PHYSICO-CHEMICAL PROPERTIES OF *VERTISOL* AT DIFFERENT STAGES OF TRANSPLANTED RICE AS INFLUENCED BY LONG TERM APPLICATION OF FERTILIZERS AND MANURE UNDER CHHATTISGARH CONDITION

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Abstract: A field study was carried out during *Kharif* season of 2010-11 at the Research and Instructional Farm of Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur. Experiment was conducted to examine the **"Physico-chemical properties of *vertisol* at different stages of transplanted rice as influenced by long term application of fertilizers and manure under chhattisgarh condition"**. The experiment was carried out in randomized block design with 4 replications having treatments: T_1 (Control without fertilizer), T_2 (100% NPK), T_3 (100% N alone), T_4 (100%NPK+FYM), and T_5 (50%NPK+Green manure). A medium duration high yielding paddy variety "Mahamaya" was taken as crop. The soil pH and EC decreased in T_3 (100% N alone) treatment. However, it remained constant in T_2 (100%NPK), T_4 (100%NPK+FYM), and T_5 (50%NPK+GM). The organic carbon content under treatment T_4 (100%NPK+FYM) was found to be significantly higher in all the growth stages when compared with control. The soil moisture was also found higher in under treatment T_5 (50%NPK+GM). The texture of the soil under study was estimated to be sand (20.40%), silt (35.30%) and clay (45.0%), respectively.

Keyword: Long Term, Rice, Different Stage, Physic Chemical Properties

INTRODUCTION

After the industrial revolution widespread introduction of inorganic fertilizers led to a decline in the use of organic material in the cropping systems (Rosegrant and Roumasset, 1987). The impact of increased fertilizer use on crop production has been large and important (Hossain and Singh, 2000). More recently, attention is focused on the global environmental problems. The world elite society is giving emphasize on utilization of organic wastes, FYM, compost, vermicompost and poultry manures as the most effective measure to save the environment to some extent. Organic materials are the safer sources of plant nutrient which have no detrimental effect to crops and soil. Cowdung, farm yard manure, poultry manure and also green manure are excellent sources of organic matter as well as primary plant nutrients (Pieters, 2005). Farmyard manure is the most commonly used organic manure, but it is limited in supply and contains low and variable nutrient contents. Green manures offer considerable potential as a source of plant nutrients and organic matter.

Rice production in Asia increased upto 25% between 1965 and 1980 due to fertilizer use (Barker et al., 1985). In recent years there has been serious concern about long-term adverse effect of continuous and indiscriminate use of inorganic fertilizers on deterioration of soil structure, soil health and environmental pollution (Ghosh and Bhat, 1998; Shukla et al., 1998; Singh, 2000). In contrast to inorganic fertilizer the use of green manures and other organic matter can improve soil structure, improve nutrient exchange and maintain soil health and that is why interests have been raising in organic farming (Ayoub, 1999; Becker et al., 1995). The integrated nutrient management can be one of the most effective means to increase the productivity of rice. Thus it is necessary to carry out studies by using fertilizers and manures in an integrated way to determine the suitable manure and fertilizer combination for optimum growth, tillering and dry matter production of transplanted rice.

MATERIAL AND METHOD

The field experiment was conducted at the Instructional farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur, C.G. during *kharif* season of 2010-2011. Raipur comes under Chhattisgarh agro-climatic plain zone of Chhattisgarh. Raipur is situated in plains of Chhatishgarh at 21°16' N latitude and 81°36' E longitude with an altitude of 289.60 meter above mean sea level.

The experiment was carried out in randomized block design with 4 replications having treatments: T_1 (Control without fertilizer), T_2 (100% NPK), T_3 (100% N alone), T_4 (100%NPK+FYM), and T_5 (50%NPK+Green manure). A medium duration high yielding paddy variety "Mahamaya" was taken as crop. The recommended dose of fertilizer (N:P:K-100:60:40) was applied as per the treatments through urea, single super phosphate and muriate of potash, for N, P and K respectively. The whole amount of P and K was applied in basal dose along with one part of nitrogen and remaining two parts in equal splits, one at maximum tillering stage and second at

panicles initiation stage of paddy. The pH was determined by glass electrode pH meter in soil water suspension (1:2.5) (Piper, 1950). Electrical conductivity was determined by taking supernatant liquid of 1:2.5 soil water suspension prepared for pH determination by using solubridge as described by Black (1965). It was determined by Walkey and Black rapid titration method as described by Piper (1967). Mechanical analysis of soil (soil texture) was carried out by International Pipette Method as described by Black and Evans (1965). The observations in percent units such as organic carbon and soil moisture per cent do not follow normal distribution there by invalidating "F" test of the analysis of variance. Therefore, to validate this test arcsine transformations of these percent data were carried out based on which subsequent analyses of variance were performed. Average transformed data were presented in corresponding tables along with corresponding means in the original per cent for convenient comprehension. The treatment means of transformed values were then compared with the corresponding least significant difference (LSD/CD) to find the significance of difference due to various treatment effects.

RESULT AND DISCUSSION
Soil pH

Soil pH was determined at four stages, i.e. transplanting, tillering, PI and harvesting of the crop growth. Data presented in Table 1 indicated that soil pH at transplanting, tillering, PI and harvesting stage of paddy is affected by continuous application of fertilizer's. Among the treatments, soil pH decreased in 100% N alone treatment supplemented by urea in T_3. However, it almost maintained in T_2 (100% NPK), T_4 (100%NPK+FYM) and T_5 (100%NPK+GM). Similar findings have been also reported by Magdoff et al. (1997) and Mahajan et al. (2007). However statistically, effect on soil pH by treatment were nonsignificant.

Soil Electrical Conductivity (EC)

The data on electrical conductivity (EC) are presented in Table 2 revealed that the effect of applied organic and inorganic fertilizer treatments was statistically non significant.
The different fertilizer treatment did not influence the EC of the soil. The values are almost constant. Similar finding was also reported by Grewal et al. (1999).

Soil Organic Carbon Content (%)

Soil organic carbon is an important index of soil quality and so plays a crucial role in sustaining crop productivity and environmental quality (Campbell et al.1996) by rejuvenating soil physical, chemical and biological properties viz., soil water retention and availability, nutrient cycling, gas flux, plant root growth and soil conservation (Gregorich, 1994).
Data presented in Table 3 indicated that changes in soil organic carbon at transplanting, tillering, PI and harvesting stages of paddy. The highest significant OC (13.71 per cent) content was observed in treatment T_4 (100%NPK+FYM) which was significantly higher than all other treatments at all the growth stages, while the lowest significant OC (9.42 per cent) content was recorded under T_1 (control), at 5% level of significance.
The table reveals that at PI stage there is no significant difference in soil organic carbon per cent due to treatments T_2 (100% NPK) and T_5 (50% NPK + GM) i.e. they are at par. However T_2 and T_5 are significantly different from T_1, T_3 and T_4.
The highest value of soil organic carbon per cent was recorded in T_4 (100%NPK+ FYM), followed by T_5 (50%NPK+GM) and T_2 (100%NPK) due to higher organic matter content in organic amendments. This is in accordance to the finding that soil organic matter levels and soil microbial activities played a vital role for nutrient turn over and long term productivity of soil which enhanced by use of organic amendments along with inorganic fertilizers. Similar were the findings of Zhang et al. (2009) and Kang et al. (2005). It is pertinent to observe that higher soil organic carbon content was recodes at tillering stages as compared to other vegetative growth stages. The attributing factor may possibly be assigns by further research.

Soil Moisture Content (%)

Data presented in Table 4 depicts changes in soil moisture per cent at different crop growth stages as affected by fertilizer application. The highest significant moisture per cent (56.34) was observed in T_5 (50% NPK+GM), while the lowest significant moisture per cent (31.43) was recorded in T_1 (control) plot for all growth stages of the crop, at 5% level of significance.
The table reveals that at transplanting stage there is no significant difference in soil moisture per cent due to treatments T_1 (control), T_2 (100% NPK), T_3 (100% N), T_4 (100% + FYM) and T_5 (50% NPK + GM), i.e. they are at par. Similarly at tillering stage, the treatments T_1, T_4 and T_5 were at par and also treatments T_2 and T_3 at par with each other but significantly different. Similarly at PI stage there is no significant difference between the treatments T_1, T_2, T_3, T_4 and T_5 i.e. they are at par. Similarly at harvesting stage, the treatments T_1, T_2, T_3 and T_4 were at par but significantly different from T_5. The results of present study corroborate the findings of Bibhuti and Dhkar (2011) who reported that soil moisture can be increased due to organic manure and FYM, as FYM is attributable to mulching effect of organic matter and improved moisture retention and water

acceptances as a result of improved soil structure and macro porosity.

Grain Yield

Data presented in fig. 1 illustrated that the grain yield of rice crop increased significantly due to application of T_4 (100%NPK+FYM), T_5 (50%NPK+GM), T_2 (100%NPK) and T_3 (100%N) respectively over control. Among all the treatments the highest significant grain yield (4955.0 kg/ha.) recorded under T_4 (100%NPK+FYM), while the lowest significant grain yield was in T_1 (control) (2585.0 kg/ha) for all growth stages of the crop.

Among all the treatments, T_4 (100%NPK+FYM) showed higher grain yield than T_5 (50%NPK+GM) followed by T_2 (100%NPK). The T_3 (100% N) treatment recorded significantly lower grain value than all other T_2 (100%NPK), T_5 (50% NPK+GM) and T_4 (100% NPK+FYM) treatments but it was significantly higher than control treatment. The rice grain yield (4517kg/ha) obtained under combined application of T_5 (50% NPK+GM) was at par with the yield recorded under recommended dose of T_2 (100%NPK) fertilizer (4542kg/ha). The findings are in accordance with those of Singh *et al.* (2007) who also reported that increase in grain yield due to combined application of organic with inorganic fertilizer over application of chemical fertilizer.

Table 1. Soil pH in different growth stages of paddy as influenced by continuous application of manure and fertilizers

Treatments	Stages			
	Transplanting	Tillering	PI	Harvesting
T_1= Control	7.52	7.47	7.4	7.37
T_2= 100% (RDF)	7.55	7.54	7.53	7.51
T_3= 100% N	7.37	7.23	7.21	7.19
T_4=100% (RDF)+FYM	7.58	7.57	7.56	7.55
T_5=50% (RDF) + GM	7.57	7.52	7.51	7.5
SEm±	**0.07**	**0.08**	**0.1**	**0.12**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**

Table 2. Electrical conductivity (EC) (d*S*/m) in different growth stages of paddy as influenced by continuous application of manure and fertilizers

Treatments	Stages			
	Transplanting	Tillering	PI	Harvesting
T_1= Control	0.26	0.26	0.25	0.24
T_2= 100% (RDF)	0.30	0.34	0.33	0.32
T_3= 100% N	0.31	0.29	0.27	0.26
T_4=100% (RDF)+FYM	0.34	0.33	0.32	0.31
T_5=50% (RDF) + GM	0.33	0.33	0.32	0.31
SEm±	**0.02**	**0.02**	**0.02**	**0.02**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**

Table 3: Soil organic carbon content (%) in different growth stages of paddy as influenced by continuous application of manure and fertilizers

| Treatments	Stages			
	Transplanting	Tillering	PI	Harvesting
T_1= Control	**2.68** (9.42)*[a]	**4.82** (12.68)[a]	**4.76** (12.60)[a]	**4.20** (11.82)[a]
T_2= 100% (RDF)	**4.75** (12.58)[c]	**5.44** (13.48)[c]	**5.41** (13.44)[c]	**4.89** (12.77)[c]
T_3= 100% N	**4.28** (11.93)[b]	**4.93** (12.82)[b]	**4.89** (12.77)[b]	**4.65** (12.45)[b]
T_4=100% (RDF)+FYM	**4.99** (12.90)[e]	**5.62** (13.71)[e]	**5.56** (13.63)[d]	**5.38** (13.41)[e]
T_5=50% (RDF) + GM	**4.85** (12.72)[d]	**5.53** (13.60)[d]	**5.47** (13.52)[c]	**5.16** (13.12)[d]
SEm±	**0.03**	**0.02**	**0.03**	**0.02**
CD (P=0.05)	**0.011**	**0.07**	**0.09**	**0.07**

Table 4: Soil moisture content (%) in different growth stages of paddy as influenced by continuous application of manure and fertilizers

Treatments	Stages			
	Transplanting	Tillering	PI	Harvesting
T$_1$= Control	64.23 (53.26)*[a]	45.88 (46.03)[a]	37.93 (38.01)[a]	27.2 (31.43)[a]
T$_2$= 100% (RDF)	66.89 (54.87)[a]	49.26 (44.57)[b]	39.51 (38.94)[a]	29.37 (32.81)[a]
T$_3$= 100% N	66.13 (55.22)[a]	48.55 (45.73)[b]	38.82 (39.52)[a]	28.24 (32.85)[a]
T$_4$=100% (RDF)+FYM	67.47 (55.22)[a]	51.29 (45.73)[a]	40.5 (39.52)[a]	29.44 (32.85)[a]
T$_5$=50% (RDF) + GM	69.29 (56.34)[a]	53.43 (46.96)[a]	42.58 (40.73)[a]	31.19 (33.95)[b]
SEm±	0.44	0.37	0.48	0.31
CD (P=0.05)	1.35	1.15	1.47	0.96

*The figures in parentheses give averaged arcsine transformed values corresponding to observed percentage of soil moisture content in the soil for the given growth stages of paddy.

Note.1 The subscripts a, b, c, d and e are showing significance of difference among different means at different growth stages of paddy as influenced by continuous application of manure and fertilizers.

Note 2 Values outside parenthesis are in percent units converted back from arcsine transformed averaged values from within the Parenthesis for the sake of compressible interpretation.
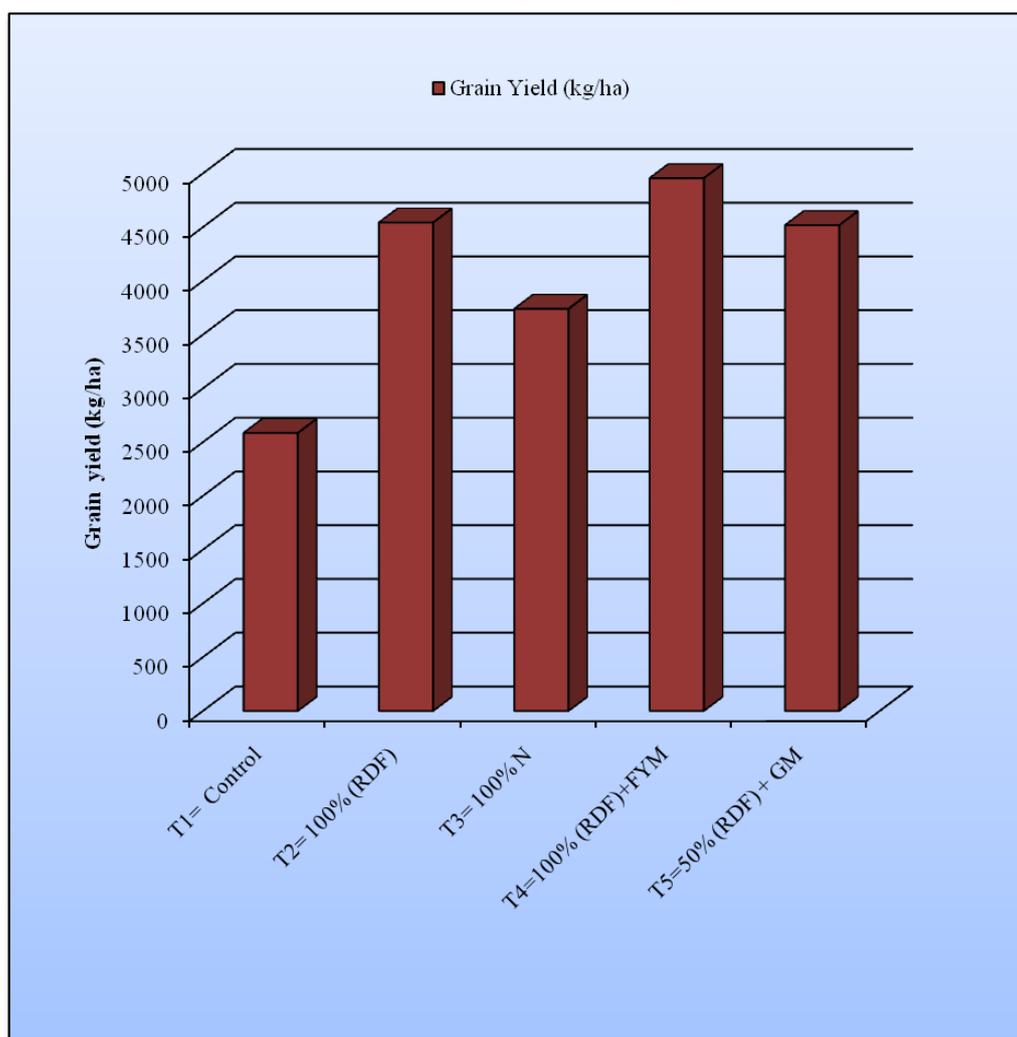
Fig. 1: Grain yield (kg/ha) as affected by different treatments as influenced by continuous application of manure and fertilizers

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