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Effect of Lignite Fly Ash and Composted Coir Pith on Cultivable Soils

V.A. Elavalagan

Department of Chemistry and Environmental Sciences, AMET University, ECR, Kanathur, Chennai 112, India.

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In Tamil Nadu alone, the daily production rate of fly ash is about 15,000 tons. At the world level 90% of coir production is concentrated in India and Sri Lanka and Tamil Nadu and Kerala stand in the forefront. Lignite fly ash along with degraded coir pith was applied to the sandy loam red soils of Thanjavur. Pot culture experiments were conducted and the performance of paddy ADT 36 was tested. The nutrient status of the soil and the yield attributes of ADT 36 were evaluated. The study revealed that the soil properties were altered and the yield parameters were changed. The sandy red soils supplemented with lignite fly ash and composted coir pith resulted in better yields than commercial fertilizers alone.

Key words: Lignite Fly Ash, Coir pith, Soil.

Organic wastes could be applied as soil amendments at lower and medium rates. The optimal application rate depends on the nutrient content and the levels of contamination in the waste.[1] Much interest was evinced in the role of organic wastes in altering the soil fertility and physico chemical properties of the soil.[2] The beneficial attributes of lignite fly ash include its use as a soil conditioner, diluents, neutralizing agent or a nutrient supplier.[3] However high concentrations of Al, B, Mn or soluble salts, as well as deficient levels of P and K may cause problems.[4,5] Decomposed organic matter such as composted coir pith reduces the toxicity of heavy metals[6] . Moreover it will be more inexpensive if alkaline fly ash could be used instead of conventional lime to treat acidic soils[7].

* To whom all correspondence should be addressed.

MATERIALS AND METHODS

Lignite Fly Ash (LFA) from Neyveli power station and coir pith from coir industries of Pattullottai, Thanjavur were collected. The coir pith was decomposed using *Pleutrotus Caju* and urea 8. The sandy loam red soils of Budalur series from the post harvested paddy fields were collected, processed and analysed for physical properties[9-13] and chemical characteristics[14-17]. The composted coir pith was analysed for its chemical properties.

The sandy loam red soils from the post harvested paddy fields were mixed with 0.375 t/ha of phosphorus (as super phosphate) 2, 4, 6, 8 t/ha of LFA (as potash), 0.0937 t/ha of nitrogen (as urea at two different stages after transplantation) and 10 t/ha of composted coir pith and labeled as T2 CCP1, T2CCP2, T2CCP3, T2 CCP4.

In the third controlled treatment the same soils were mixed with the recommended levels of commercial fertilizers viz. urea, superphosphate and muriate of potash in the levels 0.1875 t/ha, 0.375 t/ha, and 0.05 t/ha respectively. The experiment was carried out in completely randomized blocks using 20 cm pots with three replicates.

Seedlings of paddy ADT 36 were transplanted in each pot and watered as necessary. After 90 days the plants were cut at 2cm above soli level. The harvested materials were oven dried at 70 C. The growth characters and yield parameters were recorded[18]. The post harvested soils were analyzed for the chemical characteristics for the effect of crop and fly ash by adopting standard procedures.

RESULTS AND DISCUSSION

Soil analysis

The bulk density of LFA was considerably lower than SLR soils while other parameters particle density, maximum water holding capacity, porespace and volume expansion of LFA was higher than SLR soil. LFA was alkaline but the sandy loam red soils and the composted coir pith were acidic. Electrical conductivity which reflects salinity was moderately alkaline in LFA and SLR soils. The available NPK status of LPA was strikingly lower than SLR soil and composted coir pith. The total nitrogen content of SLR soil and CCP were higher than LFA. Organic carbon was high in CCP but low in LFA and SLR soils. (Table. 2)

Crop yields

Grain yield

Application of LFA with NP fertiliser imparted the same effect as that of NPK fertiliser. The treatment with 6 t/ha of LFA (T1 LFA3) gave the maximum grain yield (57 gms) per plant of paddy ADT 36 while the treatment with the recommended level of commercial fertiliser (TC) gave 56.66 gms grain yield per plant. (Table. 4).

Application of LFA (6 t ha^{-1}) along with recommended level of commercial super phosphate, half the dose of the recommended level of urea and 10 t ha^{-1} of composted coir pith (T2 CCP3) gave the maximum grain yield of 65 gms per plant i.e., 16% increase over the control.

Table 1. Pot culture design : Different levels of treatments of SLR soil with other inputs

T1 LFA 1 SLR soil	+	RL of N	+	RL of P	+	LFA(2 t/ha)		
2 “	+	“	+	“	+	“” (4 t/ha)		
3 “	+	“	+	“	+	“” (6 t/ha)		
4 “	+	“	+	“	+	“” (8 t/ha)		
T1 LFA 1 SLR soil	+	RL of N	+	RL of P	+	LFA(2 t/ha)+CCP(10t/ha)		
2 “	+	“	+	“	+	“” (4 t/ha) + “		
3 “	+	“	+	“	+	“” (6 t/ha) + “		
4 “	+	“	+	“	+	“” (8 t/ha) + “		
T control	SLR soil	+	RL of N	+	RL of P	+	RL of K	

SLR soil - Sandy loam red soil
LFA - Lignite fly ash
CCP - Composed coir path
RL of N - Recommended level of nitrogen
RL of P - Recommended level of phosphorous
RL of K - Recommended level of potash

RL of as urea - 0.1875 t/ha at three different stages
RL of N/2 as urea - 0.0937 t/ha at two stages after transplantation
RL of P as superphosphate - 0.375 t/ha as a basal dose
RL of K as muriate of potash - 0.05 t/ha as a basal dose

Table 2. Characteristics of lignite fly ash and sandly loam red soil Physical Properties

No.	Factors	LFA	SLR soil
1.	Bulk density(g cm^{-3})	1.29	1.50
2.	Particle density(g cm^{-3})	2.82	2.54
3.	Maximum water holding capacity(%)	43.00	29.03
4.	Porespace (%)	54.25	40.00
5.	Volume expansion(%)	52.00	10.00

Straw yield

LFA application (6 t/ha) with NP fertiliser alone (T1 LFA3) had significant effect on straw yield performance (38.6 gm) of paddy ADT 36 when compared with the recommended level of NPK application (42.2 gms). Similarly when LFA (6 t ha^{-1}) was applied along with the recommended level of commercial super phosphate, half the dose of recommended level of urea and 10 t ha^{-1} of composted coir pith(T2 CCP), higher straw yield 45.2 gms per plant was witnessed i.e.,6% increase over control. Increase in yield due to the application of fly ash was reported by andriono *et.al.*[19]

Effect on properties of soil

The effects of application of different levels of fly ash, NPK and composted coir pith on

Table 3. Chemical Characteristics of LFA, SLR, soil and CCP

No.	Particulars	LFA	SLR Soil	CCP
1.	Organic carbon(%)	0.34	0.24	34.06
2.	Available N(kg/ha)	0.017%	143	422
3.	Available P_2O_5(Kg/ha)	0.023%	9.81	9.21
4.	Available K_2O(Kg/ha)	135	82	130
5.	pH(1:2 soil water suspension)	9.21	6.89	6.88
6.	Electrical conductivity (dSm^{-1})	1.77	1.76	1.70
7.	Total N (%)	0.0095	0.11	1.68
8.	CN ratio	33.6:1	21.8:1	21.2:1

Table 4. Influence of graded levels of LFA and CCP on grain yield per plant and straw yield per plant of ADT 36

Bulk density(gm cm^{-3})		Soil pH					Soil EC (dSm^{-1})				
Grain Yield (gms)					Straw Yield(gms)						
		R1	R2	R3	Total	Mean	R1	R2	R3	Total	Mean
T1 LFA	1	52	51	50	153	51	36.2	36.3	36.4	108.9	36.3
	2	55	54	53	165	55	37.1	37.2	37.1	111.4	37.13
	3	58	57	56	171	57	38.6	38.7	38.5	115.8	38.6
	4	56	55	55	166	55.3	37.3	37.4	37.3	112.0	37.33
T2 CCP1	60	61	60	181	60.3		40.1	40.3	40.4	120.8	40.26
	2	63	62	61	186	62	42.2	42.1	42.1	126.4	42.13
	3	65	64	66	195	65	43.1	43.2	43.3	129.6	43.2
	4	64	63	64	191	63.6	42.7	42.6	42.8	128.1	42.7
TC		57	56	57	170	56.66	42.3	42.4	42.5	127.2	42.4

Table 5. Influence of graded levels of LFA and CCP on available NPK status of soil under paddy ADT 36(Kg ha^{-1})

	Available N				Available P				Available K			
	R1	R2	R3	Mean	R1	R2	R3	Mean	R1	R2	R3	Mean
T1 LFA1.	130.67	130.62	130.59	130.62	11.09	11.07	11.08	11.08	120.01	120.08	120.11	120.06
2.	134.27	134.29	134.18	134.24	11.07	11.06	11.07	11.08	122.67	122.58	122.69	122.64
3.	140.19	140.28	140.29	140.25	11.01	11.02	11.01	11.01	125.01	125.13	125.18	125.10
4.	141.32	135.86	135.91	135.82	11.03	11.02	11.03	11.02	123.72	123.68	123.76	123.72
T2 CCP1.	141.32	141.28	141.27	141.29	12.25	12.26	12.25	12.25	124.35	124.31	124.36	124.34
2.	145.48	145.46	146.47	145.80	12.20	12.21	12.22	12.21	128.72	128.68	128.69	128.69
3.	147.92	147.98	147.95	147.95	12.17	12.18	12.18	12.27	130.07	130.15	130.11	130.11
4.	146.21	146.38	146.46	146.35	12.18	12.19	12.19	12.18	120.34	129.28	129.31	129.31
TC	146.56	141.38	141.49	141.47	11.11	11.12	11.13	11.12	124.64	123.82	123.91	124.12

Table 6. Influence of graded levels of LFA and CCP on organic carbon, total nitrogen and C:N ratio of SLR soils

	Organic carbon(%)				Total Nitrogen(%)				C:N ratio
	R1	R2	R3	Mean	R1	R2	R3	Mean	
T1 LFA1.	0.251	0.249	0.248	0.249	0.012	0.011	0.011	0.011	22.63:1
2.	0.262	0.258	0.259	0.259	0.011	0.011	0.011	0.011	23.54:1
3.	0.281	0.279	0.278	0.279	*0.*0113	0.0112	0.0113	0.0113	24.69:1
4.	0.271	0.268	0.269	0.269	0.0112	0.0113	0.0113	0.0113	23.80:1
SE + CD									
T2 CCP1.	0.27	0.28	0.27	0.273	0.0128	0.0127	0.0127	0.01273	21.44:1
2.	0.28	0.29	0.28	0.283	0.0128	0.0129	0.013	0.0129	21.93:1
3.	0.30	0.31	0.32	0.313	0.014	0.0139	0.0138	0.0139	22.51:1
4.	0.29	0.28	0.27	0.280	0.013	0.013	0.0129	0.0129	21.70:1
SE + CD TC	0.24	0.239	0.238	0.239	0.011	0.0114	0.0116	0.0113	21.15:1

some physio chemical properties of soil are presented in Table 5.

Effect on Bulk density

Significant reduction in bulk density of SLR soil by fly ash application and composted coir pith was observed where as NPK levels had no such effects. LFA and CCP addition had beneficial effect on physical properties of soil. Lower bulk density means lower compaction, better soil aeration and drainage also. Giedroj et.al.,[20] added fly ash at the rates of 200 to 800 t ha^{-1} to sandy soil and recorded variation in bulk density.

Effect on soil pH

Very little effect is observed by the addition of LFA and CCP at different levels on the pH of SLR soil (Table 5).

Effect on soil EC

Soil electrical conductivity was increased with the addition of LFA (6 t ha^{-1}) from 1.76 d Sm^{-1} to 1.82 d Sm^{-1} but it was reduced considerably by the addition of LFA and composted coir pith.

Effect on available NPK satus of soil

Available NPK status of soil was fairly improved bby the addition of LFA and the status was remarkably increased when LFA was applied with composted coir pith. (Table 6)

Effect on organic carbon and C:N ratio

The Carbon-Nitrogen ration in soil oraganic matter is most significant and it is related not only to the availability of soil nitrogen but also to the maintenance of soil organic matter. The C:N ratio exerted influence upon the transfer of nitrogen in the soil and its availability to crop plants.(Table 7) It is observed that fly ash and composted coir pith application to SLR soils had beneficial effects on the organic carbon and nitrogen status of soils.

CONCLUSION

The application of lignite fly ash and composed coir path at graded levels to the sandy loam red soils may solve problem of managing industrial wastes due to the coal fired thermal power stations of Neyveli and coir factories of Thanjavur.

The chief response of plants to lignite fly assh and composted coir pith was their beneficial effects on soil physical structure and chemical characteristics.

The NPK status of the SLR soil and the yield of paddy ADT 36 were greatly influenced by LFA and CCP and thus application of commercial fertilisers can be minimised.

Composed organic residues might have functioned as sink for polyvalent cations , thereby reducing the toxicity danger of heavy metals.

Buffering capacity of LFA together with the metal binding power of organic matter might have reduced the risks of heavy metal toxicity, since salt damage was not observed in paddy plants grown on SLR soils with LFA and CCP.

Blending of natural organic residues like lignite fly ash and composted coir pith with commercial fertilisers may be carriesd out to meet the problems of industrial waste management and integrated plant nutrient supply system

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