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Comparative Study of Fly Ash and Fly Ash Mixed Bacterial Culture on the Growth of *Arachis hypogea*

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Fly ash the waste product from thermal power plant is used as a soil amendment along with bacterial cultures which supports plant growth by increasing the soil fertility by providing micro and macronutrients to cultivated crops. Fly ash also improves permeability status of soil and soil texture. The results of this study indicate that fly ash could be beneficial to typical plant growth if it is applied to an adequate rate and to an acceptable medium along with bacterial culture.

Key words: *Arachis hypogea*, Fly ash, Azotobacter, Phosphate solubilizing bacteria.

Fly ash, the waste product from thermal power plant has potential use in agriculture when mixed with few bacterial species. Fly ash it contains almost all macro (K,P,Ca, Mg, S etc) and micro (Fe,Zn,Co,Mo,B,M etc) nutrient except organic carbon and N_2. Fly ash may be used in conjunction with biofertilizer to increase the yields of various agricultural crops. Addition of fly ash to soil neutralizes the acidity to a level suitable for agriculture, depending on the initial pH of the soil (Moliner and Street, 1982). The foliar application of fly ash also enhances growth and metabolic rates as well as increases the photosynthetic pigments of crops like Maize and Soybeans (Mishra and Shukla, 1986). Sarangi *et al* (1997) reported that rice plant responded positively to fly ash amended soil showing 41% increase in above ground biomass and 17% increase in total biomass at 25% amendment over control. Fly ash has a high water holding capacity and contains minerals needed for plant growth. (Gangloff *et al,* 2000). Fly ash consists of Silica, Alumina, Oxides of Iron, Calcium, Magnesium and toxic heavy metals like Lead, Arsenic, Cobalt and Copper. Use of fly ash in agricultural applications has been well demonstrated and has been accepted by a large number of farmers. Fly ash improves fertility status of soil / crop yields. It reduces bulk density of soil, optimizes pH value also improves the water holding capacity / porosity and soil aeration, reduce crust formation.

Arachis hypogea , popularly known as poor man's nut has been accepted by Indians as a vegetable oil crop and has occupied the first place

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among oil seed crops grown in the country (Sinha and Bhaget,1988). The total area under ground nut cultivation in India is about 7.3 million hectares, ie 38.42% of the total groundnut cultivation area in the world. Utilization of fly ash shows potentially beneficial results in the growth of A*rachi hypogea* along with Azotobacter and Phosphate solubilization bacteria. Soil is a bank of nutrients and microorganisms. Fly ash lacks nitrogen source hence to substitute the source Azotobacter the nitrogen fixing bacteria is used. Both Azotobacter and Phosphate Solubilizing bacteria increases soil fertility (Glick, 1995).

MATERIAL AND METHODS

Fly ash collected from dry disposal method from Neyveli Lignite Thermal power Station, Neyveli, Tamilnadu. The fly ash and soil both were sun dried for 7 days and mixed together (v/v) in the proportion i.e control (soil without fly ash).Earthenware pots were filled with two combination mixture of i)soil and fly ash and ii) mixture of soil + fly ash +Microbes.Three replicates were used for each treatment. Available Nitrogen, Phosphorous and Carbon content in soil samples were estimated by Kjeldah distillation method, Oisen *et al* method and Walkely – Black rapid titration method respectively. Crude protein and fatty acid estimation of Groundnut was performed. Azotobacter and Phosphobacter were cultured in Azotobacter medium and Hydroxy apatite medium Shoot and root length were also recorded after harvest. Dry weight of shoot and root (80^0 C oven dry) were also determined.

RESULTS AND DISCUSSION

Chemical parameters

Estimation of Nitrogen

The available nitrogen in soil refers to the primary nutrient in the soil which is essential for plant growth. The level of nitrogen in the soil was found to increase in two differently treated soil (soil with fly ash 273.99kg/ha and soil with fly ash and bacterial cultures 287.69kg/ha) than the control (217.42).Table 1.

Table 1. Estimation of Nitrogen

Treatment		Amount of nitrogen expressed in kg/ha
Untreated soil(control)	C1	250.88
	C2	213.24
	C3	188.16
	Average	217.42
Soil with fly ash	T1	260.42
	T2	270.96
	T3	290.60
	Average	273.99
Soil with fly ash and Bacterial cultures	T1	273.50
	T2	275.96
	T3	313.60
	Average	287.69

Estimation of Phosphorus

Available Phosphorus refers to the inorganic form occurring in soil which is almost exclusively ortho – Phosphate only a small fraction of the total amount present may be available to plant which is direct relevance in accessing the Phosphorus fertility level. The level of Phosphorus in the soil was found to increase in two differently treated soil (soil with fly ash 26.6 kg/ha; soil with fly ash and bacterial culture 28.66kg/ha)than the control(19.55). Table 2.

Table 2. Estimation of Phoshphours

Treatment		Amount of phoshphours expressed in kg/ha
Untreated soil(control)	C1	22.52
	C2	17.90
	C3	18.24
	Average	19.55
Soil with fly ash	T1	21.66
	T2	26.22
	T3	31.92
	Average	26.60
Soil with fly ash and Bacterial cultures	T1	26.75
	T2	27.99
	T3	31.24
	Average	28.66

Estimation of Organic Carbon

The organic matter present in the soil was presumed that it contain about 0.2% organic Carbon but the Carbon content and the extend of oxidation may vary considerably from the soil. Control showed higher carbon % than the other two. It may be due to accumulation of fly ash, which is mainly inorganic or utilization of carbon source by the bacterial culture for its growth. Table 3.

Table 3. Estimation of Organic carbon

Treatment		Amount of organic carbon expressed in kg/ha
Untreated soil(control)	C1	1.11
	C2	0.18
	C3	0.06
	Average	0.45
Soil with fly ash	T1	0.50
	T2	0.10
	T3	0.18
	Average	0.26
Soil with fly ash and Bacterial cultures	T1	0.42
	T2	0.12
	T3	0.15
	Average	0.23

Estimation of crude protein

The crude protein content was analyzed and it contains 25.08% in fly ash treated sample, 28.01% in fly ash treated sample with bacterial culture where as 22.75% was present in the control. Table 5.

Effect of treatment factors on plant exhibited clear increase in the morphological parameters as shown in Table: 4. The combined effects of two factors, fly ash and Bacterial cultures had increased the nitrogen fixation and Phosphorus accumulation. Though soil can fix Phosphorus, Phosphorus fixing capacity depends on the soil texture. Additionally Phosphate is sublimented to soil by fly ash. This inorganic Phosphate cannot be utilized by plant directly; hence this inorganic Phosphate is converted to utilizable Phosphate by Phosphate solubilizing microbes. Table 1 and 2 and fig 1 and 2 clearly indicates that the amount of N_2 and PO_4 level had

Table 4. Morphological Parameters of Plant and Pod

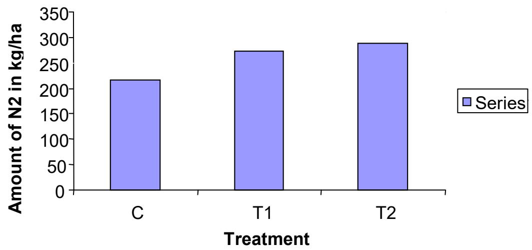
Parameters	Control	Soil with fly ash	Soil + fly ash + bacterial culture
Shoot length(cm)	47.76	51.9	55.79
Root length(cm)	20.20	25.60	34.10
Dry weight of Shoot (gm) (above ground mass)	6.03	7.23	7.52
Dry weight of Root (gm) (below ground mass)	3.90	4.70	5.20
Pod weight(gm)	2.20	2.50	3.00

Table 5. Estimation of crude protein

Treatment		Amount of crude protein expressed in %
Untreated soil(control)	C1	22.75
	C2	22.88
	C3	23.63
	Average	22.75
Soil with fly ash	T1	25.38
	T2	25.38
	T3	24.50
	Average	25.08
Soil with fly ash and Bacterial cultures	T1	26.99
	T2	27.65
	T3	29.40
	Average	28.01

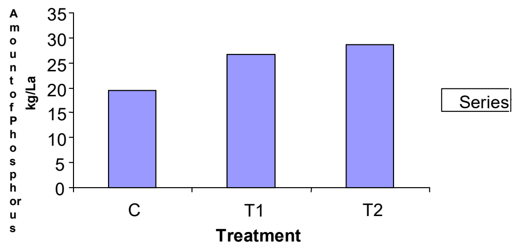
Table 6. Estimation of free fatty acid

Treatment		Amount of free fatty acid value (%)
Untreated soil(control)	C1	1.28
	C2	1.34
	C3	1.20
	Average	1.30
Soil with fly ash	T1	1.66
	T2	1.75
	T3	1.70
	Average	1.70
Soil with fly ash and Bacterial cultures	T1	1.78
	T2	1.75
	T3	1.89
	Average	1.81



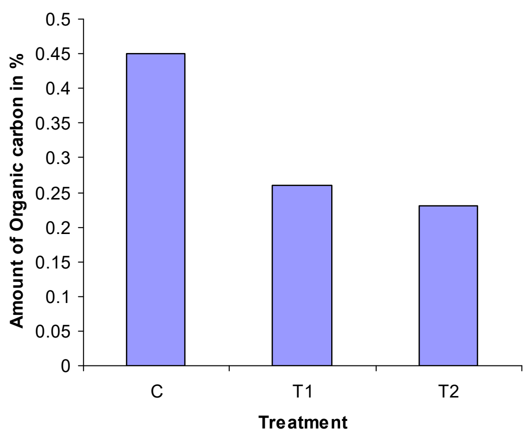
C-Control; T1-Soil with fly Ash
T2-Soil with fly as and bacterial cultures

Fig. 1. Estimation of Nitrogen



C-Control; T1-Soil with fly Ash
T2-Soil with fly as and bacterial cultures

Fig. 2. Estimation of Phosphorus



C-Control; T1-Soil with fly Ash
T2-Soil with fly as and bacterial cultures

Fig. 3. Estimation of organic carbon

increased to a notable quantity, which could have been utilized by the plant resulting in increased shoot and root length, pod weight and dry weight of shoot and root. The Phosphate solubilizing microbes and Azotobacter in fly ash soil sample are known to increase the crop yield than the soil sample with fly ash alone. Crude protein and oil content of ground nut was also high as in Table 6. Table 3 indicates the reduction in carbon source in both treated soil than the control as in Fig. 3 probably the most notable result can be predicted if the soil is enriched with carbon source.

CONCLUSION

We have concluded that fly ash along with Azotobacter and Phosphate solubilizing microbe in soil, improves soil health and plant growth which is very important in developing sustainable agriculture.

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