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Changes in available nutrient status of different soil types of Konkan as affected by FYM application

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Abstract
An incubation study was undertaken in glass house at Department of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Dist. Ratnagiri. During *Kharif*, 2013 to investigate the changes in available nutrient status of different soil types occurred in the Konkan region *viz*., coastal alluvial soils, lateritic soils, coastal saline soils, medium black soils, laterite soils, reddish brown soils, course shallow soils, acid sulphate (*Morik*) soils and *Manat* soils as affected by FYM application. The different soil types showed increase in soil pH, EC, organic carbon, available nitrogen, available phosphorus and available potassium content in soils at field capacity moisture condition in incubation study and further the application of FYM resulted in a significant increase in these parameters indicating build up of soil fertility with the application of FYM.

Keywords: Different soil types, FYM, pH, EC, Organic carbon, N, P and K

Introduction
Konkan region of Maharashtra includes Greater Bombay (603 sq.km), Thane (9558 sq.km), Raigad (7148 sq.km), Ratnagiri (8249 sq. km) and Sindhudurg (5232 sq. km) districts bound by Gujarat in north and Goa in south. It is stretch of 720 km long belt of coastal land and Sahyadri hills with a width varying from 50-60 km. The territory is flanked by Arabian Sea on western side. It is a spread over in between 15^0 60 N and 20^0 22 N latitude and 72^0 39 and 73^0 48 longitude.

Materials and Methods
Topography and Parent Material
Topographically, the Konkan coastal lands are platform of Marine denudation raised to form a narrow plain, interrupted by parallel and transverse hills which reach the sea, thus denying the plain of a uniform level. The streams bring about a vast eroded material from their upper reaches and deposit it in lowest zone near the shore line. The coast along the Raigad district appears to be different from Ratnagiri coast, being much indented and suggesting submergence, as confirmed by submerged *khair* forests of Thane district.

In the plains of Raigad, trap rock is found in tabulated masses and irregular shapeless boulders of considerably varying dimensions. The basalt has given rise to fairly thick lateritic particularly in southern part of Raigad and most of the Ratnagiri and Sindhudurg distict. The general level of laterization is 150 to 175 meters above mean sea level, but towards east, some higher plateaus also show laterite. The granite and gneisses are exposed in southern part of Sindhudurg district around Kudal (Anonymous 1990) [1].

Climate
Konkan has three seasons i) the summer from March to June ii) the rainy season from June to middle of October and iii) the winter from middle of October to end of February. The average annual rainfall of Thane District is 1808 mm (1574 to 2616 mm), Raigad district is 3128 mm (2083 to 3276 mm) and Ratnagiri and Sindhudurg districts (combined) is 3104 mm (2159 mm to 3886 mm). The maximum rainfall is the received in the month of July. The mean daily temperature is about 20 ^{0}C throughout the year. Month of May is generally hottest, when mean maximum temperature is around 33 ^{0}C. During rainy Season, humidity is as high as 90 to 98

per cent. It is least in winter afternoons, when it may come down to about 60 per cent at many places (Anonymous 1990) [1].

Soil types

The typical topography associated with high rainfall and other climatic conditions has given rise to about nine soil type's viz., coastal alluvial soils, lateritic soils, coastal saline soils, medium black soils, laterite soils, reddish brown soils, course shallow soils, acid sulphate (*Morik*) soils and *Manat* soils

Incubation study

An incubation study was undertaken in the glass house of the Department of Horticulture, College of Agriculture Dapoli, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, during *kharif* season of 2013 in factorial complete randomized design with nine soil types collected from the representative area of Konkan region as a main factor and FYM application (with and without FYM) as sub-factor comprising eighteen treatments and four periods of observations i.e. 30, 60, 90 and 120 days after incubation (DAI) with three replications.

The plastic pots were first thoroughly cleaned with water and then rinsed with distilled water before filling of the soil. Small quantities of pebbles were put at the bottom of the pots and six kg of soil was filled in each pot. As per the treatment FYM procured from the Dairy Farm, Department of Animal Husbandry and Dairy Science, Dr.B.S. Konkan Krishi Vidyapeeth, Dapoli with 0.62% N, 0.16% and 0.51% K was added and mixed thoroughly. The pots were watered by distilled water regularly by periodic addition of requisite quantity of distilled water so as to maintain the moisture content of soil at field capacity for a period of 120 days. The period of incubation was so chosen as to fit the duration of rice cultivation since all soil types are used for rice cultivation and incubated at room temperature.

In order to understand the changes in available nutrient status of different soil types of Konkan region and as affected by FYM application, periodical soil samples were collected from each treatment pot at 30, 60, 90 and 120 days after incubation (DAI). Treatment wise composite soil samples were prepared by principle of quartering. The samples were air dried in shade, pounded in wooden mortar with pestle and sieved through 2 mm sieve. After processing, the samples were stored in properly labeled corrugated boxes and used for determination of various physico-chemical in the laboratory by following the standard analytical methods.

Results and Discussion

Physico-chemical properties of different soil types as influenced by FYM application

The pH of initial soil samples of different soil types prior to experimentation indicates that the soils were neutral or acidic in reaction, which increased with incubation period irrespective of types and the perusal of the data of 30 DAI incubation revealed that coastal alluvial, coastal saline, medium black, reddish brown, and coarse shallow soils were alkaline in nature, while lateritic, laterite and acid sulphate soils remained acidic in nature.

In general, the pH showed increase at 30 DAI of incubation over its initial values irrespective of different soil types, which may probably due to the submergence effect (Ponnamperuma 1977) [14]. The data further showed decrease in pH at 60 DAI compared to incubation at 30 DAI values which further decreased gradually up to 120 DAI of incubation and thus over all fall in pH was observed during study. The decrease in pH of soils following submergence may be ascribed by several electro-chemical and bio-chemical charges. Microbial decomposition of organic matter produces CO_2 which forms carbonic acid and decreases pH of alkali soils up on submergence (Ponnamperuma 1972) [13].

The increase in pH on soil submergence probably was caused by the reduction of Fe (Ponnamperuma *et al*. 1966) there by slow of reduction reduces the pH increase. The redox reactions in soils involve the transfer of electrons and H+, which directly influence H+ concentrations. A low redox potential generally result in higher pH. Organic matter can also influence pH changes by intensifying reduction and through the concentration of CO_2 and organic acids. The pH of neutral and slightly alkaline soils is regulated by the $CaCO_3$-CO_2-H_2O equilibrium.

At 30 DAI coastal saline soils recorded the highest mean pH of 7.93, while at 60 DAI, 90 DAI and 120 DAI medium black noted the highest mean pH of 7.64, 7.58 and 7.52, respectively. In case lowest value, the acid sulphate soils recorded the lowest value at all observational periods i.e. 6.04, 5.52, 5.35 and 5.32 at 30 DAI, 60 DAI, 90 DAI and 120 DAI, respectively.

The study further revealed that the application of FYM increased the pH irrespective of different soil types over no application. But, the significant difference with mean pH was observed only at 60 DAI.

The increase in pH of acid soil due to addition of organic manures is attributed of the deactivation of Fe^{3+} and concomitant release of basic cations during their decomposition. The mechanism responsible for this increase in pH was also due to ion exchange reactions which occur when terminal OH^- of Al or Fe^{2+} hydroxyl oxides are replaced by organic anions, which are decomposed products of the manure such as malate, citrate and tartarate (Pocknee and Summer 1997) [12].

E.C. of acid soils found in Konkan region indicated that these soils of free soluble salts, which might be attributed to leaching of soluble salts due to heavy precipitation. High electrical conductivity was found in coastal saline soils. The ingress of sea/creek water during the high tides, shallow ground water table (at surface in monsoon and 1.5 to 2.0 m in summer), high ground water salinity in summer, very low soil infiltration characteristics and very poor hydraulic conductivity are the interacting factors responsible for development of coastal saline soils (*Khar* lands) in Konkan (Anonymous 1990) [1]. Mali (1989) [9] studied on the characterization of four benchmark soil of North Konkan region of Maharashtra state and stated that the EC of soil samples varied from 0.25 to 0.34, 0.25 to 0.34, 0.25 to 0.34 and 0.25 to 19.78 dS m^{-1} with mean of 0.29, 0.2, 0.28 and 9.39 dS m^{-1} for Karjat, Roha, Repoli and Panvel soil series, respectively.

Over all, a critical examination of the data showed that electrical conductivity increased after incubation at a slower rate and attained maximum values at 120 DAI during their course of time. The presence of bicarbonate and soluble hydroxides in alkali soil might be reasonable causes for observing a peak of specific conductance (Saraswat *et al*. 2012) [15]. Further, the reduction of Fe^{+++} (oxides) releases trace elements sorbed on them and thereby increase in concentration of water soluble iron Fe^{++} displaces K^+, Na^+, NH_4^+, Ca^{+2}, Mg^{+2} from the exchange site and also increase the specific conductance of soil. Ponnamperuma (1977) [14] also had the opinion that increase in conductance during first few weeks of submergence is due to mobilization of Fe^+ and Mn^+, accumulation of NH_4^+, HCO_3^- and $RCOO^-$ and displacement of cations from soil colloids by Fe^{+2}, Mn^{+2} and NH_4^+.

At all observational periods coastal saline soils recorded the highest mean E.C. and the acid sulphate and laterite soils recorded the lowest value.

The E.C. of all soils increased with FYM application. The increase in EC due to addition of FYM was attributed to the presence of salts in FYM (Saraswat *et al*. 2012) [15] and possible built up of the soluble nutrients drawn from manure on mineralization. But, the non-significant difference with mean E.C. was observed at different observational periods. Dargan *et al*. (1976) also reported no much difference in E.C. of the soil sample even under saline sodic soil condition of Karnal due to application of FYM to rice. The electrical conductivity of lateritic, medium black, reddish brown, coarse shallow, acid sulphate and manat soils appear to decrease with the advancement of incubation from 30 DAI to 60 DAI and further increased with the period of incubation. This decrease may, probably, be due to partial washing away of the salts from the surface of the soils.

The organic carbon in initial soil indicated that the organic carbon in all soil types except coastal saline and acid sulphate soils were in 'very high' range as per the ranges proposed by Bangar and Zende (1978) [3]. In general, the very high organic carbon content of the soils might be attributed to the humid climate of the Konkan region. Mali (1989) [9] studied on the characterization of four benchmark soil of North Konkan region of Maharashtra state and stated that the organic carbon of soil samples varied from 0.27 to 0.63, 0.24 to 0.51 0.24 to 0.39 and 0.18 to 0.39 per cent with mean of 0.46, 0.34, 0.29 and 0.25 per cent for Karjat, Roha, Repoli and Panvel soil series, respectively.

The data indicated that the organic carbon content of the soil increase over its initial value with the period of incubation irrespective of soil types and addition of FYM. The increase in organic carbon may be due to decomposition of organic matter and the fine root stubbles which were left in the soil (Antil *et al*. 2011) [2]. The data further indicated that the organic carbon content of different soil first decreased from 30 to 60 DAI and then increased from 60 DAI to 90 DAI and 90 DAI to 120 DAI of incubation. This is probably, due to the partial decomposition of organic matter from 30 to 60 DAI and further enhancement due to high accumulated root mass in the soil (Gupta *et al*. 2000) [8].

The addition of FYM significantly increased the organic carbon content in all soil types of Konkan. A significant difference was observed in mean organic carbon content with the addition of FYM at all observational stages. The improvement in soil organic carbon in FYM treated soil might ascribe to direct addition of organic matter through FYM.

Available nutrient status of different soil types as influenced by FYM application

The content of available nitrogen in lateritic, medium black and coastal saline soils varied from 149 to 674 kg ha^{-1}, 118 to 484 kg ha^{-1} and 207 to 337 kg ha^{-1}, respectively with corresponding average of 296, 232 and 252 kg N ha^{-1}. It is higher in lateritic soil than that of medium black and coastal saline soils. The lateritic soils of Ratnagiri district were richer followed by laterite of Sindhudurg district (Anonymous 1990) [1]. The available nitrogen content of acid sulphate and *Manat* soils of Konkan region ranged from 224 to 291 kg ha^{-1} and 207 to 270 kg ha^{-1}, respectively. (Anonymous 1990) [1].

Available nitrogen content in the soil increased at 30 DAI of incubation over initial content irrespective of soil types, which might be attributed to the release of N after mineralization of native organic matter (Antil *et al*. 2011) [2].

At 30 DAI, medium black soil recorded the highest mean available nitrogen (577.99 kg ha^{-1}) and at 60 DAI, 90 DAI and 120 DAI coastal alluvial soils recorded the highest mean available nitrogen of 466.24 kg ha^{-1}, 554.18 kg ha^{-1} and 577.54 kg ha^{-1}, respectively. In case of lowest mean available nitrogen, *Manat* soil and coastal alluvial soil recorded the lowest value at all observational periods i.e. 296.94 kg ha^{-1}, 177.18 kg ha^{-1}, 150.32 kg ha^{-1} and 147.56 kg ha^{-1} at 30 DAI, 60 DAI, 90 DAI and 120 DAI, respectively.

A significant difference was observed in mean available nitrogen content with the addition of FYM at 60 DAI, 90 DAI and 120 DAI. But, the non-significant difference with mean available nitrogen was observed at 30 DAI. The application of FYM indicated increase in N content over no application may be attributed to the mineralization of N by FYM in soil (Yaduvanshi 2001) [17] and the greater multiplication of soil microbes, which could convert organically bound N to inorganic form (Bharadwaj and Omanwar 1994 and Anonymous 1990) [4, 1].

The preponderance of less active (reductant phosphorus and occluded phosphorus) and inactive (residual phosphorus) phosphorus fractions over active phosphorus fractions, dominance of iron phosphorus over aluminum phosphorus, low concentration of solid phosphorus and high phosphorus fixing capacity of soils are some of the important reasons for low phosphorus availability in lateritic soils of Konkan (Dongale 1989 and Anonymous 1990) [6, 1]. Phonde (1987) reported that the average phosphorus fixing capacity of lateritic soil was higher (94.99 %) than that of medium black soils (77.05 %). Dongale (1987) [5] further observed that the lateritic soils (Ratnagiri district) and laterite soils (Sindhudurg district) containing R_2O_3 in the range of 29.94 to 42.24 per cent and 9.97 to 20.30 per cent have the phosphorus fixing capacity in the range of 76.04 to 86.13 and 47.48 to 66.46 per cent, respectively with the corresponding mean value of 80.85 and 55.48 per cent.

The increase in P_2O_5 content in all types of soils with incubation period over its initial values and its gradual increase under incubation may probably due to solubilization of phosphorus with increase in pH under submergence or saturated condition and greater mobilization of native as well as applied soil P (Anonymous 1990) [1]. Results of the incubation studies reported by Sawant *et al*. (1981) [16] revealed that the phosphorus availability in medium black soil was more than twice than that of lateritic soil under varying moisture regime. It gradually increased with advancement of time under moisture corresponding to half and equal the maximum water holding capacity of the soil. The use of chelating agents like FYM for increasing the potassium availability in lateritic soils has appeared to have limited utility (Patil *et al*. 1983).

Medium black soil recorded the highest mean available phosphorus of 113.17 kg ha^{-1}, 176.48 kg ha^{-1}, 168.43 kg ha^{-1} and 186.28 kg ha^{-1} at 30 DAI, 60 DAI, 90 DAI and 120 DAI, respectively. Acid sulphate soils recorded the lowest mean available phosphorus of 8.57 kg ha^{-1} and 10.11 kg ha^{-1}at 30 DAI and 60 DAI, respectively; while laterite soils recorded the highest mean available phosphorus of 8.98 kg ha^{-1} and 9.29 kg ha^{-1}at 90 DAI and 120 DAI, respectively.

A significant difference was observed in mean available phosphorus content with the addition of FYM at all observational periods. The beneficial effect of FYM on available P_2O_5 may be due to the fact that FYM itself contained 0.16 per cent P, which might have resulted into its build-up in the soil on decomposition. The improvement in available P_2O_5 with FYM incorporation may also be explained on the bases of solubilization of phosphate by the action of organic acids produced during the decomposition of FYM (Sing and Subbiah 1969) and formation of protective coating on sesquioxides which reduce P fixation (Sing and Lal, 1976).

With the advancement in incubation study, P availability in the soils decreased. The adsorption of P on clay minerals and fixation via ligand exchange probably reduced its available content in soils. The interaction between soil types and FYM application was found to be significant at all observational periods.

The available potassium ranged from 45 to 1152 kg K_2O ha^{-1}, 53 to 1355 kg K_2O ha^{-1} and 111 to 5568 kg K_2O ha^{-1} in lateritic, medium black and coastal saline soils, respectively with the corresponding mean value of 226 kg K_2O ha^{-1}, 254 kg K_2O ha^{-1} and 3009 kg K_2O ha^{-1} (Anonymous 1990) [1]. The large proportion of the lateritic soils from South Konkan are low to medium in available potassium status, whereas, the medium black soils from North Konkan have medium to very high potassium status. The potassium deficiency in general is more prominent in the soils from Sindhudurg district followed by Ratnagiri district (Anonymous 1990) [1].

The increase in available potassium content in different soil types with the incubation period over its initial values may be due to release of nutrient in soil from native pool as well as their residual effects.

Coastal saline soil recorded the highest mean available potassium while Acid sulphate and *Manat* soils recorded the lowest mean available potassium.

The build-up of available soil potassium under FYM application was the result of additional K supplied through it, the solubilizing action of certain organic decomposition and its greater capacity to hold K in the available form (Yaduvanshi 2001; Yadav and Chhipa 2007) [17]. The higher availablilty of K in soil may also be due to beneficial effect of organic manures on the reduction of potassium fixation, added organic matter interacted with K clay to release K from non-exchange able fraction to the available pool. The interaction between soil types and FYM application was found to be significant at all observational periods.

Table 1: Changes in soil pH of different soil types of Konkan as influenced by FYM application under incubation study

Treatments (Soil types)		Initial Soil (0 DAI)	Days after incubation (DAI)											
			30 DAI			60 DAI			90 DAI			120 DAI		
			Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean
T_1	Coastal alluvial	7.4	7.81	7.91	7.86	7.43	7.51	7.47	7.36	7.43	7.39	7.25	7.56	7.41
T_2	Lateritic	5.8	6.95	6.99	6.97	6.41	6.89	6.65	6.60	6.64	6.62	6.61	6.74	6.68
T_3	Coastal saline	6.5	7.89	7.97	7.93	7.59	7.66	7.62	7.46	7.26	7.36	7.10	7.17	7.13
T_4	Medium black	7.3	7.81	7.83	7.82	7.69	7.59	7.64	7.59	7.56	7.58	7.57	7.46	7.52
T_5	Laterite	5.5	6.25	6.28	6.26	5.51	5.55	5.53	5.43	5.55	5.49	5.42	5.78	5.60
T_6	Reddish brown	6.8	7.77	7.81	7.79	7.51	7.39	7.45	7.40	7.23	7.32	7.39	7.23	7.31
T_7	Coarse shallow	6.4	7.81	7.84	7.82	7.40	7.55	7.48	7.32	7.25	7.29	7.30	7.24	7.27
T_8	Acid sulphate	3.5	5.87	6.20	6.04	5.21	5.83	5.52	5.18	5.52	5.35	5.15	5.49	5.32
T_9	Manat	6.7	7.51	7.55	7.53	7.20	7.32	7.26	7.15	7.22	7.19	7.14	7.35	7.25
Mean			7.30	7.37	7.34	6.88	7.03	6.96	6.83	6.85	6.84	6.77	6.89	6.83
			S.E.±	C.D.(P= 0.01)		S.E.±	C.D.(P= 0.01)		S.E.±	C.D.(P= 0.01)		S.E.±	C.D.(P= 0.01)	
Soil type			0.05	0.21		0.05	0.19		0.04	0.17		0.08	0.34	
FYM			0.02	N.S.		0.02	0.09		0.02	N.S.		0.04	N.S.	
Interaction (Soil type x FYM)			0.07	N.S.		0.07	0.27		0.06	0.24		0.12	N.S	

Table 2: Changes in electrical conductivity (dS m^{-1}) of different soil types of Konkan as influenced by FYM application under incubation study

Treatments (Soil types)		Initial Soil (0 DAI)	Days after incubation (DAI)											
			30 DAI			60 DAI			90 DAI			120 DAI		
			Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean
T_1	Coastal alluvial	0.13	0.16	0.17	0.16	0.14	0.19	0.17	0.18	0.22	0.20	0.22	0.23	0.23
T_2	Lateritic	0.03	0.15	0.19	0.17	0.12	0.14	0.13	0.14	0.15	0.15	0.16	0.18	0.17
T_3	Coastal saline	0.21	0.42	0.53	0.48	0.58	0.62	0.60	0.62	0.58	0.60	0.58	0.53	0.55
T_4	Medium black	0.15	0.13	0.17	0.15	0.12	0.14	0.13	0.32	0.44	0.38	0.36	0.46	0.41
T_5	Laterite	0.03	0.14	0.15	0.15	0.17	0.18	0.17	0.13	0.14	0.14	0.15	0.17	0.16
T_6	Reddish brown	0.13	0.17	0.18	0.18	0.13	0.14	0.14	0.18	0.21	0.19	0.30	0.31	0.31
T_7	Coarse shallow	0.15	0.17	0.20	0.19	0.13	0.15	0.14	0.23	0.25	0.24	0.33	0.35	0.34
T_8	Acid sulphate	0.15	0.36	0.33	0.34	0.34	0.32	0.33	0.29	0.26	0.28	0.32	0.25	0.28
T_9	Manat	0.13	0.15	0.13	0.14	0.11	0.13	0.12	0.20	0.22	0.21	0.24	0.26	0.25
Mean			0.14	0.21	0.23	0.22	0.20	0.22	0.21	0.26	0.28	0.27	0.30	0.30
			S.E.±	C.D.(P= 0.01)		S.E.±	C.D.(P= 0.01)		S.E.±	C.D.(P= 0.01)		S.E.±	C.D.(P= 0.01)	
Soil type			0.02	0.08		0.03	0.12		0.01	0.06		0.03	0.12	
FYM			0.01	NS		0.01	NS		0.00	NS		0.01	NS	
Interaction (Soil type x FYM)			0.03	NS		0.04	NS		0.02	NS		0.04	NS	

Table 3: Changes in organic carbon (g kg^{-1}) of different soil types of Konkan as influenced by FYM application under incubation study

Treatments (Soil types)		Initial Soil (0 DAI)	Days after incubation (DAI)											
			30 DAI			60 DAI			90 DAI			120 DAI		
			Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean
T_1	Coastal alluvial	11.4	17.60	18.03	17.82	14.97	15.10	15.03	13.23	13.33	13.28	10.80	11.70	11.25
T_2	Lateritic	19.8	24.33	28.00	26.17	22.40	29.80	26.10	21.67	25.60	23.63	20.70	24.50	22.60
T_3	Coastal saline	5.71	13.00	21.30	17.15	15.73	15.83	15.78	14.10	15.70	14.90	13.50	14.70	14.10
T_4	Medium black	15.6	13.80	18.50	16.15	13.77	19.90	16.83	14.53	20.10	17.32	13.20	14.90	14.05
T_5	Laterite	10.6	14.83	16.40	15.62	18.03	18.10	18.07	18.20	19.40	18.80	15.30	17.50	16.40
T_6	Reddish brown	16.5	20.73	22.53	21.63	18.43	18.70	18.57	17.50	19.27	18.38	16.23	18.27	17.25
T_7	Coarse shallow	18.3	20.67	21.37	21.02	20.07	20.77	20.42	18.10	18.30	18.20	16.43	16.60	16.52
T_8	Acid sulphate	5.7	11.70	11.97	11.83	12.23	14.80	13.52	11.90	12.90	12.40	13.60	13.73	13.67
T_9	Manat	17.4	13.80	14.37	14.08	18.00	18.20	18.10	17.27	17.50	17.38	16.10	16.37	16.23
Mean			16.72	19.16	17.94	17.07	19.02	18.05	18.05	18.01	17.14	15.10	16.47	11.70
			S.E.±	C.D.(P= 0.01)		S.E.±	C.D.(P= 0.01)		S.E.±	C.D.(P= 0.01)		S.E.±	C.D.(P= 0.01)	
Soil type			0.43	1.66		0.28	1.10		0.48	1.87		0.58	2.25	
FYM			0.20	0.78		0.13	0.51		0.23	0.88		0.27	1.06	
Interaction (Soil type x FYM)			0.61	2.35		0.40	1.55		0.68	2.64		0.83	NS	

Table 4: Changes in available nitrogen (kg ha^{-1}) of different soil types of Konkan as influenced by FYM application under incubation study

Treatments (Soil types)		Initial Soil (0 DAI)	Days After Incubation (DAI)											
			30 DAI			60 DAI			90 DAI			120 DAI		
			Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean
T_1	Coastal alluvial	290.94	428.91	435.68	432.29	461.08	471.40	466.24	458.31	460.25	460.93	341.28	343.80	342.54
T_2	Lateritic	225.44	347.24	370.29	358.77	260.98	293.38	277.18	186.23	191.08	188.65	185.83	189.30	187.56
T_3	Coastal saline	244.25	496.63	529.50	513.06	446.24	454.39	450.32	427.77	448.80	438.29	415.11	440.69	427.90
T_4	Medium black	287.80	517.28	538.69	527.99	356.05	364.92	360.49	260.43	268.68	264.56	258.53	263.80	261.17
T_5	Laterite	209.87	339.23	358.54	348.88	250.84	267.92	259.38	181.59	192.95	187.27	177.21	186.48	181.85
T_6	Reddish brown	197.21	427.54	438.24	432.89	339.85	362.33	351.09	236.03	243.92	239.98	213.94	240.41	227.18
T_7	Coarse shallow	207.98	309.27	318.49	313.88	267.21	273.38	270.30	230.86	250.43	240.64	224.22	240.47	232.34
T_8	Acid sulphate	250.17	334.63	369.44	352.04	249.18	259.16	254.17	229.62	244.41	237.01	218.12	239.83	228.98
T_9	Manat	208.99	282.57	311.30	296.94	254.35	263.76	259.06	228.14	248.40	338.27	306.98	245.72	326.35
Mean			387.03	407.80	397.41	320.64	334.52	327.58	282.47	294.32	288.40	260.14	276.72	268.43
			S.E.±	C.D. (P=0.01)		S.E.±	C.D. (P=0.01)		S.E.±	C.D.(P=0.01)		S.E.±	C.D.(P=0.01)	
Soil type			24.26	93.33		5.97	22.96		6.40	24.62		5.91	22.71	
FYM			11.44	NS		2.81	10.82		3.01	11.61		2.78	10.71	
Interaction (Soil type x FYM)			34.32	NS		8.44	NS		9.02	NS		8.34	NS	

Table 5: Changes in available phosphorus (kg ha^{-1}) of different soil types of Konkan as influenced by FYM application under incubation study

Treatments (Soil types)		Initial Soil (0 DAI)	Days After Incubation (DAI)											
			30 DAI			60 DAI			90 DAI			120 DAI		
			Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean
T_1	Coastal alluvial	36.39	48.34	50.57	49.46	50.06	53.06	51.56	59.30	60.51	59.91	66.37	68.77	67.57
T_2	Lateritic	8.81	20.81	24.36	22.59	25.84	28.05	26.95	24.51	25.84	25.17	28.79	31.75	30.27
T_3	Coastal saline	58.16	81.95	88.04	85.00	119.98	140.98	130.48	124.24	145.03	134.63	110.75	137.41	124.08
T_4	Medium black	70.61	96.09	130.26	113.17	147.66	205.31	176.48	150.99	185.87	168.43	173.48	199.09	186.28
T_5	Laterite	6.56	11.54	15.48	13.51	9.95	13.08	11.51	7.62	10.33	8.98	8.06	10.52	9.29
T_6	Reddish brown	39.66	62.33	70.14	66.24	75.20	83.61	79.40	82.71	93.97	88.34	88.33	95.75	92.04
T_7	Coarse shallow	21.15	36.48	39.50	37.99	47.29	49.16	48.23	52.75	65.50	59.13	51.38	56.73	54.06
T_8	Acid sulphate	4.5	8.10	9.03	8.57	9.17	11.05	10.11	12.66	13.36	13.01	10.69	11.53	11.11
T_9	Manat	38.21	52.85	59.05	55.95	55.16	62.07	58.61	60.11	64.90	62.50	60.00	59.07	59.54
Mean			46.49	54.04	50.27	60.03	71.81	65.92	63.87	73.92	68.89	66.42	74.51	70.47
			S.E.±	C.D. (P=0.01)		S.E.±	C.D. (P=0.01)		S.E.±	C.D.(P=0.01)		S.E.±	C.D.(P=0.01)	
Soil type			2.29	8.80		1.29	4.99		1.92	7.40		1.63	6.30	
FYM			1.07	4.15		0.61	2.35		0.90	3.49		0.77	2.97	
Interaction (Soil type x FYM)			3.23	12.45		1.83	7.06		2.72	10.47		2.31	8.91	

Table 6: Changes in available potassium (kg ha^{-1}) of different soil types of Konkan as influenced by FYM application under incubation study

Treatments (Soil types)		Initial Soil (0 DAI)	Days after incubation (DAI)											
			30 DAI			60 DAI			90 DAI			120 DAI		
			Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean	Without FYM	With FYM	Mean
T_1	Coastal alluvial	92.57	267.95	283.36	275.65	200.81	220.67	210.74	152.00	157.09	154.55	167.39	172.06	169.73
T_2	Lateritic	77.95	178.80	244.51	211.65	165.39	205.47	185.43	143.44	146.48	144.96	135.33	159.73	147.53

T_3	Coastal saline	432.51	1068.64	1211.41	1140.03	1052.47	1168.49	1110.48	1207.57	1307.68	1257.63	935.57	1119.63	1027.60
T_4	Medium black	100.64	268.80	312.59	290.69	217.31	220.21	218.76	133.12	146.88	140.00	95.09	136.88	115.99
T_5	Laterite	79.29	188.53	208.80	198.67	161.35	202.96	182.15	120.88	130.29	125.59	116.29	121.47	118.88
T_6	Reddish brown	93.32	270.32	284.65	277.49	233.68	258.66	246.17	186.45	212.96	199.71	173.81	201.92	187.87
T_7	Coarse shallow	81.98	151.25	170.65	160.95	147.02	154.56	150.79	151.23	178.35	164.79	124.03	163.87	143.95
T_8	Acid sulphate	71.23	113.33	120.93	117.13	123.68	126.60	125.14	98.73	104.53	101.63	93.33	103.25	98.29
T_9	Manat	72.57	183.99	190.75	187.37	147.32	151.32	149.32	127.49	135.92	131.71	78.99	91.95	85.47
Mean			299.07	336.41	317.74	272.11	300.99	286.55	257.88	280.02	268.95	213.32	252.31	323.81
			S.E.±	C.D.(P= 0.01)		S.E.±	C.D.(P= 0.01)		S.E.±	C.D.(P= 0.01)		S.E.±	C.D.(P= 0.01)	
Soil type			6.02	23.16		7.43	28.59		4.98	19.16		3.08	11.88	
FYM			2.83	10.92		3.50	13.47		2.34	9.03		1.45	5.60	
Interaction (Soil type x FYM)			8.51	32.76		10.51	40.43		7.04	27.09		4.36	16.80	

Conclusion

In general, the pH showed continues decrease with the period of incubation irrespective of different soil types. The application of FYM increased the pH irrespective of different soil types over no application. The electrical conductivity increased after incubation at a slower rate and attained maximum values at 120 DAI during their course of time irrespective of different soil types. The E.C. of all soils increased with FYM application irrespective of different soil types over no application, but non-significantly In general, the organic carbon content showed continues decrease with the period of incubation irrespective of different soil types.

The addition of FYM significantly increased the organic carbon content in all soil types of Konkan The application of FYM indicated increase in N content over no application irrespective of different soil types. A significant difference was observed in mean available phosphorus content with the addition of FYM at all observational periods. The interaction between soil types and FYM application was found to be significant at all observational periods.

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