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Monitoring of Nutrient Status in an Alluvial Soil Amended with Different Inorganic and Organic Fertilizers

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A B S T R A C T

An incubation study was conducted to monitor the changes in nutrient status of a typic haplaquept soil treated with organic and different inorganic fertilizers including S and B. Results revealed that balanced usage of organic and inorganic fertilizers plays a critical role in sustainable agriculture. Addition of FYM increased the organic carbon content and availability of nutrients over soil alone and soil treated with only inorganic fertilizers. Results further revealed that the beneficial effects of FYM is recorded when it is applied with S and B. Again application of higher doses of S and B along with organic and inorganic fertilizer intensified the availability of nutrients in soil.

Introduction

Higher food production needs higher amount of plant nutrients. Use of inorganic fertilizers has increased considerably to meet the higher nutrient requirements of the present day which creates imbalance in nutrient supply leading to decline in soil fertility, crop productivity and sustainability. Balanced nutrition based on soil test value is the key to sustain and improve soil productivity. A suitable combination of secondary and micronutrients is an important factor that affects the productivity of the crops. Organic resources play a dominant role in soil properties through their short-term effects on nutrient supply and longer-term contribution to soil organic matter (SOM) formation (Palm *et al*., 2001). In order to supply all the nutrients to soil in adequate amount and to maintain its good health, it is necessary to use organic sources like FYM in combination with fertilizers. They not only supply macro-nutrients but also meet the demand of micro nutrients, besides improving soil health (Arbad and Ismail, 2011). Boron is a micro nutrient which is deficient in most of the soils of West Bengal , plays a vital role in augmenting growth and yield of mustard (Naik *et al.*, 2015). The present experiment was, therefore, conducted to study the influence of FYM, S and B on soil fertility build up as well as to monitor the changes in nutrient status of an alluvial soil.

Materials and Methods

Composite soil sample was collected from a farmer's field situated at Gotra mouza in Chakdah block in the district of Nadia West Bengal. The soil has been classified as Typic Haplaquept by National Bureau of Soil Science (NBSS and LUP). The field was generally cultivated for rice-mustard cropping sequence. The soils were collected prior to rice cultivation.

The collected soil sample was air-dried, ground in wooden pestle and mortar and passed through 80 mesh seive. The soil sample was analyzed for different physical, chemical and microbiological parameters following standard analytical procedures and the data are presented in Table 1. The FYM used as treatment material contain N, P_2O_5, K_2O, S and B about 0.58%, 0.26%, 0.40%, 0.02% and 2.8 $mgkg^{-1}$.

The laboratory experiment was conducted during December-February 2014-2015 under controlled laboratory conditions. Each pot containing three kg soils were incubated for a period of ninety days. Arable moisture level (60 % of water holding capacity of the soil) was maintained throughout the incubation study. Loss of moisture due to evaporation was replenished every alternate day by difference in weight. In order to ascertain the effect of added secondary and micronutrients along with NPK fertilizers and FYM, the following six treatment combinations in completely randomized design were adopted. All the treatments are replicated thrice.

T_0	**= Soil**
T_1	= Soil + NPK ($N-P_2O_5-K_2O$ at 80-40-40 Kg ha^{-1})
T_2	= Soil +NPK +FYM (FYM at 1% dry wt. of soil)
T_3	= Soil +NPK+ FYM +B (B at 10 $mgkg^{-1}$)
T_4	= Soil +NPK +FYM+S (S at 20 $mgkg^{-1}$)
T_5	= Soil +NPK+ FYM + S (S at 20 mgkg-^{1}) +B (B at 10 $mgkg^{-1}$)

To the allocated pots N, P and K were applied at 80, 40 and 40 Kg ha^{-1} as N, P_2O_5 and K_2O through urea, single super phosphate and muriate of potash, respectively. Well decomposed FYM was added as treatment material at 1% dry weight basis. Sulphur was applied through elemental sulphur (95%puriety) at 20 $mgkg^{-1}$ and Boron was applied through borax (10.5% B) at 10 mg kg-^{1}. All treatment materials were added to soil as basal on the 1st day of experiment. Samples from each pot were analyzed on the 15th, 30th, 60th and 90th day of incubation study. Soils are analysed periodically for oxidisable organic carbon, available nitrogen, available phosphorus, available potassium, available sulphur, DTPA extractable Zn and Microbial Biomass carbon. Different soil parameters were analyzed statistically following the methods of Walter T. Federar (1927) to study the significance of means among treatments at different sampling stages of incubation study.

Results and Discussion

Exchangeable NH_4^+

Changes in the amount of exchangeable NH_4^+in soil treated with different combinations of inorganic and organic fertilizers are presented in Table 2. Irrespective of treatments, NH_4^+ decreased up to 60th (except T_3) thereafter showed an increasing trend upto 90th day of incubation (except in control, T_0) (Table 2). The effect of added N fertilizer is well marked in all the treatments. The decrease in NH_4^+ upto 60th

day of the experiment is mainly due to the losses through denitrification and volatilization (Burger and Venterea, 2008). Combined application of NPK fertilizers along with FYM and B leads to accumulate highest amount exchangeable NH_4^+ on 15th and 30th day of incubation, whereas on 60th day as well as on 90th day of incubation The increase in exchangeable NH_4^+ is due to spurt in ammonifying micro-organisms under the favorable micro-environment created in soil due to addition of all types of energy materials applied through balanced fertilization (Benbi *et al.*, 2007). Addition of micro nutrient had little effect in increasing exchangeable NH_4^+ content in soil. Statistical analysis of the results revealed that the treatments, stages of sampling as well as their interactions are significant.

Soluble NO_3^-

Similar trend of results of soluble NO_3^-- N was observed which was found for changes in exchangeable NH_4^+ in soil (Table 2). Irrespective of stages of sampling, soluble NO_3^--N increases with integration of FYM along with S and B. Again, irrespective of treatments, NO_3^- content remained more or less same in 15 and 30th day of sampling and then decreased slightly (except in treatment T_2) due to loss only through denitrification (Casy and Clark, 2012). Highest amount of concentration were found on 90th days due to more activity of nitrifying bacteria as well as more N mineralization (Woldendrop and Laanbrock, 1989) under balanced nutrition system. Data are statistically significant with respect to stages of sampling, treatments.

Table.1 Physical and chemical properties of the soil used for the incubation study

Sl. No	Parameters	Result	Reference Method
1.	pH	7.56	Jackson, 1973
2.	Electrical Conductivity(dsm^{-1})	0.190	Jackson, 1973
3.	Mechanical Separates		Piper, 1966
i)	Sand %	16.8	
ii)	Silt %	18.0	
iii)	Clay %	65.2	
	Textural class	Clay loam	USDA, 1975
4.	Cation exchange capacity C $mol(p+)kg^{-1}$	24.6	Schollen Berger and Simon, (1945)
5.	Organic carbon (%)	0.52	Walkley and Black, 1934
6.	Water holding capacity (%)	47.90	Baruah and Barthakur,1997
7.	Total Nitrogen (%)	0.088	Stevenson,1996
8.	Available (NH_4^+)	123.47	Bremner and Keeney, 1965
9	Available (NO_3^-)	24.16	
10	Available phosphorus ($kgha^{-1}$)	46.34	Olsen et al.,1954
11	Available potassium ($kgha^{-1}$)	150.74	Jackson,1973
12	Available sulphur (mg kg^{-1})	6.38	Chesnin and Yien,1951
13	Available B (mg kg^{-1})	0.46	Wolf, 1971
14	Microbial biomass carbon (µgkg-1)	95.36	Joergenson,1995
15	USDA Nomenclature	Typic Haplaquept	USDA,1975

Table.2 Influence of inorganic and organic amendments on changes in availability of different soil parameters

Treatments	Incubation Period (Days)	NH_4^+ $kgha^{-1}$	NO_3^- $kgha^{-1}$	Av. P $Kgha^{-1}$	Av. K $Kgha^{-1}$	OC (%)	MBC µg kg^{-1}
T_0 =Soil	15	176.03	38.81	64.10	184.50	0.57	111.2
	30	124.06	35.08	62.63	166.10	0.59	117.06
	60	125.2	33.1	56.46	153.50	0.57	118.36
	90	113.06	34.83	53.10	139.90	0.64	122.13
T_1=Soil+ NPK	15	195.23	36.01	80.53	217.26	0.59	116.13
	30	122.16	40.53	81.80	239.50	0.63	127.12
	60	133.2	28.1	95.26	194.00	0.71	129.23
	90	171.06	38.58	90.80	173.76	0.74	135.4
T_2=Soil+NPK+FYM	15	211.63	46.01	166.46	263.40	0.56	137.83
	30	156.26	42.08	178.53	267.53	0.76	143.31
	60	176.1	50.5	164.13	218.83	0.76	141.21
	90	205.16	41.08	153.26	206.73	0.8	133.42
T_3=Soil+ NPK+ FYM +B	15	233.13	46.51	160.20	255.13	0.54	131.68
	30	161.26	55.03	168.66	263.30	0.82	157.56
	60	134.2	34	156.66	223.23	0.75	148.09
	90	184.96	51.48	157.33	204.50	0.83	161.23
T_4= Soil+ NPK + FYM + S	15	214.43	33.06	147.53	258.40	0.71	126.34
	30	151.46	38.53	154.16	264.83	0.71	141.04
	60	141.1	37.5	159.16	223.30	0.71	149.42
	90	176.16	43.08	160.23	183.03	0.79	161.1
T_5= Soil + NPK+ FYM +S + B	15	222.03	45.51	154.50	257.93	0.7	137.54
	30	230.26	38.63	160.76	256.26	0.73	157.76
	60	107.1	24.15	164.96	219.93	0.76	154.1
	90	162.96	48.03	160.13	201.9	0.81	165.14
SE_m(Tr x Days)		0.78	0.77	0.51	0.60	0.01	0.90
CD (P=0.05)		2.20	2.19	1.46	1.70	0.02	2.55

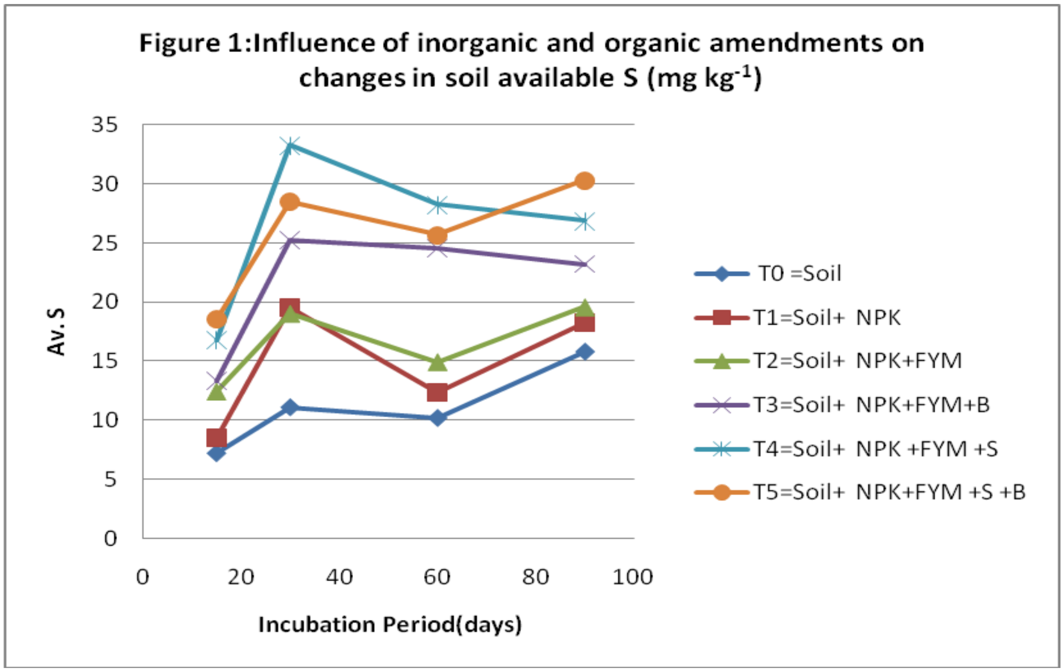

Figure 1:Influence of inorganic and organic amendments on changes in soil available S (mg kg^{-1})

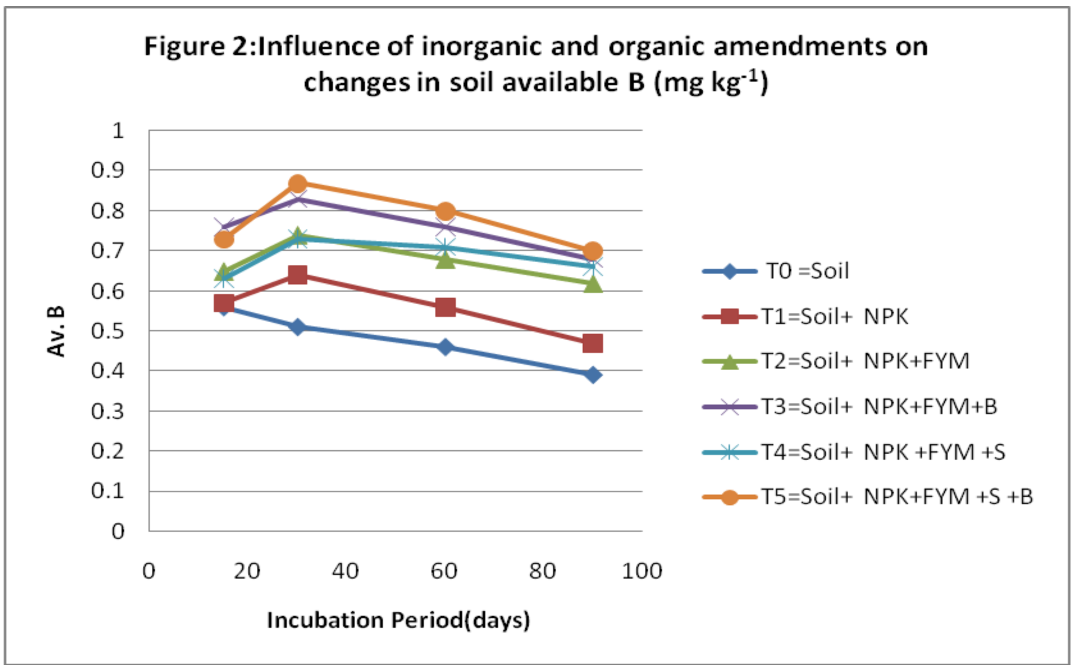

Figure 2:Influence of inorganic and organic amendments on changes in soil available B (mg kg^{-1})

Available P

Irrespective of treatments (except in control), in general, available phosphorus showed an increasing trend up to 30th then showed an decreasing trend up to 60th day (with T_2 and T_3) and then slightly decreased with T_1 and T_2 up to the last stage of incubation (Table 2). Highest amount of accumulation of available phosphorus on 30th day of experiment is due to mineralization of organic phosphorus as well as non utilization of available phosphorus by the growing crops. The decrease in available phosphorus at the last stage of incubation in some treatments is due to consumption of available phosphorus by the microorganisms and the conversion of available phosphorus into other inorganic and organic form with time (Clark, 1998).The decrease in available phosphorus at the last stage of incubation in some treatments is due to consumption of available phosphorus by the microorganisms and the conversion of available phosphorus into other inorganic and organic form with time (Antil and Singh, 2007). The effect of added treatment materials is very prominent in accumulation of available P. Addition of organic and inorganic fertilizers including micronutrients is essential for the proliferation of P-solubilizing organisms in soil (Buurash, 1997), which in turn increased the available P content in soil (Fraser, 1994).

Available K

Table 2 showed that amount of available K first increased up to 30th day and afterward it decrease up to 90th day in all the treatment except T_3. Results in Table 2 further showed that highest amount of available K are accumulated in treatment T_3 in all the sampling stages. This is perhaps due to release of higher amount of available K from FYM and inorganic source under favorable microbial growth. Similar results were also obtained (Burger and Venterea, 2008).

Organic Carbon

Changes in the amount of oxidizable organic carbon in soil treated with different combinations of inorganic and organic fertilizers are presented in Table 2. Results revealed that irrespective of treatments, in general, oxidizable organic carbon increased with increase in the period of incubation. The increase in organic carbon is more prominent in organic matter treated systems. FYM increased the organic carbon content in soil. Highest amount of oxidizable organic carbon content is accumulated in soil in T_3 closely followed by T_5 treatment. Balanced fertilization increased the proliferation of microbial population and its activities in soil. The death of these microbes enhances microbial biomass carbon which in turn increases the oxidizable organic carbon content in soil (Sarkar and Singh, 1997). The increase in oxidizable organic carbon with the period of investigation particularly at the last stage is due to increase in number of micro-organisms. Decomposition of dead cells of these organisms increased the organic carbon content in soil at the later stage of incubation (Premi, 2003). There were earlier works of (Abraham and Lal, 2003) reported percent increase of organic carbon in the soil due to integration of different nutrient sources. Statistical analysis of the results revealed that the treatments differ significantly among themselves.

Microbial Biomass Carbon

Irrespective of treatments, microbial biomass carbon increased with increase in the period of incubation (Table 2). The increase in microbial biomass carbon with time is due to proliferation of microbial activities in soil. Results also revealed that addition of organic matter further increased the microbial biomass carbon in soil. This is due to supply of energy rich materials for the growth and activities of microorganisms prevail in soil (Kanchikerimath and Singh, 2001). Treatment T_5 and T_3 are statistically at par with each other. Results clearly pointed out that biomass carbon was increased within 15 days very sharply and reached a near constant level after 30 days of incubation (Paul and Solaiman, 2004). In T_5, T_3 and T_4 treatments MBC results showed significant results for all the incubation stages due to balanced fertilization which help to proliferate microbial growth and in turn higher MBC in organic matter added under treatments. Results of treatments and stages of sampling as well as their interactions differ significantly.

Available S

Figure 1 represent changes in the amount of available S in soil treated with different inorganic and organic fertilizers. Higher amount of available S accumulated in soil due to mineralization of higher amount organic matter present in soil. However, the accumulation of mineralized sulphur in soil depends upon treatment combinations (Saren and Saha, 2018). Available S slightly decreased from 30 to 60 day period of incubation and then again increased in the last stage of incubation except in treatment T_3 and T_4. Statistical analysis of the results, however, showed that the treatments differ significantly with each other. The stages of sampling as well as interaction between stages and treatments are also significant.

Available B

Available boron increased on 30th (except in control, T_0), thereafter showed a decreasing trend upto 90th day of incubation (Figure 2). Application of organic matter significantly increased the availability of boron in soil along with organic matter and full dose of NPK. This is due to release of boron from adsorbed phase to soil solution form which is available to plants Berger, 1962). Application of boron in combination with NPK, FYM and S (treatment T_5) increased the availability of B in soil. Gupta (1979) also observed that the application of FYM resulted in an increase in the content of the boron in the soil. The similar finding was also reported Yadav (2016). Data are statistically significant with respect to treatments and stages of sampling as well as their interaction.

Application of research

The results of the laboratory experiment can be extrapolated under field condition. The results of field experiment may be then implemented in vast area of alluvial soil of West Bengal to raise mustard crop with high yield.

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