

Original Research Article

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Residual Effect of Fly Ash, Farm Yard Manure and Fertilizers Applied to Groundnut on Growth Parameters, Nutrient Uptake, Yield of Sesame and Post-Harvest Soil Available Fertility Status in Groundnut - Sesame Cropping System in Northeastern Zone of Tamil Nadu, India

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ABSTRACT

Field experiments were conducted during 2010-12 at Regional Research Station, Virudhachalam to find out the residual effect of fly ash, farm yard manure and fertilizers applied to groundnut on growth parameters, nutrient uptake, yield of sesame and post-harvest soil available nutrients. The Neyveli Lignite Corporation fly ash contained higher amount of Ca, Mg, S and Si, moderate amount of P, K and B. Application of fly ash @ 40 t/ha significantly increased growth parameters, yield attributes, seed yield and harvest index of sesame. Combination of FYM + STCR based NPK recorded higher growth characters, yield parameters and seed yield of sesame crop. Application of fly ash @ 40 t/ha significantly improved nutrient uptake by residual sesame crop and post-harvest soil available nutrients in groundnut – sesame cropping system. Maximum nutrient uptake by sesame and post-harvest soil fertility status were registered under application of FYM + STCR based NPK.

Keywords

Groundnut,
Residual effect,
Nutrient uptake,
Cropping system.

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Introduction

Sesame is one of the important oilseed crops in India and is called as queen of oilseed crops due to its excellent quality. The importance of sesame lies in its high content of oil, protein, calcium, iron and methionine. It needs balanced supply of nutrients to produce higher yield. Fly ash is a waste product in thermal power stations where lignite is used to generate electricity.

Dumping up of fly ash will cause air, ground water and soil pollution besides it is occupying several lakhs of hectares of cultivated lands. It can be used as amendment in crop field. Presence of various nutrients such as P, K, Ca, S and micronutrients in the fly ash make it as source of plant nutrients (Manoharan, 1995). In India, only 3 - 4 % of the fly ash is utilized as compared to other

countries. Researches on the nutrition of sesame in the tropics have shown significant yield increase due to inorganic and biofertilizers in India (Kalaiselvan *et al.*, 2002).

Higher number of seeds /plant, capsules /plant, seed yield/plant, weight of capsule /plant, test weight, seed yield, straw yield and harvest index were recorded from 30:60:00 kg NPK /ha and the combined application of *Azotobacter* + PSB (Wayase *et al.*, 2014). Yield target concept has the added advantage that targets can be varied by taking into consideration the resources available. The targeted yield concept has proved to be superior to others whose theoretical basis and proof was demonstrated by Ramamoorthy *et al.*, (2009).

Targeted yield approach has been an unique one in the sense that this method not only indicates soil test based fertilizer dose, but also the levels of yield, the farmers can hope to achieve if good agronomy is followed in raising the crop (Dev and Rattan,1998).

Supply of nutrients through organic manures [farmyard manure (FYM) and fly ash] to the first crop in a cropping system and raising second crop on the residual fertility of those organic manures along with the application of chemical fertilizers based on STCR approach can help to maintain the soil nutrient reserves for attaining higher crop yields in sequence cropping system.

Hence, an attempt was made to find out the effect of fly ash, farm yard manure and fertilizers applied to groundnut on growth parameters, nutrient uptake, yield of sesame and post-harvest soil available nutrients.

Materials and Methods

The field experiments were conducted at Regional Research Station, Virudhachalam

during 2010 – 12. The experiment was laid out in split plot design with three replications. Different levels of fly ash viz., 0, 20 and 40 t/ha was tested in main plots whereas fertilizer levels such as control (No fertilizer application), blanket application of NPK, NPK application based on STCR and FYM @ 12.5 t/ha + NPK application based on STCR were assessed in the subplots.

The soil was sandy loam in texture with PH 6.5 and EC 0.15 dSm⁻¹. The soil available nutrient contents were low in nitrogen (145 kg/ha), medium in phosphorus (16.2 kg/ha) and low in potassium (102 kg/ha). Sesame cultivar VRI1 was sown on 2nd and 7th October during 2010-11 and 2001-12 respectively.

Fly ash was incorporated into the soil one week before sowing of groundnut crop as per the treatments and sesame crop was raised as residual crop.

No fertilizers and organic manure were applied for sesame crop. All the recommended package of practices were followed during the period of investigation. Initial and post-harvest soil samples were collected and analyzed for nutrient availability.

Plant samples were collected after harvest and analyzed for nutrient uptake. Growth parameters such as plant height, leaf area index and number of branches /plant, yield attributes such as pods/plant, seeds/pod and test weight, seed yield and harvest index of sesame were recorded at harvest stage of sesame crop.

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads:

Properties of fly ash

The Neyveli Lignite Corporation fly ash contained particles having the size in the range of 0.002 - 0.2 mm and bringing their textural class under silty loam. The bulk density was low (1.08 gcm^{-3}) as compared on normal cultivable soil. It was also found to be alkaline in reaction (pH 11.6) and saline (5.2 dSm^{-1}), CEC, organic carbon and total N contents were $1.60 \text{ cmol (p1) /kg}$, 0.35 % and 0.06 % respectively. The fly ash contained P (0.07 %), K (0.51 %), Zn (230 mg/kg), Fe (4200 mg/kg) and B (8.8 mg/kg). It also consisted of appreciable amount of Si ($50.5 \text{ mg/kg as SiO}_2$), Ca (14.0 %), Mg (6.4 %) and S (1.5 %) and very traces of heavy metals (45, 10.6 and 4.5 mg/kg of Cr, Pb and Cd respectively).

Growth parameters

Fly ash and fertilizer levels exerted a pronounced effect on plant height, leaf area index and number of branches/plant (Table 1). Among the fly ash levels, uses of fly ash @ 40 t/ha recorded higher plant height (85.7 and 83.9 cm), leaf area index (2.94 and 2.90) and number of branches /plant (10.97 and 10.83) and was on par with application of fly ash @ 20 t/ha.

Application of fly ash increased the availability of nutrients throughout the crop period, which might be the reason for higher growth parameters of sesame. Similar results were also reported by Prakash (2014). With regard to fertilizer levels, maximum plant (88.5 and 87.1 cm), leaf area index (3.13 and 3.07) and number of branches/plant (11.42 and 11.33) were observed under application of FYM + STCR based NPK which was followed by the application of NPK based on STCR.

This might be due to balanced and sustained supply of all the plant nutrients by the combined application FYM + STCR based NPK. Similar findings were reported by Ragupathy (1988).

The lowest growth characters were registered under control (No fertilizer application) during both the years.

Nutrient uptake

Application of fly ash and fertilizers to groundnut crop significantly improved the nutrient uptake of residual sesame crop during both the years (Table 2).

Application of fly ash @ 40 t/ha increased the uptake of N (39.2 and 38.3 kg/ha), P (8.86 and 8.74 kg/ha), K (28.8 and 28.5 kg/ha), calcium (26.8 and 25.9 kg/ha), Mg (6.29 and 6.14 kg/ha) and sulphur (7.51 and 7.33 kg/ha). By providing conducive physical environment and essential nutrients, the addition of fly ash might have enhanced uptake of nutrients by the crop.

The lowest nutrient uptake by sesame was resulted when no fly ash was applied to groundnut crop. As far as fertilizer levels concerned, maximum uptake of nutrients were registered under combined application of FYM + STCR based NPK which was followed by the application of NPK based on STCR value alone.

This might be due to the balanced supply of plant nutrients both by FYM and chemical fertilizers and higher growth parameters under application of FYM + STCR based NPK. Similar results were earlier reported by Seshadri Reddy *et al.*, (2005). No fertilizer (control) recorded the lowest uptake of nutrients by residual sesame crop.

Table.1 Residual effect of fly ash and fertilizer levels applied to groundnut on Growth parameters, yield attributes and yield of sesame

Treatments	Growth parameters			Yield attributes			Seed yield (kg/ha)	Harvest index (%)
	Plant height (cm)	Leaf area index	Branches / plant	Pods / plant	Seeds/ pod	1000 seed weight (g)		
2010-11								
Fly ash levels								
0 t/ha	73.2	2.45	7.33	23.41	42.45	2.56	690	22.11
20 t/ha	81.1	2.75	9.45	25.94	46.82	2.62	769	23.76
40 t/ha	85.7	2.94	10.97	27.39	48.07	2.68	794	23.94
CD (5%)	5.8	0.26	1.69	0.68	3.11	NS	30	-
Fertilizer levels								
Control	61.4	2.02	6.71	19.64	38.92	2.43	442	21.36
Blanket NPK	78.8	2.88	9.64	25.19	44.28	2.56	708	22.83
NPK based on STCR	82.3	2.96	10.56	26.27	46.41	2.67	766	23.64
FYM + NPK based on STCR	88.5	3.13	11.42	28.29	49.96	2.74	822	24.09
CD (5%)	6.2	0.29	1.83	0.71	3.26	NS	33	-
2011-12								
Fly ash levels								
0 t/ha	70.5	2.41	7.24	23.25	41.31	2.52	648	22.03
20 t/ha	80.4	2.68	9.37	25.78	45.66	2.59	733	23.70
40 t/ha	83.9	2.90	10.83	27.23	46.93	2.65	777	23.88
CD (5%)	5.5	0.23	1.63	0.65	3.03	NS	29	-
Fertilizer levels								
Control	59.7	1.94	6.66	19.08	37.81	2.41	405	21.30
Blanket NPK	76.3	2.81	9.52	24.47	43.15	2.52	691	22.78
NPK based on STCR	80.6	2.90	10.47	25.54	45.27	2.63	727	23.56
FYM + NPK based on STCR	87.1	3.07	11.42	28.47	48.81	2.71	805	24.02
CD (5%)	5.9	0.26	1.80	0.69	3.22	NS	31	-

Table.2 Residual effect of fly ash and fertilizer levels applied to groundnut on Uptake of nutrients (kg/ha) by sesame crop

Treatment	Nitrogen		Phosphorus		Potassium		Calcium		Magnesium		Sulphur	
	2010	2011	2010	2011	2010	2011	2010	2010	2010	2011	2010	2011
Fly ash levels												
0 t/ha	33.86	32.31	6.98	6.86	21.82	21.07	19.14	18.47	4.69	4.51	5.06	4.84
20 t/ha	37.42	36.57	8.34	8.25	26.53	25.93	24.92	24.14	5.77	5.64	6.59	6.41
40 t/ha	39.28	38.39	8.86	8.74	28.85	28.58	26.87	25.92	6.29	6.12	7.51	7.33
CD (5%)	1.9	1.8	0.39	0.36	1.18	1.13	1.08	1.03	0.26	0.24	0.29	0.26
Fertilizer levels												
Control	23.14	20.48	5.02	4.78	16.42	15.56	14.81	14.03	3.26	3.11	3.48	3.31
Blanket NPK	36.65	35.61	8.38	8.17	23.65	22.93	21.37	20.64	5.37	5.22	5.86	5.70
NPK based on STCR	40.81	39.29	9.41	9.03	25.68	24.75	22.39	21.77	6.09	5.85	6.69	6.42
FYM + NPK based on STCR	46.27	44.63	10.44	10.01	28.21	27.13	25.56	24.94	6.80	6.57	7.72	7.45
CD (5%)	1.96	1.88	0.43	0.41	1.22	1.16	1.12	1.06	0.22	0.26	0.31	0.29

Table.3 Residual effect of fly ash and fertilizer levels applied to groundnut on available nutrients (kg/ha) of soil after harvest of sesame crop

Treatment	Nitrogen		Phosphorus		Potassium		Calcium		Magnesium		Sulphur	
	2010	2011	2010	2011	2010	2011	2010	2010	2010	2011	2010	2011
Fly ash levels												
0 t/ha	147	148	14.0	13.8	110	108	3.49	3.46	1.26	1.24	7.0	6.9
20 t/ha	149	150	15.6	15.9	115	114	5.39	5.30	2.80	2.91	13.9	14.5
40 t/ha	151	153	16.5	17.1	118	119	6.26	6.19	4.14	4.25	19.3	20.6
CD (5%)	5.4	4.9	0.61	0.56	4.3	4.0	0.18	0.15	0.08	0.07	0.51	0.47
Fertilizer levels												
Control	138	135	11.6	11.4	98	96	5.53	5.50	2.58	2.54	13.3	13.1
Blanket NPK	144	147	15.0	15.9	112	110	5.48	5.45	2.57	2.53	13.1	13.0
NPK based on STCR	151	153	16.2	17.3	116	117	5.50	5.42	2.58	2.55	13.0	12.8
FYM + NPK based on STCR	158	161	17.5	18.7	121	123	6.09	5.98	3.19	3.12	14.1	14.3
CD (5%)	5.5	5.2	0.66	0.62	4.4	4.2	0.21	0.19	0.11	0.09	0.59	0.55

Yield parameter and yield

Fly ash and fertilizer applied to groundnut crop had significant influence on yield parameters, seed yield and harvest index of residual sesame crop (Table 1). The 1000 seed weight of sesame was not significantly influenced by both the fly ash and fertilizer levels applied to groundnut crop. Higher number of pod /plant (27.39 and 27.23), number of seeds/pod (48.07 and 46.93), seed yield (794 and 777 kg/ha), harvest index (23.94 and 23.88 %) were registered when fly ash applied @ 40 t/ha but it was comparable with that of application of fly ash @ 20 t/ha. A seed yield increase of 104-128 kg/ha was observed due to the application of fly ash @ 40 t/ha over control. Similar finding was obtained in black gram by Anandaraj (2009). The enhanced nutrient availability in the lateritic soil which are generally characterized by multinutrient deficiencies, coarse texture and poor organic carbon and favourable changes in physical and microbiological properties might be ascribed for the marked response in sesame to the addition of fly ash. These results were corroborated with the earlier findings of Prakash *et al.*, (2014). Control registered the lowest yield parameters, seed yield and harvest index of sesame crop.

Among the fertilizer levels, application of FYM + NPK as per STCR value produced significantly higher number of pod /plant (28.29 and 28.47), number of seeds/pod (49.96 and 48.81), seed yield (822 and 805 kg/ha) and harvest index (24.09 and 24.02 %). This might be due to the higher uptake of plant nutrients and growth parameters of sesame under FYM + STCR based NPK application. Similar results were recorded by Varalakshmi *et al.*, (2005) and Nayak *et al.*, (2014). Control (no fertilizer application) gave the lowest seed yield and harvest index during both the years.

Post-harvest soil fertility status

The available nutrients of the post-harvest soil were found to increase by the addition of graded levels of fly ash and fertilizer levels (Table 3). Not only the supply of nutrients, but also the increase in pH of the soil by fly ash application might have indirectly helped to increase the nutrient availability of soil. The fly ash might not have contributed N from it directly since it contained only negligible quantity of N, but it was found to supply P and K as evidenced by the marked increase in their content in the post-harvest soil samples.

Khan *et al.*, (1996) reported increase in available P and K status in soil and they attributed it to the P and K content of fly ash. The combined addition of fertilizer and FYM recorded higher availability of post-harvest soil nutrients. The synergistic effect of FYM and fertilizer NPK would have resulted in higher soil fertility status after harvest of sesame crop. Similar results were also reported by Malewar (1996). Control and treatments with fertilizers alone exhibited a sharp decline in the availability of secondary nutrients than combined application of FYM + fertilizers.

It can be concluded that application of fly ash @ 40 t/ha applied to groundnut crop significantly increased growth parameters, yield attributes and seed yields of succeeding sesame crop. FYM @ 12.5 t/ha + STCR based NPK applied to preceding groundnut crop recorded higher growth attributes, yield parameters, yield and nutrient uptake of succeeding sesame crop.

Application of fly ash @ 40 t/ha significantly improved nutrient uptake of sesame and post-harvest soil available nutrients in groundnut - sesame cropping sequence.

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