

Original Research Article

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Effect of Fly Ash, Organic Manure and Fertilizers on Soil Microbial Activity in Rice-Wheat Cropping System in Alfisols and Vertisols

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ABSTRACT

Keywords

Fly ash, Microbial activity, Rice-wheat cropping system.

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Field experiment was conducted under Alfisols at KVK, Farm Katghora, Korba and Vertisols at Instructional Farm Indira Gandhi Krishi Vishwavidyalaya, Raipur during 2011, 2012 and 2013. To assess the effect of different doses of fly ash alone or in combination with manure and fertilizers in rice-wheat cropping system with sixteen treatments (i.e. T₁ Control, T₂- 10 t FA ha⁻¹, T₃-20 t FA ha⁻¹, T₄-STCR (based fertilizer recommendation), T₅-75 % NPK ha⁻¹, T₆-100 % NPK (100:60:40), T₇-75 % NPK ha⁻¹+ 10 t FA ha⁻¹, T₈-75 % NPK ha⁻¹+ 20 t FA ha⁻¹, T₉-100 % NPK ha⁻¹+ 10 t FA ha⁻¹, T₁₀-100 % NPK ha⁻¹+ 20 t FA ha⁻¹, T₁₁-75 % NPK ha⁻¹+ 5 t FYM ha⁻¹, T₁₂-100 % NPK ha⁻¹+ 5 t FYM ha⁻¹, T₁₃- 75 % NPK ha⁻¹+ 5 t FYM+10 t FA, T₁₄- 75 % NPK ha⁻¹+ 5 t FYM+20 t FA ha⁻¹, T₁₅-100 % NPK ha⁻¹+ 5 t FYM+10 t FA ha⁻¹ and T₁₆- 100 % NPK ha⁻¹+ 5 t FYM+20 t FA ha⁻¹) under Split Plot Design with factorial arrangement of crop and soil in main plot and treatment in sub plot. The microbial biomass carbon and dehydrogenase activity in soil at harvest of crops was significantly increased due to addition of fly ash and FYM in rice-wheat cropping system in *Alfisol* and *Vertisol*. The treatment, T₁₆ recorded highest microbial biomass carbon and dehydrogenase activity during the year 2011, 2012 and pooled data. The interaction of crop x soil x treatments was non-significant

Introduction

Fly ash is an amorphous ferroaluminosilicate. Physically fly ash occurs as fine particles (60-70%) which has a size below 0.075 mm, it is a by-product of pulverized coal fired thermal power station and has low to medium bulk density, high surface area and very light texture with pH varying from 4.5 to 12 depending upon sulphur content in the coal (Lal *et al.*, 2012). In India and most of the other countries major source of electrical energy is coal based thermal power plants, which produce 175 million tonnes, fly ash which would require about 40,000 hectares of land for the construction of ash ponds (Lal *et*

al., 2012). The ash production in India is expected to reach about 225 million tonnes per annum by 2017.

The Ministry of Power and Planning Commission estimates that the coal requirement and generation of fly ash during the year 2031-32 would be around 1800 million tonnes and 600 million tonnes respectively (Kanungo, 2013). The fly ash utilization in the country is estimated to be about 59% only (Kanungo, 2013). Eleven major Thermal Power Plants in Chhattisgarh which produces fly ash to the tune of about

26880 metric tones per day i.e. nearly 9.7 million tones of fly ash annually, out of which the four major Thermal Power Plants in Korba district alone generate about 24000 metric tones per day.

This is nearly 90% of the total ash generated in the state and about 8.7% of the total ash generated in the country.

The microbial activity in soil increases due to addition of fly ash and organic matter and consequently provided sufficient nutrition for the proliferation of microbes.

Lal *et al.*, (1996) reported that application of fly ash in presence of FYM to an acid soil (*Alfisols*) resulted in increased microbial population, urease and cellulose activities than alone.

Sarangi *et al.*, (2001) reported that invertase, amylase, dehydrogenase and protease activity increased with increasing application of fly ash up to 15 t ha⁻¹.

The dehydrogenase activity in soil was determined by method given by Klein *et al.*, (1971).

Biomass carbon was determined by the fumigation extraction method as per the procedure of Jenkinson and Powlson (1976).

Microbial biomass carbon

Table 1 shows that microbial biomass carbon in soil at harvest of crops was significantly increased due to addition of fly ash and FYM in rice-wheat cropping system in *Alfisol* and *Vertisol*.

The higher microbial biomass carbon recorded in rice and wheat under *Vertisol* during 2011, 2012 and pooled data.

Table 2 shows that the treatment, T₁₆ recorded highest microbial biomass carbon during the year 2011, 2012 and pooled data. The lowest microbial biomass carbon was recorded in T₁. The interaction of crop x soil x treatments was non-significant.

Dehydrogenase activity

Table 1 shows that dehydrogenase activity in soil at harvest of the crop significantly increased due to addition of fly ash and FYM in rice-wheat cropping system in *Alfisol* and *Vertisol*.

The higher dehydrogenase activity was recorded in wheat under *Vertisol* during 2011-12, 2012-13 and pooled data.

Table 3 shows that the treatment; T₁₆ recorded higher dehydrogenase activity in 2011, 2012 and pooled data. It was at par with treatment, T₁₅ and T₁₄ in 2011, and T₁₅ in 2012 and pooled data. The lowest dehydrogenase activity was recorded in treatment, T₁. The interaction of crop x soil x treatments.

Microbial activity significantly increased with application of fly ash alone or in combination with organic manure and fertilizer as compared to control.

These results might be due to the fact that applied organic sources were able to get mineralized rapidly and consequently provided sufficient nutrition for the proliferation of microbes and their activities in terms of soil enzymes.

Addition of organic sources acts as good sources of carbon and energy to heterotrophs by which their population increased with an increase in enzyme activities. Similar results were also reported by Jala (2005) and Kohli *et al.*, (2010).

Table.1 Effect of fly ash alone or in combination with organic manure and fertilizers on microbial activity in soil in Rice-wheat cropping system in *Alfisol* and *Vertisol* at harvest

Particular	Microbial biomass carbon (ppm)						Dehydrogenase activity (Mg of TPF produced/g soil/ha)					
	2011		2012		Pooled		2011		2012		Pooled	
	<i>Vertisol</i>	<i>Alfisol</i>	<i>Vertisol</i>	<i>Alfisol</i>	<i>Vertisol</i>	<i>Alfisol</i>	<i>Vertisol</i>	<i>Alfisol</i>	<i>Vertisol</i>	<i>Alfisol</i>	<i>Vertisol</i>	<i>Alfisol</i>
Rice	214.50	168.70	214.50	168.03	214.50	168.37	4.05	3.60	4.05	3.63	4.06	3.61
Wheat	200.88	165.61	201.42	166.60	201.65	167.23	4.23	3.90	4.35	3.95	4.29	3.92
	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
A	0.642	2.217	0.540	1.862	0.562	1.940	0.025	0.088	0.024	0.084	0.023	0.080
B	0.642	2.217	0.540	1.862	0.562	1.940	0.025	0.088	0.024	0.084	0.023	0.080
A×B	0.908	3.135	0.763	2.634	0.795	2.743	0.036	N/A	0.034	0.119	0.033	N/A

Table.2 Effect of fly ash alone or in combination with organic manure and fertilizers on microbial biomass carbon in Rice-wheat cropping system in *Alfisol* and *Vertisol* at harvest

Treatments	Microbial biomass carbon (in ppm)					
	2011		2012		Pooled	
T ₁ - Control	113.80		115.25		112.59	
T ₂ - 10 t FA ha ⁻¹	123.24		125.57		124.60	
T ₃ - 20 t FA ha ⁻¹	139.43		138.56		138.87	
T ₄ - STCR	176.75		173.99		175.67	
T ₅ - 75%NPK ha ⁻¹	171.44		168.14		169.06	
T ₆ - 100% NPK ha ⁻¹	188.98		188.42		188.31	
T ₇ - 75%NPK ha ⁻¹ +10 t FA ha ⁻¹	180.14		179.72		180.34	
T ₈ - 75%NPK ha ⁻¹ +20 t FA ha ⁻¹	184.03		185.01		184.29	
T ₉ - 100%NPK ha ⁻¹ +10 t FA ha ⁻¹	194.69		194.25		194.21	
T ₁₀ - 100%NPK ha ⁻¹ +20 t FA ha ⁻¹	202.42		201.13		201.64	
T ₁₁ - 75% NPK ha ⁻¹ +5 t FYM ha ⁻¹	200.40		200.12		199.44	
T ₁₂ - 100%NPK ha ⁻¹ +5 t FYM ha ⁻¹	210.63		212.20		211.87	
T ₁₃ - 75%NPK ha ⁻¹ +5 t FYM+10 t FA ha ⁻¹	214.73		214.20		215.07	
T ₁₄ - 75%NPK ha ⁻¹ +5 t FYM+20 t FA ha ⁻¹	219.24		221.68		220.79	
T ₁₅ - 100%NPKha ⁻¹ +5 t FYM+10 t FA ha ⁻¹	230.08		234.56		233.00	
T ₁₆ - 100%NPK ha ⁻¹ +5 t FYM+20 t FA ha ⁻¹	248.74 ^a		249.35 ^a		249.32 ^a	
	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
C	1.49	4.19	1.44	4.03	1.34	3.76
A×C	2.12	5.93	2.04	N/A	1.90	N/A
B×C	2.12	5.93	2.04	5.71	1.90	5.32

Table.3 Effect of fly ash alone or in combination with organic manure and fertilizers on dehydrogenase activity in Rice-wheat cropping system in Alfisol and Vertisol at harvest

Treatments	Dehydrogenase activity (mg of TPF produced/g soil/h)					
	2011		2012		Pooled	
T ₁ - Control	2.69		2.66		2.67	
T ₂ - 10 t FA ha ⁻¹	3.43 ⁱ		3.43		3.43	
T ₃ - 20 t FA ha ⁻¹	3.60 ^h		3.65		3.62	
T ₄ - STCR	3.87 ^f		3.90		3.88	
T ₅ - 75%NPK ha ⁻¹	3.70 ^g		3.75		3.72	
T ₆ - 100% NPK ha ⁻¹	3.82 ^f		3.84		3.83	
T ₇ - 75%NPK ha ⁻¹ +10 t FA ha ⁻¹	3.81 ^f		3.85		3.83	
T ₈ - 75%NPK ha ⁻¹ +20 t FA ha ⁻¹	3.91 ^e		3.87		3.89	
T ₉ - 100%NPK ha ⁻¹ +10 t FA ha ⁻¹	4.09 ^d		4.11		4.10 ^e	
T ₁₀ - 100%NPK ha ⁻¹ +20 t FA ha ⁻¹	4.19 ^c		4.29		4.24 ^d	
T ₁₁ - 75% NPK ha ⁻¹ +5 t FYM ha ⁻¹	4.09 ^d		4.15		4.12 ^e	
T ₁₂ - 100%NPK ha ⁻¹ +5 t FYM ha ⁻¹	4.19 ^c		4.25		4.22 ^d	
T ₁₃ - 75%NPK ha ⁻¹ +5 t FYM+10 t FA ha ⁻¹	4.32 ^b		4.31		4.31 ^c	
T ₁₄ - 75%NPK ha ⁻¹ +5 t FYM+20 t FA ha ⁻¹	4.39 ^a		4.46		4.42 ^b	
T ₁₅ - 100%NPKha ⁻¹ +5 t FYM+10 t FA ha ⁻¹	4.49 ^a		4.64 ^a		4.56 ^a	
T ₁₆ - 100%NPK ha ⁻¹ +5 t FYM+20 t FA ha ⁻¹	4.53 ^a		4.71 ^a		4.62 ^a	
	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
C	0.045	0.125	0.040	0.112	0.036	0.100
A×C	0.063	0.177	0.057	0.159	0.050	0.141
B×C	0.063	0.177	0.057	0.159	0.050	0.141

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