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(Received : May 1998 Revised : August 1999)

Madras Agric. J., 86(10-12): 556-561 October - December 1999
https://doi.org/10.29321/MAJ.10.A00657

FLYASH IN INTEGRATED PLANT NUTRITION SYSTEM AND ITS IMPACT ON SOIL PROPERTIES YIELD AND NUTRIENT UPTAKE OF GROUNDNUT

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ABSTRACT

A pot experiment was conducted during 1997 with groundnut (VRI 2) using laterite soil to study the effect of flyash (FA) alone and in combination with compost and fertilisers on nutrient uptake, yield of groundnut and available NPK status of the post-harvest soils. The results showed that the application of FA either alone or when integrated with other components increased the nutrient uptake and yield of groundnut significantly. The presence of essential plant nutrients, and the physical properties FA could be attributed for its favourable effect on yield of groundnut as well as for the sustenance of soil fertility. It was also inferred that integration of FA with other components of the nutrient supply system, on account of the synergistic effects had resulted in better nutrient uptake, higher yield and soil fertility sustenance.

KEY WORDS: Flyash, Compost, Fertilisers, Groundnut, Yield, Uptake of nutrients, Available nutrients

Flyash is a waste product in Thermal Power Stations where coal or lignite is used to generate electricity. Since the power famine of the country can not afford to block the promotion of power projects, the accumulation of flyash will go on increasing. It is occupying several lakhs of hectares of precious land causing air, ground water and soil pollution. A country like India with agriculture as its mainstay cannot obviously afford to let such a vast area of land being set apart for ash dumping. It is, therefore, necessary to establish regular utilization avenues of coal ash. India utilises only3-4 pr cent of the flyash generated (Vimalkumar nad Preeti Sharma,. 1998) as compared 40 per cent utilisation in France and U.K. and 100 per cent utilisation in Neherlands. Agriculture is one of the avenues, where it can be used for gainful purpose. Presence of various elements such as P, K, Ca, Mg, S and micronutrients in the flyash make it a good source of plant nutrients.

Groundnut is an important oilseed crop. It needs not only macronutrients but also secondary and micro nutrients to produce manures, organic wastes and biofertiliser is gaining wide acceptance to reduce input cost and sustain soil fertility. The present investigation was conducted to find out the effect of flyash either alone or in integrated

Table 1. Initial characteristics of soil and flyash

Parameter	Unit	Laterite soil	NLC flyash
Bulk density	g cm^{-3}	1.41	1.08
Pore space	per cent	43.9	42.8
MWHC	per cent	35.6	65
pH	-	6.5	11.6
EC	dSm^{-1}	0.15	5.20
CEC	c mol (p^{+}) kg^{-1}	8.0	1.60
Organic Carbon	per cent	0.32	0.35
Total N	per cent	0.074	0.06
Total P	per cent	0.019	0.07
Total K	per cent	0.039	0.51
Total Ca	per cent	0.31	14.0
Total Mg	per cent	0.10	6.4
Total S	per cent	0.035	1.5
Total Zn	mg kg^{-1}	26	230
Total Fe	mg kg^{-1}	2080	4200
Total Cu	mg kg^{-1}	16	30
Total Mn	mg kg^{-1}	79	39
Hot water soluble B	mg kg^{-1}	0.56	8.8
Avail. Si	mg kg^{-1}	27.3	1100
Available N	mg kg^{-1}	84	48
Available P	mg kg^{-1}	4.45	21
Available K	mg kg^{-1}	50.5	400

plant nutrition system on yield and nutrient uptake of groundnut as well as soil properties.

MATERIAL AND METHODS

A pot experiment was conducted using laterite soil with groundnut VRI 2 as test crop. The experiment was conducted in factorial completely randomised block Design with five treatments replicated twice. The details of the treatments are, M_0 - Control ; M_1 – Compost alone @ 12.5 t ha –1; M_2 – Blanker recommendation of N P K through fertilisers alone M_3 – 100 % N. 75 % P_2O_5 and K_2O as per M_2; and M_4 – M_3 plus compost @ 12.5 t ha-1. The levels of flyash were O (Fa_0), 20 (FA_{20}), 40 (FA_{40}) and 60 (FA_{60}) t ha-1.

The soil was sandy loam in texture with pH 6.5 and EC 0.15 dSm^{-1}. The organic carbon content was 0.32 per cent. The available nutrient contents were 84 mg kg^{-1} (Alkaline $KMnO_4$-N), 4.45 mg kg^{-1} (Olsen-P) and 50.5 mg kg^{-1} (NH_4 Oac – K). The initially characteristic of soil and flyash collected from Neyveli Lignite Corporation (NLC) are furnished in Table 1

The crop was grown to maturity and the data on pod and haulm yield were recorded. The soil and plant samples from all the treatments were collected and analysed as per the procedure suggested by Tandon (1995). From the yield and N,P,K, content, the N,P and K uptake was calculated and the data were satistically analysed.

RESULTS AND DISCUSSION

Nutrient availability (Table 2)

The increase in the alkaline $KMnO_4$-N status of the post-harvest soil was marked by the addition of FA alone as well as FA integrated with fertilisers and compost. The addition of FA at 20,40 and 60 t ha^{-1} increased the $KMnO_4$-N status of the soil to the tune of 0.8,1.8 and 4.3 mg kg-1 respectively. The combined addition of FA plus compost plus fertiliser recorded the highest value of 101 mg kg^{-1}. Of available of N of $KMNO_4$-N. the contribution of N made through FA as well as its influence on N fixation by groundnut on account of its P,Ca,S and B content might be reasons for the increased availability of N in the post harvest soils.

Regarding Olsen-P, Flyash application recorded significant increase of 0.81 mg kg^{-1} for FA_{60} over FA_0 in the post-harvest soils. The improvement in the available P status of the soil by the addition of FA was also reported by Kunchanwar et al.(1997). The favorable effect of FA on P availability was ascribed to its effect on biotic activity and the P release via biotic activity. In laterite soil, the rise in pH, consequent to addition of Si through FA may be responsible for the solubilisation and release of soil P by the replacement of adsorbed phosphate ions by silicate ions (Ragupathy,1988). The conjoint application of FA and organics had marked influence on P availability. The integrated use of FA with compost plus fertilisers recorded an increase of 1.0 mg kg^{-1} of Olsen-p, over compost

Table 2. Effect of flyash and manures on available N, P and K status of the post harvest soil (mg kg^{-1})

Treatments	$KMnO_4$-N					0.5M $NaHCO_3$-P					NH_4OAc-K				
	FA_0	FA_{20}	FA_{40}	FA_{60}	Mean	FA_0	FA_{20}	FA_{40}	FA_{60}	Mean	FA_0	FA_{20}	FA_{40}	FA_{60}	Mean
M_0	83.0	85.0	84.5	86.5	85.0	4.43	4.60	4.80	5.10	4.70	49.5	52.5	55.5	57.0	54.0
M_1	88.8	91.5	92.0	93.0	91.5	6.50	6.55	6.70	6.90	6.55	54.5	57.5	61.0	62.0	59.0
M_2	93.7	95.0	97.5	99.0	96.8	7.15	7.35	7.55	7.80	7.45	63.0	64.0	67.0	68.0	65.5
M_3	93.5	95.0	97.0	98.0	96.0	6.83	7.35	7.48	7.60	7.30	60.0	62.5	65.0	67.5	63.5
M_4	97.2	98.0	99.5	101	99.0	7.05	7.65	7.95	8.05	7.70	63.0	65.0	67.5	69.0	66.0
Mean	91.2	93.0	94.0	95.5		6.29	6.70	6.91	7.10		58.0	60.5	63.0	64.5	

CD (P=0.05)			
FA	1.5	0.13	1.2
M	1.7	0.15	1.4
M X FA	3.4	0.30	2.7

plus fertiliser, thereby indicating the build-up of soil available P by the use of FA either alone or in combination with compost and fertilisers in laterite soils. The synergistic effect of combined addition and the contribution of P from the organic sources might have resulted in the marked enhancement of P availability of post harvest soils. Also the organic acids would have hastened the solubility of flyash P and thus adding more to available pool. Jambagi et al. (1995) also reported that the combined application of FYM and flyash had cumulative effect on the available P status of Vertisols and Alfisols.

The NH4OAc-K status of the post-harvest soil was also significantly increased with the addition of FA either alone or in combination with compost/ compost plus fertilisers. When FA alone was added at 20, 40 and 60 t ha^{-1} the increase in NH4 Oac-K was found to be 3.0, 6.0 and 7.5 mg kg^{-1} respectively over Fao Grewal et al. (11998) repored that flyash could add good amount of K to soil. When FA_{60} was integrated with compost plus fertilisers, an increase of 6.0 mg kg^{-1} of NH_4Oac-K was recorded over compost plus fertilisers.

The P and K present in FA are insoluble in nature. Only on dissolution they could be used by the crop. Results showed that FA either alone or integrated with compost and fertiliser might have left residues of P and K thereby building up thereby building up their availability in the post harvest soil. The presence of P and K in flyash and the fineness of the material make its addition to acid soil to benefit crop growth by increasing the availability of these nutrients (Lal et al., 1996).

Nutrient uptake (Table 3)

The N uptake by kernal and haulm was found to be significant for FA addition. The increase was 20.8,32.4 and 40.4 percent in haulm and 16.2, 26.2 and 39.1 percent in kernel for FA_{20}, FA_{40} and FA_{60} respectively over Fa_0. Among the manurial treatments, M4 recorded the maximum N uptake of 690 and 395 mg pot^{-1} in kernel and haulm respectively followed by M2 (620 and 339 mg pot^{-1} for kernel and haulm and M_3 (589 and 319 mg pot^{-1} in kernel and haulm). The M_1 and M_0 recorded significantly less N uptake of 448 and 315 mg pot^{-1} in kernel and 284 and 225 mg pot^{-1} in haulm than other treatments. The interaction effect of M_4 and FA_{60} recorded the highest N uptake of 788 and 439 mg pot^{-1} in kernel and haulm. It was followed by M_4 FA_{40} (716 and 408 mg pot^{-1} in kernel and haulm) and M_3 FA_{60} (697 and 364 mg pot^{-1} in kernel and haulm). In all the manurial treatments, the addition of FA recorded significant increase in N uptake both by the kernel and haulm over manurial treatments alone. By providing conducive physical environment and essential nutrient elements especially Ca, Mg, S, B and Mo, the addition of FA might have enhanced the N fixation which in turn facilitated more N uptake by

Table 3. Effect of flyash and manures on N,P and K uptake (mg pot^{-1}) by groundnut kernel and haulm.

Treatments	N-uptake					P-uptake					K-uptake				
	FA_0	FA_{20}	FA_{40}	FA_{60}	Mean	FA_0	FA_{20}	FA_{40}	FA_{60}	Mean	FA_0	FA_{20}	FA_{40}	FA_{60}	Mean
$M_0$236	313	342	369	315	22.1	31.0	35.4	38.9	24.1	38.2	51.4	55.1	59.9	51.2	
	(169)	(255)	(239)	(268)	(225)	(23.3)	(32.8)	(36.8)	(40.7)	(33.4)					
$M_1$269	426	483	514	448	33.3	39.3	45.5	50.7	42.2	50.4	59.9	68.9	74.1	63.3	
	(231)	(283)	(300)	(232)	(284)	(32.2)	(43.0)	(47.5)	(52.6)	(43.8)	(230)	(288)	(307)	(332)	(289)
$M_2$533	602	634	709	620	45.2	51.8	55.9	63.8	54.2	72.2	80.6	86.0	95.8	83.7	
	(274)	(331)	(351)	(379)	(339)	(38.6)	(53.5)	(59.8)	(66.9)	(54.9)	(272)	(330)	(356)	(390)	(335)
$M_3$466	580	616	697	589	38.4	49.8	54.0	62.3	51.1	61.0	77.8	83.6	93.4	79.0	
	(249)	(321)	(341)	(364)	(319)	(33.5)	(51.5)	(59.7)	(61.6)	(51.6)	(246)	(320)	(339)	(375)	(320)
$M_4$608	649	716	788	690	50.0	52.5	59.9	69.4	57.8	83.4	90.2	102	116	98.0	
	(353)	(381)	(408)	(439)	(395)	(49.3)	(58.9)	(68.4)	(78.1)	(63.7)	(340)	(373)	(401)	(427)	(358)
Mean	442	514	558	615		37.8	44.7	50.1	57.0		61.0	72.0	79.1	87.8	
	(255)	(308)	(328)	(358)		(35.4)	(47.9)	(54.4)	(60.1)		(254)	(310)	(332)	(363)	
CD (P=0.05)															
FA		15			0.9			1.3							
		(7)			(1.1)			(8)							
M		17			1.1			1.4							
		(8)			(1.2)			(9)							
M X FA		33			2.1			2.9							
		(15)			(2.4)			(18)							

* Figures in parentheses denote haulm uptake

the crop.

With reference to P uptake, application of FA at 20, 40 and 60 t ha^{-1} recorded an increase of 35.3, 53.6 and 69.7 percent in haulm and 18.3, 32.5 and 50.8 percent in kernel over FA_0. The differences due to treatments were significant. Among the manurial treatments, M_4 recorded 57.8 and 63.7 mg pot^{-1} of kernel and haulm followed by M_2 (54.2 and 54.9 mg pot^{-1} in kernel and haulm), M_3 (51.1 and 51.6 mg pot^{-1} in kernel and haulm), M_1 (42.2 and 43.8 mg pot^{-1} in kernel and haulm) and M_0 (24.1 and 33.4 mg pot^{-1} in kernel and haulm). The integration of FA with compost or fertilisers or both recorded significant increase of P uptake over their individual application. In the interactions, M_4FA_{60} recorded the maximum P uptake of 69.4 and 78.1 mg pot^{-1} in kernel and haulm. The M_2FA_{60} and M_3FA_{60} recorded 63.8 and 62.3 mg pot^{-1} in kernel and 66.9 and 61.6 mg pot-^{1} in haulm. Both the combinations were comparable. The M_0FA_{60} recorded significantly less P uptake of 38.9 and 40.7 mg pot^{-1} in kernel and haulm then of that M_2FA_{60} and M_3FA_{60}. For all manurial treatments when the level of FA increased, the uptake also increased. Ajay Kaushal *et al* (1998) also reported increased uptake of P when silicate material (Poha industry waste ash) was added to soya bean crop with recommended dose of fertiliser NPK.

With reference to K uptake also, the application of FA at 20, 40 and 60 t ha^{-1} Recorded an increased of 22,30.7 and 42.9 per cent in haulm and 18,29.7 and 43.9 per cent in kernel over control. With reference to manurial treatments, the lowest K uptake (51.2 and 242mg pot^{-1} in kennel and haulm) was in M_0. It increased significantly in M_1 M_2 M_3 and M_4. In M_1 the uptake was 63.3 and 289 mg pot^{-1} for kernel and haulm. Among M_2 M_3 and M_4 M_3 recorded less K uptake (79.0 and 320 mg pot^{-1} in kernel and haulm) than M_2 (88.7 and 335 mg pot^{-1} in kernel and haulm) and M_4 (98.0 and 358 mg pot^{-1} in kernel and haulm). Application of compost or fertilisers or both recorded significantly

Table 4. Effect of flyash and manures on pod and haulm yield (g pot^{-1}) of groundnut (VRI 2)

Treatments	Pod yield					Haulm yield				
	FA_0	FA_{20}	FA_{40}	FA_{60}	Mean	FA_0	FA_{20}	FA_{40}	FA_{60}	Mean
M_0	9.8	12.8	13.6	14.4	12.7	13.7	18.2	19.3	21.4	18.2
M_1	12.8	14.4	16.0	16.9	15.0	17.9	21.6	22.6	23.9	21.5
M_2	17.2	18.9	19.8	21.9	19.5	20.3	24.3	26.0	27.9	24.6
M_3	15.0	18.5	19.3	21.5	18.8	18.6	23.4	24.9	26.8	23.7
M_4	18.5	19.4	21.3	23.2	20.6	25.2	26.8	28.5	30.3	27.7
Mean	14.8	16.8	18.0	19.6		19.4	22.8	24.3	26.1	

CD (P=0.05)		
FA	0.7	0.7
M	0.8	0.8
M X FA	1.5	1.6

lesser K uptake than when they were integrated with FA, especially at FA_{40} and FA_{60}. In the interactions, M_4 FA_{60} had the highest K uptake of 116 and 427 mg pot^{-1} in kernel and haulm followed by M_4 FA_{40} (102 and 401 mg pot^{-1} in kernel and haulm). Similarly at M_2 and M_3 with FA_{20} and FA_{40}, the K uptake in kernel and haulm data were comparable. In all the combinations, the increasing levels of FA in combination with manurial treatments recorded significant rise in K uptake. The increase in the uptake K might be due to the presence of K in FA.

The results of nutrient uptaken suggest that application of FA brought about favourable influence in augmenting the uptake of N, P and K. But the effect was small, as compared to that of manurial treatmcts. The three component system had surpassed all other treatments in uptake of N, P and K. The variation in the nutrient uptake between the application of full recommended dose of fertilisers and reduced dose of P_2O_5 and K_2O was not noticed when the latter treatment was integrated with FA. From that it could be inferred that there would be a possibility of reducing 25 per cent of the recommended dose of P_2O_5 and K_2O when FA was added for groundnut raised in laterite soil. The application of FA alone might not have contributed much of P and K from it. But the integrated nutrient supply system might have helped in releasing these nutrients to the available pool due to complementary effect.

Pod and haulm yield (Table 4)

When flyash was applied to the groundnut crop raised on laterite soil, pronounced response was obtained. An increase of 32.4, 16.3 and 13.5 per cent of pod yield and 34.5, 25.2 and 17.5 per cent of haulm yield over FA_0 were obtained for the addition of FA at 60, 40 and 20 t ha^{-1} respectively. The enhanced nutrient availability in the laterie soils which are generally characterised by multinutrient defficiencies, coarse texture and poor organic carbon (Dev and Rattan, 1998) and favourable changes in physical and microbiological properties (Singh and Tripatti, 1996) might be ascribed for the marked response in groundnut to the addition of FA. Regarding the manurial treatments, addtion of compost record 18.1 per cent increase both in the yield of pod and haulm over control. The treatmetns M_1, M_2 and M_3 resulted in an increase of 53.5, 48.0 and 62.2 per cent of pod yield and 35.2, 30.2 and 522.2 per cent of haulm yield over control. Results have clearly brought out the profound influence of the conjoint application of compost and NPK fertilisers on groundnut pod and haulm yield over compost of fertilisers alone. The significant interaction effects showed that integration of FA, compost and fertilisers a three component system could produce pod and haulm yield far higher than that produced by either fertiliser or compost of FA alone as well as in a two component system consisting of FA and fertiliser or FA and compost. The additional yield obtained in the two or three component system could be due to the additional nutrients gthat were made available for the crop growth.

So it could be concluded that the increased availability of nutrients through three component system viz., FA plus compost plus fertilisers increased the uptake of essential nutrients which in turn increased the yield of groundnut. The results also clearly borught out that Pand K could be reduced to the tune of 25% of the blanket recommendation when FA was integrated with compost and fertilisers.

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(Received : April 1998 Revised : May 2000)

Madras Agric. J., 86(10-12): 561-565 October - December 1999

EFECT OF ORGANIC MANURES AND TILLAGE PRACTICES ON SOIL PHYSICAL PROPERTIES AND CROP YIELDS UNDER SORGHUM-SOYBEAN CROPPING SEQUENCE

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ABSTRACT

A field experiment was conducted to study the effect of organic manure application on soil physical properties at the harvest of the sorghum crop and its residual effect on the succeeding crop of soybean. The residual effect was studied in combination with tillage treatments that the addition of organic manures to the first crop especially poultry manure and farm yard manure increased the yield besides improving the physical properties of soil and organic carbon status. The residual effect of organic manures was well pronounced in soybean yield. Though the improvement in soil physical properties as influenced by different organic manures did not significantly vary among themselves, the physical fertility increased markedly over control. Disc ploughing and stubble management without irrigation enhanced the total porosity and hydraulic conductivity of the soil significantly.

KEY WORDS: Soil physical properties, Bulk density, Porosity, Hydraulic Conductivity, Organic manures, Sorghum-Soybean sequence.