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REGRESSION MODELS FOR SOME SOIL QUALITY PARAMETERS UNDER INTEGRATED USE OF NUTRIENTS IN *VERTISOLS* OF CHHATTISHGARH

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ABSTRACT

Field experiments were conducted at research farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) during 2008-10 to develop fertilizer adjustment equations for hybrid rice and cauliflower in Vertisols of Chhattisgarh. After four cropping seasons, sole application of NPK and FYM showed no effect on dehydrogenase activity, microbial biomass carbon and nitrogen. However, the combination of fertilizer nutrients with FYM as integrated use have significant role to change the different soil's biological quality parameters as evidenced from the higher R^2 value. There was an increasing trend in all the parameters with increasing fertilizer NPK levels at varying levels of FYM.

Key Words: Soil quality parameters, integrated use of nutrients, *Vertisol*, Chhattisgarh

INTRODUCTION

The soil quality, soil health and soil condition are interchangeable as describe the soil's ability to support crop growth without becoming degraded or otherwise harming the environment. Soil quality is defined by the interactions of measurable chemical, physical and biological properties of particular soil. Soil quality assessment typically includes the quantification of indicators that are derived from educational studies or general quantitative observations of soil (Seybold *et al.* 1998). Soil organic matter is generally one of the most important criteria of soil quality. Soil organic matter has an influence on the processes occurring in the soil and many soil properties (Gülser and Candemir, 2012; Cercioğlu *et al.*, 2014). The indicators of soil quality can be categorized in to four general group; visual, physical, chemical and biological properties that can be measured by monitoring changes in the soil. Biological indicators include measurement of micro and macro organisms and their activities. Some parameters of biological indicators for screening of soil quality are soil organic carbon, dehydrogenase activity, microbial biomass carbon and nitrogen. In this study, regression models developed under integrated use of nutrients in *vertisols* of chhattishgarh for some soil quality parameters viz., dehydrogenase activity, microbial biomass carbon and nitrogen.

MATERIALS AND METHODS

Field experiments were conducted at research farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh) to establish soil test crop response correlation study with rice-cauliflower cropping system during 2008-09 and 2009-10 in *Vertisol*. Indira Sona varieties of Hybrid rice and NS 106 varieties of cauliflower were taken during two consecutive kharif and rabi seasons. Soil was represented as typical *fine montmorillonitic, hyperthermic, udic chromustetr.* It is clayey in texture with 23.3 % sand, 21.4% silt and 55.3% clay, dark brown to black in color, neutral to alkaline in reaction due to presence of lime concretion in lower horizon. The profile depth of soil under study was 1-1.5 meter. Some physico-chemical properties of experimental field soil were: pH (1:2.5 soil: water) 7.8, EC (dSm^{-1}) (1:2.5 soil: water) 0.27, cation exchange capacity (c mol (p^+) kg^{-1}) 39.5, organic carbon (g kg^{-1}) 4.2, available N (kg ha^{-1}) 224, available P (kg ha^{-1}) 16.2 and available K (kg ha^{-1}) 454. Prior to conducting the actual field experiment, a pre-requisite fertility gradient was created by applying the graded doses of N, P and K fertilizer for obtaining the appropriate variation in soil fertility in different strips (Ramamurthy *et al.* 1967). For this purpose, field was divided in to three equal long strips and denoted as L_0, L_1 and L_2. Variation in soil fertility with respect to N, P and K were created by applying 100-75-50 and 200-150-100, kg ha^{-1} of N, P_2O_5 and K_2O in L_1 and L_2 strip, respectively, keeping L_0 strip as unfertilized (control). Fodder maize crop was grown during summer season 2008 as a preparatory crop so that fertilizer nutrients may transform naturally by interacting with soil, plant and microbes and thus become a part of soil system. In this way by growing the exhaust crop, the ranges of soil fertility were created in the fertility strips which were evaluated in terms of variations in fodder yields and soil test values (Table No. 2). After the harvest of the fodder crop, the main complex experiment with hybrid rice was conducted in subsequent kharif season. Each strip was divided in to three equal sizes for three levels of

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FYM (0, 5 and 10 t ha^{-1}) and was treated as block. A representative sample of FYM applied was analyzed for nutrient content and resulted with 0.4, 0.3, 0.8 % N, P and K, respectively. Twenty four selected fertilizer treatment combinations constituted from 4 levels each of N (0, 60, 120 and 180 kg ha^{-1}), P_2O_5 (0, 40, 80 and 120 kg ha^{-1}) and K_2O (0, 40, 80 and 120 kg ha^{-1}) were randomly distributed in three blocks of each strip along with three control ($N_0P_0K_0$) plots having seven treatments in each block with one control. Plot-wise soil samples (0-15 cm) were collected before application of fertilizer and FYM treatments at each crop season.

RESULTS AND DISCUSSION

Soil organic carbon, microbial biomass carbon and nitrogen

The nutrients application in an integrated manner through fertilizer and organic source (FYM) had significantly altered the organic matter status, soil microbial biomass carbon and nitrogen (Table 2). All these parameters increased across the fertility strips from L_0 to L_2. Increase in microbial biomass C and N may be due to supply and availability of additional mineralizable and readily hydrolysable carbon owing to manure application that may be responsible for higher microbial activity, addition of inorganic fertilizers alone increased the soil MBC over control which could be due to increased crop growth. (Kaur and Brar 2008, Santhy *et al.* 1999, Nayak *et al.* 2007) and also owing to added effect of bio-fertilizer and FYM, that led to increase in microbial population in soil. Post and Known (2000) described factors and processes that determine the direction and rate of change in SOC content when vegetation and soil management practices are changed.

Table 1: Fertilizer doses added to various strips and fodder yield of maize during summer season, 2008 to create fertility gradient (Pre-requisite for main complex experiment)

Fertility Strips	Fertilizer doses (kg ha^{-1})			Fodder yield	Post harvest soil test values (kg ha^{-1})		
	N	P_2O_5	K_2O	(t ha^{-1})	SN	SP	SK
L_0	0	0	0	19.24	235	10.28	442
L_1	100	75	50	21.24	242	17.82	465
L_2	200	150	100	26.12	249	27.34	475

Ones that may be important for increasing SOC storage include increasing the input rates of organic matter, changing the decomposability of organic matter inputs that increase LF-OC in particular and placing organic matter deeper in the soil either directly by increasing belowground inputs or indirectly by enhancing surface mixing by soil organisms. Paddy management favors the accumulation of OC as paddy soils obtain high inputs of OC (Gong and Xu, 1990; Tanji *et al.*, 2003) and the management of the soils seems to retard the OC decomposition (Neue *et al.*, 1997; Sahrawat, 2004), both leading to a relatively great tendency to accumulate OC. Addition of FYM and chemical fertilizers together in balanced form provides favorable C: N ratio for higher activity of microbes in the integrated treatments (Gogai *et al.* 2010).

Table 2: Range and average values of soil quality parameters at time of cauliflower harvesting after four crops season

Soil quality parameter	Fertility strips			SD	CV
	L_0	L_1	L_2		
Organic Carbon (g kg^{-1})	2.95-7.69 (5.62)	3.70-7.76 (6.25)	5.11-8.29 (6.26)	1.07	17.16
Soil microbial biomass carbon (mg kg^{-1})	135-238 (198)	163-238 (213)	180-242 (216)	23.44	2.31
Soil microbial biomass nitrogen (mg kg^{-1})	24.66-44.95 (36.63)	29.84-43.90 (39.78)	32.88-44.62 (39.78)	4.42	5.46
Dehydrogenase activity of soil (tpf g^{-1})	10.75-33.13 (21.51)	18.55-36.44 (28.57)	20.42-38.00 (30.45)	7.31	9.97

Dehydrogenase activity

Perusal of the data (Table 2) revealed that integrated application of nutrients has significantly altered the dehydrogenase activity. Increase in enzymic activity can be attributed to microbial origin developed during decomposition of organic source of nutrients. Addition of organic source acts as good source of carbon and energy to heterotrophs by which their population increased with increase in enzymic activities. The activities of enzymes were generally well correlated with the organic carbon content indeed in general; there is a significant correlation between the activity of soil enzymes and organic carbon content (Graham and Haynes, 2005). Similar

Table 3: Selected regression model to account for soil quality parameters variation at time of harvesting of cauliflower 2009-10 (after four crops season)

S. No.	Model for soil microbial biomass carbon	R^2
1	Y = 195.607 + 2.747 FYM	0.23
2	Y = 172.627 + 0.214 FN + 2.747 FYM	0.55
3	Y = 173.126 + 0.337 FP + 2.747 FYM	0.55
4	Y = 182.484 + 0.213 FK + 2.747 FYM	0.35
5	Y = 168.049 + 0.137 FN + 0.216 FP – 0.008 FK + 2.747 FYM	0.64
Model for soil microbial biomass nitrogen		
6	Y = 35..880 + 0.454 FYM	0.26
7	Y = 34.344 + 0.039 FN	0.31
8	Y = 31.6267 + 0.039 FN + 0.544 FYM	0.56
9	Y = 31.652 + 0.062 FP + 0.544 FYM	0.57
10	Y = 33.365 + 0.040 FK + 0.544 FYM	0.37
11	33.276 + 0.024 FN +0.040 FP – 0.0008 FK	0.39
12	Y = 30.559 + 0.024 FN + 0.040 FP +0.0008 FK + 0.544 FYM	0.65
Model for dehydrogenase activity of soil		
13	Y = 20.446 + 1.335 FYM	0.56
14	Y = 19.398 + 2.593 FYM – 0.126 FYM^2	0.61
15	Y = 13.747 + 0.062 FN + 1.335 FYM	0.85
16	Y = 15.253 + 0.078 FP + 1.335 FYM	0.74
17	Y = 16.885 + 0.058 + 1.335 FYM	0.66
18	Y = 12.814 + 0.050 FN + 0.029 FP + 0.0045 FK + 1.335 FYM	0.87

Where, FN, FP, FK and FYM are fertilizer N, P_2O_5, K_2O (Kg ha^{-1}), and Farm Yard Manure (t ha^{-1}), respectively as independent variables and Y as dependent variable.

relationships between organic carbon and enzyme activities were reported by Bohme and Bohme (2006), Rai and Yadav (2011) and Zantua and Bremner. (1977).

Regression equations for soil quality parameters

The regression analysis (Table 3) on effect of different nutrients and FYM indicated that only four seasons of cropping have not altered the level of different parameters however, the integration of fertilizer nutrients with FYM had significant role to change the different soil quality parameters. There was an increasing trend in all parameters with respect to increasing fertilizer NPK levels at varying levels of FYM. Post harvest soil test values with appreciably higher R^2 values for above soil quality parameters can be useful for formulating fertilizer recommendation and improving overall fertilizer use efficiency.

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