



Integrated Use of Co-Compost with Lignite Fly Ash on Yield and Nutrient Uptake of Certain Crops

Angayarkanni, A¹, M.V. Sriramachandrasekharan², M. Salahuddin³, P. Poonkodi⁴

^{1,2,4}Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University, Annamalainagar-608002

³Director, Ministry of Environment, Forest and Climate Change, New Delhi

ABSTRACT: A field experiment was conducted to know the response of crops to combined application of co compost and lignite fly ash. Field experiments were conducted in experimental farm (rice and maize) and farmers holding (groundnut and brinjal) to study the response of certain crops to the application of co composts and lignite fly ash grown in clay loam and sandy clay loam soil, respectively. The treatment consisted of Dairy Farm Waste + Crop Residues, Pressmud+ Crop Residues, Dairy Farm Waste + Crop Residues + LFA @5 t ha⁻¹, Dairy Farm Waste + Crop Residues + LFA @10 t ha⁻¹, Dairy Farm Waste + Crop Residues + LFA @15 t ha⁻¹, Pressmud + crop residues + LFA @5 t ha⁻¹, Pressmud + crop residues + LFA @10 t ha⁻¹ and Pressmud + crop residues + LFA @15 t ha⁻¹. The grain and straw yield in rice and maize, pod and haulm yield in groundnut and fruit yield of brinjal were recorded during harvest. Differences in yield of crops between the treatments indicate significantly different effects on soil fertility and crop yield after long-term fertilization. The uptake of nutrients increased linearly with levels of LFA tried and it was higher when it was applied with co compost of pressmud and crop residue. The addition of co composts alone or with graded dose of lignite fly ash significantly improved the physical properties of the soil.

KEYWORDS: Co-compost, Crops LFA, Yield, Uptake.

I. INTRODUCTION

Applying compost can contribute to agricultural sustainability. Reuse of organic waste through composting is promoted as a primary measure to mitigate such environmental threats by developed nations (Pampuro *et al.*, 2016). Adequate use of compost with proper management has been shown to have many advantages. These advantages include adding an array of nutrients to soils (Tejada *et al.*, 2009), increasing SOM, improving water holding capacity and other physical properties of soil such as bulk density, penetration resistance and soil aggregation (Wells *et al.*, 2000). Co-composting is an effective technique, which turns both on and off-farm wastes into a resource. The primary advantage of co-composting on-farm and off-farm wastes is to blend and balance the C: N ratio of the waste materials. Co-composting Dairy farm and crop residue wastes with clean organic agricultural and non-agricultural wastes offers a number of opportunities for farmers. It can generate revenue by converting livestock manure into a stable soil conditioner. The co-compost prepared can be effectively utilized for all crops along with fertilizers to improve the nutrient use efficiency Fly ash (FA) is a fine grey powder, produced by combusting coal in thermal power station, which was considered in previous times as a waste, is now used as a valuable resource in agriculture to improve texture, reduce acidic character of soil, enhance nutrient levels, increase water holding capacity and can be used against pests to protect vegetables. (Rautaray *et al.*, 2003, Jala and Goyal, 2006). Fly ash is gaining importance in agriculture as it contains many nutrients, especially the secondary (Ca, Mg & S) and the micronutrients (Fe, Mn, Zn & Cu). Therefore, it may be used as nutrient source to plants and also to improve the physicochemical properties of soils. Adding fly ash and chemical fertilizers could influence the decomposition ability of organic materials, and thus, the released pattern of nutrients from organic materials could also change. Thus, a field experiment was conducted to know the response of crops to combined application of co compost and lignite fly ash.

II. MATERIALS AND METHODS

Field experiments were conducted in experimental farm (rice and maize) and farmers holding (groundnut and brinjal) to study the response of certain crops to the application of co composts and lignite fly ash grown in clay loam and sandy clay loam soil, respectively. The experimental soil was low in available nitrogen and medium in available phosphorus and potassium The



treatment consists of Dairy Farm Waste + Crop Residues, Pressmud+ Crop Residues, Dairy Farm Waste + Crop Residues + LFA @5 t ha⁻¹, Dairy Farm Waste + Crop Residues + LFA @10 t ha⁻¹, Dairy Farm Waste + Crop Residues + LFA @15 t ha⁻¹, Pressmud + crop residues + LFA @5 t ha⁻¹, Pressmud + crop residues + LFA @10 t ha⁻¹, Pressmud + crop residues + LFA @15 t ha⁻¹ and were laid out in RBD with three replications. The test crop tried were rice var ADT43, Maize var hybrid: P3502, groundnut var TMV 3 and Brinjal var Annamalai. All the crops received recommended dose of fertilizer viz., rice (150:50:50), maize (150:62.5:50), groundnut (17:34:54) and Brinjal (120:60:30) N, P₂O₅ and K₂O kg ha⁻¹, respectively. The chemical composition of DFW and CR co compost was N-1.32%, P-0.434%, K-0.833%, C-17.56 and C: N ratio- 13.3 and pressmud and crop residue co compost had N-1.50, P-0.596%, K- 0.883%, C- 16.04% and C:N ratio- 10.7. The grain and straw yield in rice and maize, pod and haulm yield in groundnut and fruit yield of brinjal were recorded during harvest. The samples were analysed for nutrient content following standard procedure and their uptake was computed. The post-harvest soil samples were analysed for bulk density, moisture retentive capacity and water stable aggregates.

III. RESULTS AND DISCUSSION

A. Yield of crops

Addition of graded levels of lignite flyash either with co compost of dairy farm waste plus crop residue or with pressmud with crop residue registered significant response of crops examined over co compost alone (table 1). The response of crops to combined application of lignite flyash with pressmud and crop residue was higher than that of combined addition of lignite fly ash with dairy farm waste and crop residue. The yield response due to conjoint application of LFA with dairy farm waste plus crop residue over dairy farm waste plus crop residue alone ranged from 725 to 1425 kg /ha (rice), 550 to 1110 kg/ha(maize), 298 to 710 kg/ha (groundnut) and 2.72 to 6.61 t/ha(Brinjal). Similarly, the yield response due to conjoint application of LFA with pressmud with crop residue ranged from 950 to 1525 kg/ha (rice), 500 to 1200 kg/ha (maize), 300 to 725 kg/ha (groundnut) and 5.10 to 8.81 t/ha (brinjal). The percent increase due to combined addition of LFA and co compost over co compost alone ranged 14 to 29 in grain and 11.4 to 23.3 in straw of rice, 10.9 to 26.1 in grain and 14.1 to 29 in straw of maize, 13.1 to 31.5 in pod and 9.9 to 22.1 in haulm of groundnut and 14.1 to 43.9 in Brinjal (fig.1). The highest response of crops (6775, 8475 kg ha⁻¹ in rice, 5800, 9940 kg ha⁻¹ in maize, 3025, 3882 kg ha⁻¹ in groundnut and 28.87 t ha⁻¹ in Brinjal) was realized with application of LFA@15 t ha⁻¹ and co compost of pressmud with crop residue. It was comparable with LFA @ 10 t ha⁻¹ with co compost of pressmud and crop residue. Compost is a stable humus-like product, which results from the biological decomposition of organic materials under controlled conditions. Compost helps retain moisture in the soil, provides crucial, slow-release nutrients to crops and can lead to long-term yield increases. Differences in yield of crops between the treatments indicate significantly different effects on soil fertility and crop yield after long-term different fertilization. Multiple benefits derived from compost using as fertilizer by increasing organic content and microbial activity (Scotti *et al.*, 2015). The enhancement effect of compost may be resulted from a greater concentration of plant nutrients like N, P, K, and Mg and a root reinforcement induced by compost (Donn *et al.*, 2014 and Nadjat *et al.*, 2014). Several researchers have reported the significance of compost in triggering and enhancing soil fertility via supplying nutrients for plant use (Gul *et al.*, 2016; Irshad *et al.*, 2014) resulting in higher yield of crops. The Co compost of crop residue and pressmud had lowest CN ratio besides higher organic carbon content and nutrient content compared to dairy farm waste and crop residue co compost which was reflected in obtaining maximum yield across the crops studied. The contribution of essential plant nutrients and the favourable physical environment in the soil treated with FA, would have facilitated the growth and yield of crops. The addition of Si through FA was reported to produce erect leaves that could account for a 100 percent increase in the photosynthesis of the canopy and consequently would have increased the yield. Not only the supply of nutrients but also the better utilization of nutrients made available on account of the complementary effect of compost and FA, favourable physical conditions, higher uptake of nutrients would have paved the way for realizing the full potentials of crops. In the present study, combined addition of co compost and LFA recorded higher nutrient uptake and physical properties. Further, the agronomic efficiency of crops due to lignite fly ash application with co compost of pressmud and crop residue was higher than with co compost of dairy farm waste and crop residue (fig.2) also supports higher response of crops to LFA application



B. Nutrient uptake

The uptake of nutrients by grain and straw in rice and maize, pod and haulm in groundnut and fruit in brinjal was significantly higher when fly ash at graded levels was applied with co compost compared to co compost alone. (table2). The uptake of nutrients increased linearly with levels of LFA tried and it was higher when it was applied with co compost of pressmud and crop residue compared to co compost of dairy farm waste and crop residue. The highest uptake of nutrients irrespective of crops was recorded with conjoint application of LFA@15 t ha⁻¹ with co compost of pressmud and crop residue and it was comparable with LFA@10 t ha⁻¹ with co compost of pressmud and crop residue. Increased nutrient uptake by crops by co compost application indicated high quality of organic matter which might have increased bioavailability of N, P K, S and Ca. The increased nutrient content has been attributed to the elemental contents of the composts, which improved the root growth and increased the nutrient uptake by plants (Aziz *et al.*,2006). Irshad *et al.* (2002) reported that increasing composted manure application profoundly increased the nutrients uptake by plants for better growth. Malhi (2012) reported that, application of organic manures favoured the uptake of N, K and S in wheat. Further increase in nutrient uptake on addition of lignite fly ash could be due to higher availability of nutrients in soil solution from direct supply of fly ash. Fly ash being a good source of silicon, silicon application enhanced nitrogen uptake, reduced P fixation and increased P uptake and increase in K uptake possibly due to the stimulation effect of silicon on the activation of H-ATPase in the cell membrane. Incorporation of fly ash and organic manures recorded higher N, P, and K uptake by rice was reported by Mittra *et al.* (2003).

C. Soil properties

The addition co composts alone or with graded dose of lignite fly ash significantly improved water stable aggregates, moisture retentive capacity and reduced bulk density compared to initial soil across all crops (table 3). The improvement in water stable aggregates and moisture retentive capacity and reduction in bulk density was more visible in the presence of lignite fly ash. In the studies reporting a reduction in bulk densities, the most common explanation was that the OM increased the void spaces leading to a decrease in the bulk density. Layman (2010) described this phenomenon as the “fluff” effect on soil bulk density as OM has a lower density than the mineral fraction of soil. Compost is known to have a high-water holding capacity and can provide water to plants over time (Crogger, 2005). Aggelides and Londra (2000) compared water retention with different rates of a mixed source compost incorporated 15 cm into a clay and loam soil. They found increased water retention with higher compost rates in both the clay and loam soil. Compost increased large pores especially the pores holding water at around 5 kPa tension for water retention. The clay soil tended to have higher water contents values at all pressures compared to the loam soil. This was observed in the present study, moisture retention in rice and maize soil was higher than groundnut and brinjal soil by virtue of being clay loam soil compared sandy clay loam soil. Improved soil moisture associated with compost is attributable to mulching effect of organic matter and improved moisture retention and water acceptance as a result of improved soil structure and macro porosity (Aluko and Oyedele, 2005). Fly ash addition reduced bulk density of soil, which in turn improved soil porosity and workability and enhanced water retention capacity (Sharma and Kalra, 2006).

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Table I. Effect of Co-Compost and Lignite Fly Ash on Yield of Crops

Treatments	Rice (kg/ha)		Maize(kg/ha)		Groundnut(kg/ha)		Brinjal (t/ha)
	Grain	Straw	Grain	Straw	Pod	Haulm	Fruit
T ₁ - DFW+CR	5175	6750	4520	7610	2270	3110	19.23
T ₂ - PM+CR	5250	6875	4600	7950	2300	3180	20.06
T ₃ - DFW+CR+ 5 t/ha LFA	5900	7525	5070	8920	2568	3456	21.95
T ₄ - DFW+CR+ 10 t/ha LFA	6500	7950	5580	9590	2882	3755	25.12
T ₅ - DFW+CR+ 15 t/ha LFA	6600	7975	5630	9820	2980	3860	25.84
T ₆ - PM+CR+ 5 t/ha LFA	6200	7675	5100	9070	2600	3495	25.18
T ₇ - PM+CR+ 10 t/ha LFA	6750	8425	5770	9850	2964	3800	27.94
T ₈ - PM+CR+ 15 t/ha LFA	6775	8475	5800	9940	3025	3882	28.87
SE _d	21.9	24.6	80	150	57.0	65.0	0.94
CD@5%	60.4	68.0	220	430	157.3	179.4	2.60

Table II. Effect of Co-Compost and Lignite Fly Ash on Nutrient Uptake by Crops

Treatments	Rice				Maize			Groundnut				Brinjal		
	N	P	K	S	P	K	S	P	K	S	Ca	P	K	S
T ₁ - DFW+CR	114	22.9	12.3	8.95	37.4	14.5	13.0	18.2	96.2	16.4	39.8	8.3	18.2	7.1
T ₂ - PM+CR	118	29.3	13.8	11.3	40.7	14.9	14.4	24.0	103.1	18.7	42.4	10.6	21.6	8.6
T ₃ - DFW+CR + 5 t/ha LFA	112	25.2	12.8	11.2	42.2	15.0	14.3	22.4	101.7	20.6	41.7	10.7	20.5	8.8
T ₄ - DFW+CR + 10 t/ha LFA	114	31.0	13.5	13.8	47.0	15.5	15.8	27.5	107.8	24.8	43.5	13.4	22.9	10.5
T ₅ -	117	33.0	13.7	15.3	48.7	15.7	16.2	29.3	109.5	25.8	44.7	14.1	24.1	11.1



DFW+CR + 15 t/ha LFA														
T ₆ - PM+CR+ 5 t/ha LFA	123	35 .3	14 5	14 .3	46. 5	15 4	15. 8	28. 6	108. 3	23. 6	43. 9	12. 9	23. 9	10. 4
T ₇ - PM+CR+ 10 t/ha LFA	126	42 .3	15 2	18 .2	52. 4	15 9	17. 1	34. 1	113. 7	28. 3	45. 9	15. 4	26. 4	12. 0
T ₈ - PM+CR+ 15 t/ha LFA	128	44 .0	15 4	19 .4	55. 1	16 1	17. 6	36. 8	115. 9	29. 9	46. 9	16. 5	27. 5	12. 7
SE _d	1.66	1. 7	1. 8	0. 7	1.6	1.6	0.4	1.9	2.4	1.9	0.5	0.8	0.6	0.6
CD@5%	4.60	4. 6	5. 2	2. 0	4.3	4.4	1.0	5.1	6.7	5.4	1.3	2.2	1.6	1.6

Table III. Effect of Co-Compost and Lignite Fly Ash on Physical Properties

Treat ments	Rice			Maize			Groundnut			Brinjal		
	Water Stable Aggre gates (> 0.25m m size)	Mois ture reten tive capa city (%)	Bul k Den sity (Mg m ⁻³)	Water Stable Aggre gates (> 0.25m m size)	Mois ture reten tive capa city (%)	Bul k Den sity (Mg m ⁻³)	Water Stable Aggre gates (> 0.25m m size)	Mois ture reten tive capa city (%)	Bul k Den sity (Mg m ⁻³)	Water Stable Aggre gates (> 0.25m m size)	Mois ture reten tive capa city (%)	Bul k Den sity (Mg m ⁻³)
T ₁ - DFW+ CR	44.8	60.6	1.46	43.2	53.2	1.37	40.4	40.3	1.40	37.3	35.5	1.43
T ₂ - PM+C R	49.2	63.4	1.44	45.5	55.3	1.33	40.9	41.8	1.32	39.4	37.2	1.40
T ₃ - DFW+ CR+ 5 t/ha LFA	47.9	63.0	1.45	45.6	55.5	1.32	43.0	42.9	1.31	40.1	38.1	1.40
T ₄ - DFW+ CR+ 10	51.6	65.8	1.41	47.9	57.4	1.28	45.9	45.5	1.22	43.2	41.3	1.33



t/ha LFA													
T ₅ - DFW+ CR+ 15 t/ha LFA	52.8	66.4	1.39	48.3	57.9	1.27	46.7	46.6	1.18	44.5	42.6	1.25	
T ₆ - PM+C R+ 5 t/ha LFA	53.6	66.0	1.41	47.8	57.6	1.29	44.4	44.7	1.22	43.1	39.9	1.32	
T ₇ - PM+C R+ 10 t/ha LFA	56.8	68.8	1.36	50.4	59.5	1.25	47.5	47.8	1.13	46.3	42.8	1.25	
T ₈ - PM+C R+ 15 t/ha LFA	57.9	69.6	1.35	50.7	60.1	1.24	48.2	48.6	1.09	47.4	43.7	1.18	
SE _d	0.9	0.8	0.02	0.8	0.7	0.01	0.9	0.9	0.03	0.9	0.9	0.02	
CD@ 5%	2.6	2.2	0.04	2.2	1.8	0.04	2.5	2.4	0.07	2.7	2.4	0.06	

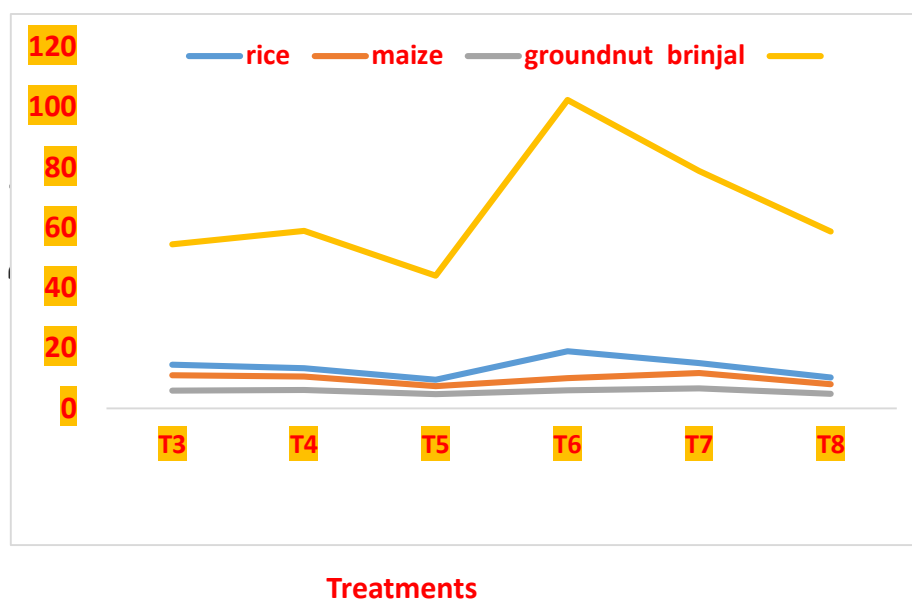


Fig.1. Percent increase in yield of crops due to Lignite fly ash and co compost over co compost alone

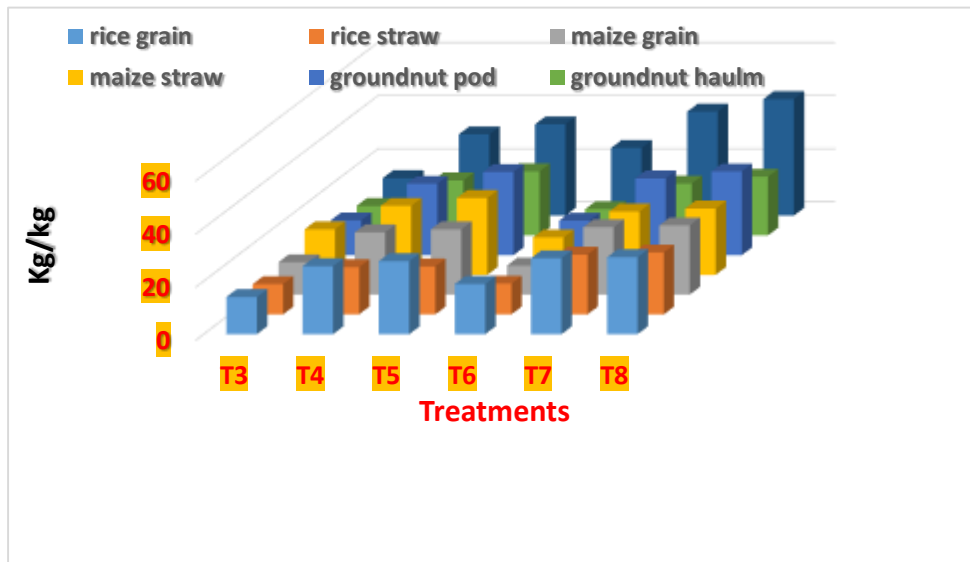


Fig.2. Effect of lignite fly ash and co compost on agronomic efficiency of crops

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