + 10 kg 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 to 10 kg 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 (Laxminarayana; 2006 and 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 remain 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**.**

Effect of organic and inorganic sources of nutrients on organic carbon content during incubation study: Data regarding organic carbon content (g kg^{-1}) have been shown by fig.4 a, 4.b. Significant as well as non-significant variation in the effect of treatments were recorded at 0, 30, 60, 90, and 120-DAI. The values varied from 5.50 to 7.72 g kg^{-1} at zero days of incubation. The lowest value was observed in case of control (T_1) and the highest value was found in case of treatment T_8 (100% N through FYM) followed by T_{10}, T_{11}, T_{12}, T_9, T_3, T_5, T_6, T_7, T_4 and T_2 with values as 6.41, 6.12, 5.82, 5.79, 5.70, 5.58, 5.54, 5.53, 5.52, and 5.51 respectively. At zero days of incubation significant improvement was recorded in combined use of 100% NPK + equivalent to 10 kg N ha^{-1} through organic sources except, T_3 and T_5.at zero days of incubation, at par values were found in the treatment of T_2, T_4, T_5, T_6, and T_7. Mostly, through our experimentation period (0 to 120 days), when only organic sources were given (T_8 to T_{12}) they proved superior to integrated approaches of inorganic and organics. The decomposition position of organic sources at 30, 60, 90, and 120 DAI was 30-35%, 50 to 55%, 65to 70%, and 75 to 80 %, respectively in different treatment. At 30-DAI at par value were found in the treatments of T_2, T_4, T_5, T_6, and T_7. At 90 and 120 DAI significant improvement in organic carbon content was found in all treatment except T_2 (100% NPK as chemical fertilizers).

In the present study, greater increase in organic carbon content in T_8 (100% N as FYM) was probably due to higher organic carbon content in FYM. Yaduvanshi (2001) [15] was also of the opinion that organic carbon in the soil increases with application of organics. Few workers like Gupta *et. al,*. (1986) [3], Kant and Kumar (1992) [7] Mukherjee *et al.,* and Ram *et.al.,* (2000) [8] observed increased organic carbon content in soil due to incorporation of PM and DS. The lower content of organic carbon in T2 is due to application of 120 N ha^{-1} through chemical fertilizers with narrow C:N ratio. Similarly, low organic carbon content observed in T_4 and T_7 (CW and PyM), treatments may also be due to lower C:N ratio as compared to FYM and PM.

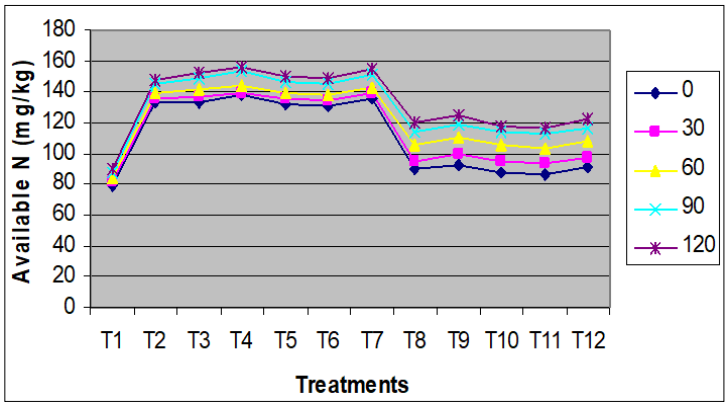

Fig 1a: Effect of organic and inorganic sources of nutrients on available N in the soil during incubation study

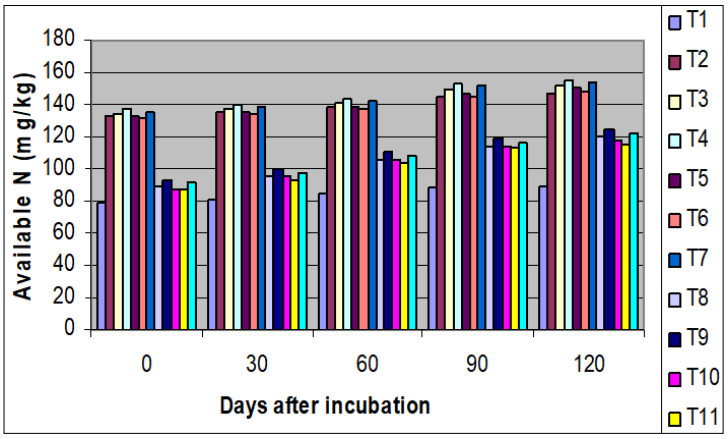

Fig 1b: Effect of organic and inorganic sources of nutrients on available N in the soil during incubation study

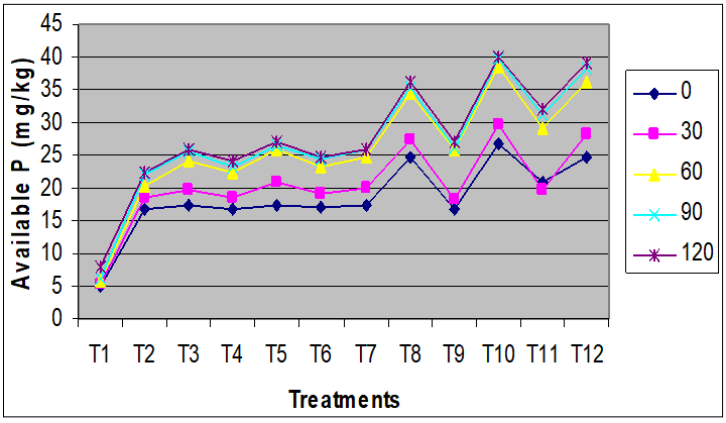

Fig 2a: Effect of organic and inorganic sources of nutrients on available P in the soil during incubation study

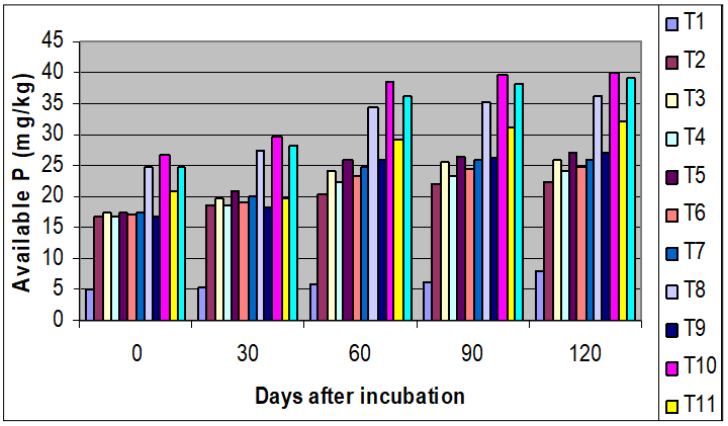

Fig 2b: Effect of organic and inorganic sources of nutrients on available P in the soil during incubation study

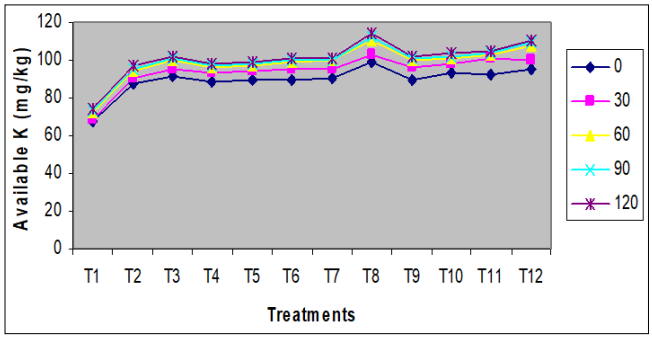

Fig 3a: Effect of organic and inorganic sources of nutrients on available K in the soil during incubation study

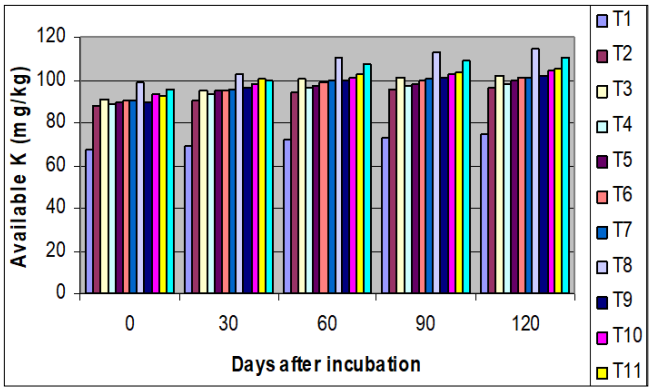

Fig 3b: Effect of organic and inorganic sources of nutrients on available K in the soil during incubation study

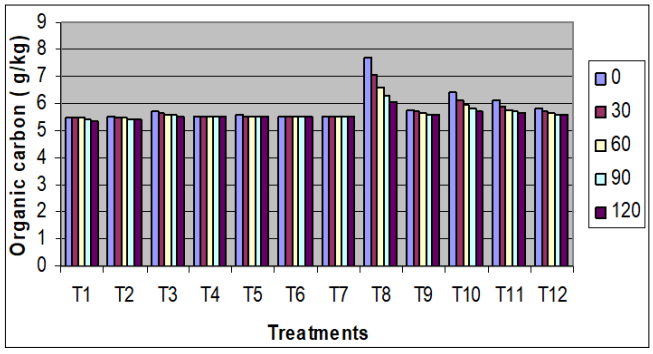

Fig 4a: Effect of organic and inorganic sources of nutrients on organic carbon content during incubation study

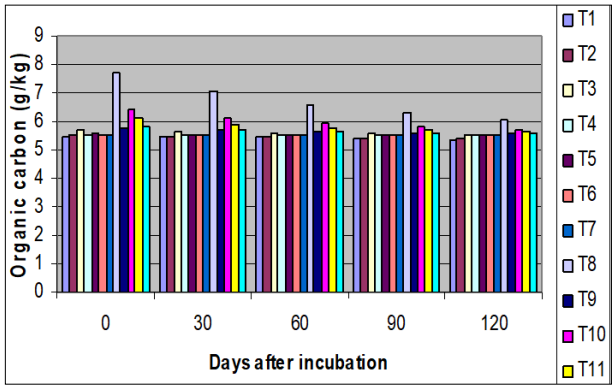

Fig 4b: Effect of organic and inorganic sources of nutrients on organic carbon content during incubation study

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 10 kg 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 is 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 10 kg 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 author is thankful to Mr. Sanjeev Kumar Rai for typing of manuscript and also thanks to Dr. K. N. Rai, who provided financial support for research works and publications.

References

1. Black CA. (Ed.). Methods of soil analysis, Part I and 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 and zinc on the yield and uptake of zinc and 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 and 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 and farmyard manure on soil properties and 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 and 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 and fertilizer-manure combination on soil physicochemical properties and 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 and titration method. *Soil Sci,*1934:37:29-38.
14. Watanabe FS, Olsen SR. Test of an ascorbic acid method for determining phosphorous in water and $NaHCO_3$ extracts from soil. *Proc. Soil Sci. Am,* 1956, 667-679.
15. Yaduvanshi NPS. Effect of five years of rice-wheat cropping and NPK fertilizer use with and without organic and green manures on soil properties and crop yields in a reclaimed sodic soil. *J. Indian Soc. Soil Sci,*2001:49(4):714–719.