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Impact of thermal fly ash and cow dung on growth, yield and metal residues in *Solanum melongena*

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ABSTRACT

Thermal fly ash with cow dung amendments caused significant improvement in soil quality. Water holding capacity (50.60-68.59), PH (6.05- 7.50) and few growth parameters (fresh weigh, roots length, shoot length) of S.melongena with the increase in Thermal fly ash and cow dung amendments. Fruit (edible part) of plants grown in fly ash and cow dung amended soil had metal residues (mg Kg^{-1}) like Zn (24.56-35.42), Ni (1.23-1.66), Cr (0.81-1.42), Co (0.52-1.57), Pd (0.25-0.41) and Mo (0.98-1.44) within acceptable limits. Results indicate that soil amended with fly ash and cow dung at 150 tons ha^{-1}, not only improved the physical properties of the soil but also contributed to the better growth and yield of brinjal (S. melongena).

Key words: Amendment, Thermal fly ash, cow dung, *Solanum melongena*, metal residues.

INTRODUCTION

Currently thermal fly ash (TFA) dumping into the environment is one of the chief apprehensions throughout the Globe mainly in developing countries. In developing countries like India 75% of power is produced by thermal power plants, which generate nearly 65 million tons of fly ash in a year as a waste byproduct [1]. The disposal of such a massive quantity of TFA is one of the chief problems and is usually disposed in ponds or landfills close to the power plants. To make use of of fly ash to vegetate the landfill areas is an alternative for TFA management, which will serve for both the stabilization and providing a pleasant landscape [2]. Dumping of TFA affects the quality of the surface land area, ground water, soil and agriculture. TFA contains a high concentration of toxic heavy metals such as Cu, Zn, Cd, Pb, Ni, Cr etc. [3] along with low nitrogen and phosphorus content. Besides the application of TFA can be used as a raw material for brick, cement factories and disposal in agricultural land is a possible alternative. TFA use as a fertilizer at commercial scale is rare in most of the developed countries as coal ash contains non essential elements that badly affect crops, soils and ground water quality. Use of TFA in irrigation lands has to take into consideration about its possible toxic effect, if any, due to the presence of high concentrations of toxic heavy metals. In view of the above and to find an effective disposal problem of TFA, the present investigation was carried out with the main objectives to assess the effect of TFA + cow dung amended soil on heavy metals accumulation, growth and yield of *Solanum melongena* plant species.

MATERIALS AND METHODS

Collection of Thermal fly ash, soil and cow dung:
Thermal fly ash samples were collected in large plastic bags from dumping sites of nearby ash ponds of Thermal power station (Dr.NTPC), Ibrahimpatnam, Krishna district, Andhra Pradesh. The cow dung and soil were collected from the local areas of Ibrahimpatnam. The fly ash and cow dung were sun dried for 5-10 days before various

amendments (manually). Certified seed of *S. melongena* L. were collected from local market. Crops were harvested between 100-120 days for metal accumulation.

Experimental Design: All the seeds were sterilized with 0.2% mercuric chloride for 2-3 min to avoid fungal contamination and washed 2-3 times with sterile distilled water and soaked in water for 5 -8 hrs. The soaked seeds were evenly sown in earthen pots (15 inch in diameter) filled with 7 Kg of amendments (four number) and control (soil) in triplicates. For preparing amendments, equivalent weight of 1 sq m of top soil has been mixed with equivalent weight of thermal fly ash and cow dung in the increments of 5 % to prepare four amendments with the ration of 5, 10, 15 and 20 % fly ash and cow dung in soil. Percentage values corresponds to 50, 100, 150 tons ha^{-1} along with one set of control. Prepared seeds were sown in each pot to depth of 0.10cm, kept in natural condition and watered daily till seed germination. The seeds were irrigated with municipal water at regular intervals (250 ml) avoiding leakage of water from the pots and measured root and shoot length respectively.

Physico-chemical analysis of amendment and soil: Physico-chemical analysis was carried out in triplicate on soil and their different amendments with thermal fly ash (TFA) and cow dung (cd) before the growth of *S. melaongena* L. Moisture content of soil and TFA + cd was calculated as the difference of fresh weight of the soil and dry weight of the soil divided by dr weight and multiplied by 100. The pH of different amendments was measured in 1: 25 soil water suspension using pH meter. Organic carbon values of 10 days for old soil and amended samples were determined by oxidation method with potassium dichromate with few modifications [4], Total concentrations of metals including Zn, Ni, Cr, Co, Pb, and Mo were determined using open acid digestion methods of Roy et al., 2007 [5].

Plant growth and yield:
Measurements of roots and stem length were taken at the age of 50 and 100 days after germination. Yield was estimated by detaching and weighing the fresh fruit with the help of a balance. Total concentrations of metals in plant parts were determined by Wiermans and Ver Goor, 1986)[6]s with little modifications.

RESULT AND DISCUSSION

The study the soil amendment property of fly ash and utilize it as a substitute for fertilizers, in the present investigation a TFA sample has been subjected to study with the following composition as represented in Table -1.

Table 1: Chemical composition of Thermal Fly ash

Constituents	Wt % Composition
Si_2O_3	62.20
Al_2O_3	25.12
Fe_2O_3	10.23
CaO	14.84
MgO	2.01
SO_2	1.59
Mo	389
Zn	200
MnO	0.01
Pb	15
Co	16
Cr	87
Cu	69

In order to modify the texture and composition of TFA, cd is added at various ratios to fly ash samples to enhance the Wt % composition of P, N, K in TFA and soil. The cd used in the study has the following composition as represented in Table -2.

Table 2: Chemical composition of Cow dung Wt %(cd)

Cow Dung Composition	Concentration
Nitrogen (%)	1.91
Phosphorus (%)	0.68
K (%)	0.64
Mg	0.92
Ca	2.73
Na	0.68

The water holding capacity increased from (50.60-68.59) and moisture content showed an increasing trend of (2.25-4.69) when compared to control and mixture. The pH values of the mixed soil (TFA+cd) increased from 6.05 to 7.50. It may be due to alkaline pH of TFA + cd [7-8]. Other co-workers reported that fly ash and cow dung combination improves the physical and nutrient status of the soil [9-11]. The values of organic carbon (OC %) (0.70-0.99) and organic carbon matter (OM %)(1.28-1.68) increased with the addition of TFA and cd [8]. The application of TFA and cd resulted in an increase in available macro and micro nutrients (P, K Cr, Co, Ni, Zn, and Mo) (Table -4). The plants grown under soil accumulated appreciable amounts of metals in their fruit. The concentration of metals in plant increased proportionally with the concentration of fly ash and cow dung in different treatments as compared to control (Table 4). Selective uptake of different metals by the plant body was observed in the study [12]. The plants grown in TFA and cd amended soil mixture shown the following order: Zn > Cu> Ni> Co> Cr> Pb. The accumulation of toxic heavy metal like Pb, Cr and Ni was considerably low in 100 and 150 t ha^{-1} amendments including control soil indicating safe for human consumption. The results are in agreement with the findings of [7,11,12]. The data observed in Table 5 shows that all the plants growth parameters (root length and weight of fruit) of *S.melongena* were significantly increased in all amendment soil compared to control. The plant growth was maximum in 150 ton ha^{-1} levels of amendment. The beneficial effects of fly ash have been reported in several plant species [8]. Among all the amendments, applications of TFA in combination with cd were found beneficial for the plant growth and yield.

Table 3: Physico-chemical analysis of control and Thermal Fly Ash (TFA) and Cow dung (cd) amended soil

Parameters	Control soil	Amended soil		
		50 t ha^{-1}	100 t ha^{-1}	150 t ha^{-1}
Water holding capacity (%)	40.11	50.60	61.15	68.59
Moisture content (%)	1.85	2.25	3.42	4.69
pH	6.05	6.25	7.21	7.50
OC (%)	0.70	0.81	0.90	0.99
OM (%)	1.28	1.38	1.50	1.68
Ca	2.92	4.52	6.91	8.15
Mg	16.70	17.41	18.38	20.54
P	9.62	9.73	10.56	11.93
N	289	270	290	320
K	112.51	115.16	116.21	117.32
Metals (mg Kg^{-1})				
Zn	462	598	523	497
Ni	23.56	35.66	42.73	49.77
Cr	80.10	105.32	130.25	123.59
Co	11.16	14.56	17.92	17.56
Pb	-	15.23	15.34	15.45
Mo	36.80	34.24	36.72	30.11

Table 4: Analysis of metal (mg Kg^{-1}) in control and TFA+ cd amended soil

Metal	Control soil	Amended soil		
		50 t ha^{-1}	100 t ha^{-1}	150 t ha^{-1}
Zn	30.62	24.56	35.42	33.53
Ni	1.55	1.23	1.08	1.66
Cr	1.56	0.81	1.02	1.42
Co	1.79	0.52	0.86	1.57
Pb	1.59	0.25	0.33	0.41
Mo	0.92	0.98	0.56	1.44

Table 5: Analysis of control and TFA +cd amended soil on growth and yield of *S. melongena*

THF + cd amendment	50 days Shoot length (inch)	100 days Shoot length (inch)	50 days Root length (inch)	100 days Root length (inch)	Yield of Fruit (g $plant^{-1}$ f.wt)
Control soil	2.40	26.17	3.69	5.81	357.65
50 t ha^{-1}	2.55	28.37	4.21	6.12	369.59
100 t ha^{-1}	3.21	32.54	6.56	9.43	520.11
150 t ha^{-1}	3.83	36.22	7.92	12.54	1092.23

CONCLUSION

The present investigation concludes that TFA in combination with the Cow dung is found to be a promising material to substitute for artificial fertilizers. In order to increase the nitrogen content in the fly ash cow dung is used as an additive to increase the property of nitrogen fixation by the plants**.** So this is a novel method for the utilization of TFA for agriculture.

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