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Influence of flyash and organic manures on soil microbial population

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Abstract
A field experiment was conducted to study the soil microbial population as influenced by application of flyash and organic manures during the *kharif* 2015. The results revealed that the microbial population viz., bacteria, fungi and actinomycetes conspicuously increased with application of flyash with organic manures compare to application of only flyash. The highest population of bacteria (13.43 cfu x 10^6 gm^{-1}), fungi (5.67 × 10^3 cfu g^{-1}) and actinomycetes (15.03 × 10^4 cfu g^{-1}) were reported in treatment receiving flyash @ 15 t ha^{-1} + municipal compost @ 15 t ha^{-1} along with RDF over other treatment combinations.

Keywords: Maize, flyash, municipal compost, vermicompost, FYM, RDF, microbial population

Introduction
Flyash is a resultant waste produced from the combustion of coal in thermal power plants. Its disposal poses a serious problem considering storage space and cost involved in it and dust pollution arising out of its fineness. About 130 coal-based thermal power stations in India are producing over 165 million tons flyash per year. Presence of essential plant nutrients such as N, P, K, Ca, Mg, S and micronutrients make it a source of plant nutrients (Pandey and Singh, 2010) and increases yield of several crops by its application. Apart from nutrition, flyash generation is increased to 300 million tons per annum in 2017 and it expected to increase 900 million tons per annum by 2031-32. This will lead to major environmental problem. Both in disposal as well as in utilization, utmost care has to be taken to safeguard the interest of human life, wild life and environment (Central electricity authority India, 2012-13). Maize (*Zea mays* L.) is the world's third most important cereal crop after wheat and rice. It is one of the leading crop cultivated over an area of 9.5 mha and productivity of 2.45 t ha^{-1} in India (FAO STAT, 2014). In Karnataka, maize is cultivated over an area of 1.38 mha with an average productivity of 2.88 t ha^{-1} which is far below the potential. Similarly, in Raichur district area and productivity is 850 ha and 32.87 q ha^{-1}, respectively (FAO STAT, 2015). A considerable amount of research has been carried out to blend flyash with varieties of organic and inorganic materials, like animal manure, poultry manure, sewage sludge, composts, pressmud, vermicompost, biochar, bio inoculants, *etc*. In combination with organic manure, flyash can enhance soil microbial activities, nutrient availability and plant productivity (Sikka and Kansal., 1995) [9]. There are little studies about the effect of fly ash with different organic manures on biological properties of clay loam soil. We hypothesized that a positive effect on soil microbial population was produced with application of fly ash and different organic manures. Hence, the objective of this study was to determine the effect on soil microbial population as a result of applying fly ash, FYM, Muncipal compost and vermicompost alone or in combination to clay loam soil cropped with maize (*Zea mays* L).
Hence, keeping these above facts in view, present investigation was undertaken.

Material and methods

Table 1: Initial properties of soil of experimental site

Particulars	Values
Soil pH	8.02
EC (dSm^{-1})	0.25
OC (g kg^{-1})	5.10
Nitrogen (N)	117.51
Phosphorus (P_2O_5)	55.36
Potassium (K_2O)	188.61
Sulphur (S)	14.39
Bacteria (No. ×10^6 cfu g^{-1} soil)	6.04
Fungi (No. ×10^3 cfu g^{-1} soil)	5.26
Actinomycetes (No. ×10^4 cfu g^{-1} soil)	5.64

The field experiment on effect of flyash and organic manures application on soil microbial population was conducted during the *kharif* 2015 at Agricultural college farm, Raichur, situated on the latitude of 16º 15' N latitude and 77º 20' E longitude with an altitude of 389 meters above the mean sea level and is located in North Eastern Dry Zone of Karnataka. The soil of the experimental site was medium black and clay loam in texture with the available nitrogen (117.51 kg ha^{-1}), phosphorus (55.36 kg ha^{-1}), potassium (188.61 kg ha^{-1}), Sulphur (14.39 kg ha^{-1}), organic carbon content (5.10 g kg^{-1}). Likewise the initial microbial population *viz.*, bacteria (6.04), Actinomycetes (5.64) and fungi (5.26) of the experimental site was recorded (Table 1). The experiment included eight treatments consisted of T_1: Control, T_2: Flyash @ 30 t ha^{-1}, T_3: FYM @ 10 t ha^{-1}, T_4: Muncipal compost @ 30 t ha^{-1}, T_5: Vermicompost @ 5 t ha^{-1}, T_6: Flyash @ 15 t ha^{-1} + FYM @ 5 t ha^{-1}, T_7: Flyash @ 15 t ha^{-1}+ Muncipalcompost @ 15 t ha^{-1}, T_8: Flyash @ 15 t ha^{-1} + Vermicompost @ 2.5 t ha^{-1}. For each treatment NPK @150:75:37.5 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} applied.

Table 2: Properties of amendments used in experiment

Particulars	FA	FYM	MC	VC
Soil pH	7.98	7.00	7.65	6.97
EC (dS m^{-1})	1.86	0.70	2.80	1.50
OC (%)	1.50	11.50	17.24	31.60
Total N (N) (%)	0.056	0.98	1.3	3.5
Total P (P_2O_5) (%)	0.082	0.014	0.72	0.258
Total K (K_2O) (%)	2.100	1.500	2.28	0.870
Total S (S) (%)	0.550	0.680	0.57	0.60
Total Fe (mg kg^{-1})	13.02	25.60	350.64	39.80
Total Cu (mg kg^{-1})	1.70	3.40	6.98	3.50
Total Mn (mg kg^{-1})	9.40	125.6	135.2	136.50
Total Zn (mg kg^{-1})	28.50	20.32	118.70	29.84

Maize crop variety C-818 were used for investigation. The amendments like flyash (FA), municipal compost (MC), vermicompost (VC) and farm yard manure (FYM) were analysed before using for experiment (Table 2) and were applied 30 days before sowing as per treatments. Nitrogen (N), phosphorus (P) and potassium (K) were applied in the form of urea, diammonium phosphate (DAP) and muriate of potash (MOP), respectively and zinc was applied in the form of $ZnSO_4$ @ 25 kg ha^{-1}. All these nutrients were applied 5 cm away from the seed line and 5 cm deep in to soil. Basal dose of fertilizer (half of nitrogen and full dose of phosphorus and potassium) was applied at the time of planting and remaining half of nitrogen was applied at 30 DAS. The soil sample were collected at 0-15 cm depth from each plot of experiment site before sowing, at 55 DAS and at harvest stage and used for the following microbial analysis. The enumeration of total bacteria, fungi and actinomycetes in free rhizosphere was carried out before sowing, 55 DAS and after the harvest of crop by serial dilution and agar plate method (Pramer and Schmidt, 1964) [7]. Using specific growth media *viz.*, nutrient agar for bacteria, Rose Bengal agar for fungi, Kusters agar for actinomycetes, were used and expressed in cfu g^{-1}.

Result and discussion

In the present study, the application of FA @ 15 t ha^{-1} + MC @ 15 t ha^{-1} along with RDF exerted significant influence on the soil microbial population. Significantly higher bacterial population was recorded at harvest of maize in treatment receiving flyash plus municipal compost along with RDF (13.43×10^6 cfu g^{-1}), followed by flyash plus vermicompost along with RDF and flyash plus FYM along with RDF (10.83 and 12.53×10^6 cfu g^{-1} respectively) (Table 3). This might be due to application of flyash and different organic manures along with fertilizers, which has resulted in more organic carbon accumulation and lead to more microbial activity. The results are in line with the earlier findings of Sivapalan *et al*. (1993) [10] and Lee *et al*. (2004) [11] reported that combined application of organics and chemical fertilizer significantly improved bacterial population over chemical fertilizer in all stages of growth. The data showed that the fungal and actinomycetes population was significantly higher in treatment receiving flyash plus municipal compost along with RDF (5.67×10^3 cfu g^{-1} and 15.03×10^4 cfu g^{-1} respectively), followed by treatment receiving flyash plus vermicompost along with RDF (5.53×10^3 cfu g^{-1} and 14.13×10^4 cfu g^{-1} respectively) and treatment receiving flyash plus FYM along with RDF (5.20×10^3 cfu g^{-1} and 12.57×10^4 cfu g^{-1} respectively) (Table 4 & 5). This may due to the positive influence of inorganic source at initial stages by masking the initial inhibitory effect of organic acids produced during decomposition which promoted the rapid multiplication of micro flora in the soil. High count of actinomycetes in the FYM treated plots is in accordance with the findings of Shah *et al*. (1990) [8] who have observed more proliferation of these organisms in soils containing high organic matter content.

Table 3: Effect of fly ash and organic manures application on bacterial population of soil

Treatments	Bactria (cfu x 10^6 gm^{-1})		
	Initial	50% tasseling	Harvesting stage
T_1: RDF	6.37	11.47	8.43
T_2: FA @ 30 t ha^{-1}	3.53	12.87	8.33
T_3: FYM @ 10 t ha^{-1}	5.30	14.17	8.63
T_4: MC @ 30 t ha^{-1}	4.90	11.77	8.13
T_5: VC @ 5 t ha^{-1}	5.80	17.57	8.83
T_6: FA @ 15 t ha^{-1} + FYM @ 5 t ha^{-1}	6.30	18.77	10.83
T_7: FA @ 15 t ha^{-1}+ MC @ 15 t ha^{-1}	9.67	25.17	13.43
T_8: FA @ 15 t ha^{-1} + VC @ 2.5 t ha^{-1}	6.43	20.37	12.53
S. Em.±	1.9	3.3	1.0
C.D. at 5%	NS	9.8	2.9

Table 4: Effect of fly ash and organic manures application on actinomycetes population in soil

Treatments	Actinomycetes (cfu x 10^4 gm^{-1})		
	Initial	50% tasseling	Harvesting stage
T_1: RDF	3.43	8.37	7.43
T_2: FA @ 30 t ha^{-1}	3.77	9.17	7.90
T_3: FYM @ 10 t ha^{-1}	5.30	11.38	8.50
T_4: MC @ 30 t ha^{-1}	3.87	10.17	9.17
T_5: VC @ 5 t ha^{-1}	4.83	13.57	11.13
T_6: FA @ 15 t ha^{-1} + FYM @ 5 t ha^{-1}	6.57	15.43	12.57
T_7: FA @ 15 t ha^{-1}+ MC @ 15 t ha^{-1}	10.07	18.23	15.03
T_8: FA @ 15 t ha^{-1} + VC @ 2.5 t ha^{-1}	7.30	16.47	14.13
S. Em.±	0.62	1.0	0.9
C.D. at 5%	NS	2.9	2.7

Table 5: Effect of fly ash and organic manures application on fungal population in soil

Treatments	Fungi (cfu x 10^3 gm^{-1})		
	Initial	50% tasseling	Harvesting stage
T_1: RDF	4.20	4.73	3.57
T_2: FA @ 30 t ha^{-1}	4.70	5.10	4.00
T_3: FYM @ 10 t ha^{-1}	4.30	4.67	3.73
T_4: MC @ 30 t ha^{-1}	4.60	5.07	3.53
T_5: VC @ 5 t ha^{-1}	5.23	6.38	4.03
T_6: FA @ 15 t ha^{-1} + FYM @ 5 t ha^{-1}	6.17	7.55	5.20
T_7: FA @ 15 t ha^{-1}+ MC @ 15 t ha^{-1}	6.60	7.90	5.67
T_8: FA @ 15 t ha^{-1} + VC @ 2.5 t ha^{-1}	6.30	7.71	5.53
S. Em.±	0.16	0.4	0.4
C.D. at 5%	NS	1.1	0.10

Note: NPK @ 150:75:37.5 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} was applied for all treatments

Conclusion

From this study, it can be concluded that application of flyash and organic manures increased the microbial population in the soil, among the treatments T_7: FA @ 15 t ha^{-1} + MC @ 15 t ha^{-1} along with RDF recorded highest followed by T_6: FA @ 15 t ha^{-1} + FYM @ 5 t ha^{-1} and T_8: FA @ 15 t ha^{-1} + VC @ 2.5 t ha^{-1}. Thus, combined application of both flyash and organic manures going to increases the organic matter content of soil, and improves the soil properties hence, there will be tremendous increase in growth and it leads to higher yield and benefit to growers.

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