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Changes in Soil Chemical Properties as Affected by Application of different Levels of Bio-K

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ABSTRACT

A soil incubation experiment was conducted to study the changes in soil chemical properties and rate of release of nutrients in three soil types viz; red, black and laterite soils which were treated with FYM and three different levels of bio-K during December to February, 2011 at Department of Soil Science and Agricultural Chemistry, UAS, GKVK, Bengaluru. With the increased levels of bio-K, the pH of red, black and laterite soils decreased slightly, but FYM at 25 t ha^{-1}, significantly increased pH of the red and laterite soils and decreased pH of the black soil. Generally, the EC of all the treated soils increased due to application of FYM and bio-K. With increase in the level of bio-K, the organic carbon, available nitrogen and available phosphorus content of all soils increased, but FYM @ 25 t ha^{-1}, significantly increased the organic carbon, available nitrogen and available phosphorus content of all the soils. The available potassium content of soil was higher in treatment which received bio-K @ 1000 kg ha^{-1} than the treatment receiving FYM @ 25 t ha^{-1}.

Keywords : Bio-K; Soil chemical properties

RECYCLING of nutrients through crop residues, animal manures and industrial wastes is one of the alternatives to improve soil and crop productivity. Also, residues return carbon to the soil, which improves soil structure, the ability of the soil to hold nutrients and water. Residues provide potassium (K) as well as nutrients that may not be available in inorganic fertilizers.

Industrial growth resulted in generation of large quantity of solid and liquid wastes posing a threat to the environment. Distillery is one such industry which is generating large quantities of liquid wastes in the form of spentwash. Bio-K; a brown coloured powder is a value added product of distillery industry, where untreated spentwash is spray dried at high temperature. It retains most of the nutrients of spent was particularly potassium (More *et al.,* 2008). Potassium content ranges from 13-15 per cent and can be used as a source of K. Hence, the present investigation was conducted to study the effect of different levels of bio-K on soil chemical properties compared with FYM.

MATERIAL AND METHODS

Incubation experiment was conducted to study the changes in soil properties and rate of release of nutrients in three soil types *viz.,* red, black and laterite soils which were treated with FYM and three different levels of bio-K during December to February, 2011 at Department of Soil Science and Agricultural Chemistry, UAS, GKVK, Bengaluru. The 5 treatments consisted of Absolute control T_1, FYM @ 25 t ha^{-1} T_2, Bio-K @ 500 kg ha^{-1} T_3, Bio-K @ 750 kg ha^{-1} T_4, Bio-K @ 1000 kg ha^{-1} T_5.

Chemical composition of bio-K and FYM in the experiment is shown in Table 1. Also, initial soil samples

TABLE 1
Physico-chemical properties of bio-K and FYM used in the incubation experiment

Parameter	Values	
	FYM	Bio-K
Moisture content (%)	27.85	8.64
Bulk density (g cm^{-3})	-	0.61
pH (1:10)	7.62	9.87
EC (1:100) (dS M^{-1})	0.26	6.53
Carbon (%)	22.14	25.5
Nitrogen (%)	0.85	2.28
Phosphorus (%)	0.25	0.12
Potassium (%)	0.72	16.2
Calcium (%)	0.55	1.52
Magnesium (%)	0.20	2.40
Sulphur (%)	0.18	1.46
Iron (mg kg^{-1})	63.5	2939.5
Manganese (mg kg^{-1})	145	124
Zinc (mg kg^{-1})	29	104
Copper (mg kg^{-1})	3.5	44.5
C : N ratio	26:1	11:1

TABLE 2
Initial properties of soils used in the incubation experiment

Parameter	Red soil	Black soil	Laterite soil
Physical Properties			
Coarse sand	51.1	9.9	63.65
Fine sand	29.1	18.30	26.35
Silt (%)	9.2	19.5	7.6
Clay (%)	10.5	52.3	2.4
Soil type	Sandy loam	Clay	Gravelly sandy Loam
Chemical properties			
pH (1:2.5)	6.34	0.01	5.13
EC (1.2.5) (dSm^{-1})	0.15	0.61	0.046
Organic carbon (%)	0.48	0.33	0.62
Available N (mg kg^{-1})	65.80	56.0	81.2
Av. P_2O_5 (mg kg^{-1})	4.32	8.64	1.32
Av. K_2O (mg kg^{-1})	155.6	548.4	136

were analyzed for its properties which is presented in Table 2.

Each air-dried (2 mm sieved) soil weighing 1 kg was taken in plastic pots and thoroughly mixed with Bio- K / FYM as per the treatments in four replications. The soils were incubated at field capacity under greenhouse condition. The water content of the soil was maintained throughout the experiment at field capacity by weighing the pots and adding water, if required. The experiment was conducted for 90 days and periodic sampling was done at 30, 60 and 90 days of incubation to study the changes in pH, EC, OC, available NPK content of soils. During December 2010 to February 2011 the mean weekly maximum room temperature varied from 24.1 to 30.4°C and minimum temperature varied from 10.3-17.6°C.

RESULTS AND DISCUSSION

The results of the incubation study, on the changes in soil pH, EC, OC and available NPK content of red, black and laterite soils at different intervals due to application of bio-K levels and FYM are presented in Tables 3, 4 and 5. The pH of soil increased due to application of FYM in red and laterite soils, but slightly decreased due to application of bio-K at different levels. While, both FYM and bio-K decreased the pH of black soil, the extent of decrease was more in the black soil due to FYM bio-K.

Black soil in general recorded a higher EC value compared to red and laterite soils, because of its higher salt content. The EC of black soil reached its peak after 60 days of incubation. FYM increased the EC of soils to a greater extent than bio-k levels. Singh *et al.* (1980) reported that continuous application of FYM and chemical fertilizers decreases the soil pH by about one unit from the initial value, which is attributed to decomposition and mineralization of organic matter. Addition of FYM along with inorganic fertilizer significantly increased the electrical conductivity of soil (Subramoney and Kumaraswamy, 1989). Rodella *et al.* (1995) reported that a drop in pH was especially evident from compost, which could be explained by the accumulation of nitrogen as NH_{4+} ion and its nitrification. Similarly, application of FYM

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TABLE 3

Effect of bio-K levels on pH, EC, OC, available NPK in red soil at 30, 60 and 90 days of incubation

Treatment	pH			EC (dSm^{-1})			OC (%)			Av. N. ($mg\ kg^{-1}$)			Av. P_2O_5 ($mg\ kg^{-1}$)			Av. K_2O ($mg\ kg^{-1}$)		
	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI
T_1	6.4	6.4	6.4	0.19	0.27	0.23	0.48	0.56	0.67	112	96.6	92.4	5.64	6.66	6.30	142.8	142.8	142.8
T_2	6.6	6.6	6.6	0.33	0.46	0.49	0.71	0.79	0.70	143	119.0	114.8	21.84	21.6	21.1	204.6	204.6	205.2
T_3	6.3	6.4	6.3	0.22	0.33	0.34	0.48	0.60	0.64	112	107.8	105.0	6.01	7.11	6.01	190.8	199.8	199.8
T_4	6.2	6.3	6.2	0.21	0.33	0.34	0.64	0.64	0.69	123	107.8	96.6	6.81	7.33	6.59	199.8	200.4	225.6
T_5	6.2	6.4	6.2	0.24	0.35	0.43	0.68	0.58	0.71	125	113.4	98.0	6.74	7.69	6.74	225.0	228.6	253.2
SEm+	0.03	0.06	0.05	0.005	0.006	0.005	0.02	0.02	0.02	2.63	2.76	3.04	0.27	0.39	0.74	3.44	3.31	3.50
CD (P = 0.05)	0.09	NS	0.14	0.014	0.016	0.02	0.06	0.05	0.04	7.89	8.33	9.16	0.83	1.18	2.24	10.4	9.97	10.5

Note : T_1 : Absolute Control ; T_2 : FYM @ 25 t ha^{-1} ; T_3 : Bio-K@ 500 kg ha^{-1} ; T_4 : Bio-K@ 750 kg ha^{-1} ; T_5 : Bio-K@ 1000 kg ha^{-1} ; DAI – Days After Incubation

TABLE 4

Effect of bio-K levels on pH, EC, OC, available NPK in black soil at 30, 60 and 90 days of incubation

Treatment	pH			EC (dSm^{-1})			OC (%)			Av. N. ($mg\ kg^{-1}$)			Av. P_2O_5 ($mg\ kg^{-1}$)			Av. K_2O ($mg\ kg^{-1}$)		
	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI
T_1	8.8	8.6	8.8	0.77	0.96	0.84	0.26	0.26	0.34	74.2	70.0	58.8	7.91	8.72	8.06	569.4	573	576
T_2	8.6	8.2	8.6	0.92	0.95	0.81	0.56	0.64	0.64	91.0	77.0	78.4	18.9	18.2	16.7	576.0	600	601
T_3	8.7	8.6	8.8	0.85	0.88	0.67	0.31	0.36	0.51	72.8	71.4	65.8	8.28	8.72	8.21	568.8	600	600
T_4	8.7	8.6	8.8	0.85	0.89	0.74	0.36	0.34	0.54	77.0	74.2	71.4	8.64	8.86	8.35	588.0	606	627
T_5	8.6	8.5	8.8	0.93	0.90	0.71	0.34	0.41	0.56	81.2	72.8	72.8	9.01	9.16	8.43	598.2	622	630
SEm+	0.05	0.05	0.07	0.003	0.005	0.004	0.004	0.02	0.01	1.45	2.55	4.80	0.67	0.75	0.33	3.62	3.78	3.94
CD (P = 0.05)	0.15	0.14	NS	0.009	0.015	0.013	0.012	0.05	0.04	4.38	NS	14.5	2.04	2.25	0.99	10.9	11.4	11.9

Note : T_1 : Absolute Control ; T_2 : FYM @ 25 t ha^{-1} ; T_3 : Bio-K@ 500 kg ha^{-1} ; T_4 : Bio-K@ 750 kg ha^{-1} ; T_5 : Bio-K@ 1000 kg ha^{-1} ; DAI – Days After Incubation

in alkaline soils caused a decrease in soil pH, but its application in acid soils caused increase in soil pH (Deka and Poonia, 1997).

Application of bio-K levels and FYM in general increased the organic carbon status of all three types of soils (Tables 3, 4 and 5). Among all the treatments and different days of incubation, FYM treated soils showed significantly higher organic carbon content to a greater extent than bio-k levels. With the increased level of bio-K, there was an increase in organic carbon content of soils. Grewal *et al.* (1981) reported that continuous application of FYM to five potato crops significantly increased the organic carbon and available nutrients status in soil. The increased organic carbon content of soil due to FYM application in the present study was attributed largely to increased returns of organic matter through bio-k. Bharadwaj and Omanwar (1992) reported increased organic matter content of soil due to addition of organics through FYM along with recommended NPK.

The available nitrogen content in FYM and bio-K incorporated soils were found to increase up to 30th day of incubation and then it showed a decrease. Higher nitrogen content was recorded in FYM treated soils followed by high level of bio-K. The soil nitrogen content was lowest in control pots (Tables 3, 4 and 5). It is expected that in soils treated with FYM and graded levels of bio-K, higher nitrogen content would be observed due to decomposition of organic materials added to the soil.

Bhandari *et al*. (1999) studied the integrated nutrient management in rice-wheat system and observed that the available nitrogen status of soil decreased appreciably in control plot with continuous cropping, while application of NPK at 100 per cent level or more through chemical fertilizers or their combined use with organic N source showed an increase of 5-22 kg ha^{-1} in available N over the initial value. Merangatham and Chellamutthu (2000) reported that the post harvest soil of sunflower crop showed significant build-up of soil N compared to the initial level ranging from 165 to 228 kg ha^{-1} due to addition of FYM. All organic manures enhanced soil organic C, total N. available P, exchangeable K content of soil (Adeniyan *et al.,* 2011).

TABLE 5

Effect of bio-K levels on pH, EC, OC, available NPK in laterite soil at 30, 60 and 90 days of incubation

Treatment	pH			EC (dSm^{-1})			OC (%)			Av. N. (mg kg^{-1})			Av. P_2O_5 (mg kg^{-1})			Av. K_2O (mg kg^{-1})		
	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI	30 DAI	60 DAI	90 DAI
T_1	5.5	5.6	5.2	0.17	0.20	0.23	0.64	0.64	0.76	103.6	84.0	81.2	1.23	1.24	1.39	114.0	118.8	137.4
T_2	6.0	5.9	5.8	0.35	0.29	0.39	0.93	0.93	1.01	142.8	127.0	89.6	4.76	4.98	4.18	171.6	200.4	204.0
T_3	5.4	5.6	5.2	0.17	0.21	0.26	0.64	0.64	0.78	109.0	85.4	82.6	1.32	1.46	1.61	144.0	171.6	171.6
T_4	5.1	5.6	5.2	0.18	0.21	0.24	0.64	0.71	0.78	131.6	88.2	88.4	1.37	1.46	1.83	171.6	199.2	199.8
T_5	5.0	5.4	5.1	0.21	0.25	0.38	0.66	0.78	0.86	137.2	91.0	89.6	1.61	1.61	1.98	199.8	228.6	228.6
SEm+	0.05	0.06	0.05	0.005	0.013	0.004	0.02	0.03	0.04	3.06	2.89	2.95	0.16	0.08	0.12	3.95	5.07	4.79
CD(P=0.05)	0.15	0.17	0.14	0.015	0.039	0.012	0.07	0.08	0.13	9.21	8.73	NS	0.49	0.25	0.37	11.91	15.3	14.45

Note : T_1 : Absolute Control ; T_2 : FYM @ 25 t ha^{-1} ; T_3 : Bio-K@ 500 kg ha^{-1} ; T_4 : Bio-K@ 750 kg ha^{-1} ; T_5 : Bio-K@ 1000 kg ha^{-1} ; DAI – Days After Incubation

There was significant difference between FYM and bio-K treated soils with regard to available phosphorus content at all the stages of the incubation. FYM treated soils showed higher available phosphorus content than bio-K at different levels (Tables 3, 4 and 5).

The increase in P availability was attributed to some native inorganic P released from mineralization of organic P pools of soil and decomposition of FYM and bio-K during incubation. Sharma and Gupta (1991) reported that the available soil P was about 15-16 kg/ha without P fertilizer or manure, and 45-49 kg with 90 kg P + farmyard manure. Organic C, available NPK content of soil was found to be increased with increase in the quantity of FYM applied (Prasanna and Kumar, 2011).

Available potassium content of soils increased with time (Tables 3, 4 and 5) at all the bio-K levels. The highest potassium content was recorded in the treatment receiving highest level of bio-K (1000 kg ha^{-1}) at all the stages of incubation and in all the soils. In general, the potassium released from FYM treatment at the rate of 25 t/ha was approximately same as bio-K treatment at 750 kg/ha. Whereas, in black soil, the bio-K at the level of 500 kg/ha was comparable with FYM at 25 t/ha with respect to available potassium content of soil.

Bio-K is a rich source of potassium and also, it supplies substantial quantity of N and a small amount of phosphorus.

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