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Study of some growth parameters of soybean (*Glycine max* L.) plant grown in the soil amended with *Rhizobium* sp. and fly ash from thermal power plant

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Abstract

Fly ash is a solid waste residue exhausted during coal combustion from the thermal power stations. Disposal of this huge amount of fly ash is the major concern of the country. From last few decades, utilization of fly ash in agriculture in judicial manner was practiced by many researchers and Research and development institutes. In present study we used five different doses of fly ash amendments viz. 0, 10, 20, 30 and 40% (w/w) with soil. Plant growth and crop yield are the major objectives of the agriculture industry. To achieve this, fly ash utilization approaches eco-friendly. Fly ash contains micro and macro nutrients which provides beneficial role in plant growth. Fly ashes are deficient of nitrogen and organic carbon and hence fly ash amendment has been supplemented with *FYM*, biofertilizers viz. *Plant growth promoting rhizobacteria* and organic waste. In present study, *Rhizobium sp.* (biofertilizer) was inoculated in the pots containing seeds of soybean (*Glycine max* L) grown in fly ash amended soil. Present paper was focused on the growth parameters viz. germination%, root and shoot length of soybean plants grown in the soil amended *with Rhizobium sp.* and fly ash from thermal power station.

Keywords: Fly ash, *Rhizobium sp*. plant growth parameters.

Introduction

Soil microorganism especially rhizospheric plant growth promoting rhizobacteria play vital role in the growth and yield of crop plants. *Rhizobium sp.* belongs *to Plant growth promoting bacteria(PGPR*) group are the beneficial symbioants that enhance the plant growth. Rhizoshphere is the area around root region where plants roots were influenced by microbial activity. These organisms promote plant growth by enhancing nitrogen fixation, facilitate nutrient uptake from soil and enhance phytohormone production **(Burd *et al*.2000).** *Rhizobium* bacteria are known to participate in many biological activities such as biological control of plant pathogens, nutrient cycling and seedling/plant growth **(Wu *et al.* 2006),**

(Dubey *et al*.2001). Fly ash is a heterogeneous mixture of ferro-allumino-silicate is the residue produced in Thermal power plants. Fly ash contains micro and macro nutrients viz. Cu, Fe, Mn, Mg, Ca, Na and K. It also contains toxic heavy metals like Cd, Cr, Co and Pb but found within permissible limit (**Aggarwal *et al*. 2009)**, **(Rai *et al,* 2010)** Use of fly ash in agriculture with recommended doses provides better alternative in fly ash disposal problem and also in agronomic practices. Numerous researchers revealed that appropriate doses of fly ash incorporarion in soil alter the physico-chemical and biological properties of soil. Fly ashes are deficient of nitrogen and organic carbon content **(Siddiquei *et al.***

2004). Many researchers used the *Farm Yard Manure (FYM),* biofertilizers and organic waste to provide the nitrogen and organic carbon source to the plants grown in fly ash amended soils. Soils physico-chemical properties determine the functioning and diversity of soil microbiota **(Kodobocz. 2008)**. The objective of this paper was to study the growth parameters viz. germination % and root and shoot length of soybean plant grown in the soil amended with *Rhizobium sp.* and fly ash from thermal power plant.

Materials and Methods

Sampling site

Fly ash was collected from dumping sites of Chandrapur thermal power station, Chandrapur, (M.S.) and soil sample was collected from farm field situated in the vicinity of thermal power station. Different concentration of soil-fly ash admixture was taken in pots viz. 0%, 10%, 20%, 30%, and 40% . Experiment was performed in randomized manner(in triplicate) by pot assay method. Seeds of soybean cultiar-335 were purchased from local market and then washed with distilled water and were sown in pots containing soil+ *Rhizobium sp.*+ fly ash in respective pots viz. 0%(A), 10%(A1), 20%(A2), 30%(A3) and 40%(A4). 0% was without fly ash and consider as control. Pots were irrigated at regular interval avoiding subsequent seepage. During the growth period, morphological parameters viz. germination % and root and shoot length of soybean plants were recorded. After termination of experiment (after 45-60 days), root shoot length was measured. Seed germination percentage was calculated by counting normal seedling growth after a week of sowing from each pot.

Measurement of root and shoot length

The plants were removed from the soil and the roots were traced on paper and root length was calculated from the soil line with measuring scale. Similarly shoot length was measured from above the soil line to the top of the plant by tracing the plants on the paper. **(Abady.2015)**

Results and Discussion

Germination Percentage

Table 1: Soybean seed germination in soil (soil+FA) in presence of *Rhizobium* sp.

Treatment (Soil+FA)	N	Mean	SD	SE	Min.	Max.	F	P
A (0%)	3	30	±5.0	2.9	25	35	94.186	<0.05
A1 (10%)	3	40	±2.0	1.2	38	42		
A2 (20%)	3	70	±3.0	1.7	67	73		
A3 (30%)	3	40	±1.0	0.6	39	41		
A4 (40%)	3	60	±2.0	1.2	58	62		
Total	15	48	±15.4	4.0	25	73		

SD: Standard Deviation; **SE**: Standard Error; **Min**.: Minimum; **Max**.: Maximum; **F**: 'f' ratio, P= Probability

Above table presents results pertaining to the seed germination of soybean studied under various soil matrix containing Fly Ash (FA) and microorganisms (*Rhizobium* sp.) as an amendment. Overall there are five different soils, identified as A (soil with no FA), A1 (soil with 10% FA), A2 (soil with 20% FA), A3 (soil with 30% FA) and A4 (soil with 40% FA). The experiment revealed that there is a significant (P0.05) difference in the soybean seed germination as a function of different Fly ash addition to the soil. Specifically, for A, 30% seeds germinated, while for A1, A2, A3 and A4, the percentage of seeds germinated is 40%, 70%, 40% and 60% respectively. The study results indicated that highest germination rate of 70% was obtained when the soil contained 20% FA and *Rhizobium* sp. amendment. Thus, it is concluded that the percentage of FA does play a role in the germination of soybean seeds.

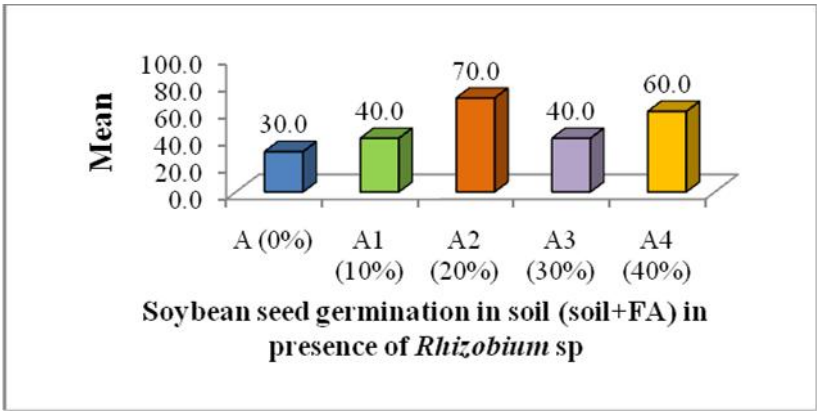

Fig.1: Soybean seed germination in soil (soil+FA) in presence of *Rhizobium* sp.

Shoot length (cm)

Table 2: Soybean plant shoot length (cm) in soil (soil+FA) in presence of *Rhizobium* sp.

Treatment (Soil+FA)	N	Mean	SD	SE	Min.	Max.	F	P
A (0%)	3	10.7	±0.2	0.1	10.5	10.9	189.925	<0.05
A1 (10%)	3	14.0	±2.0	1.2	12.0	16.0		
A2 (20%)	3	29.3	±0.4	0.2	28.9	29.7		
A3 (30%)	3	18.6	±0.3	0.2	18.3	18.9		
A4 (40%)	3	12.9	±0.2	0.1	12.7	13.1		
Total	15	17.1	±6.9	1.8	10.5	29.7		

SD: Standard Deviation; **SE**: Standard Error; **Min.**: Minimum; **Max.**: Maximum; **F**: 'f' ratio, P= Probability

Above **Table 2** presents results pertaining to the plant shoot length of soybean studied under various soil matrix containing Fly Ash (FA) and microorganisms (*Rhizobium* sp.) as an amendment. Overall there are five different soils, identified as A (only soil with no FA), A1 (soil with 10% FA), A2 (soil with 20% FA), A3 (soil with 30% FA) and A4 (soil with 40% FA). The experiment revealed that there is a significant ($P<0.05$) difference in the shoot length of soybean as a function of different FA addition to the soil.

Specifically, for A, 10.7cm shoot length was recorded while for A1, A2, A3 and A4 shoot length showed significant increase viz. 14.0cm, 29.3cm, 18.6cm, 12.9cm respectively. The study results indicated that highest shoot length was obtained when the soil contained 20% FA and *Rhizobium* sp. Amendment followed by A3, and A4. Thus, it is concluded that the percentage of FA does play role in shoot length. **(Almarghrabi *et al*. 2013)**

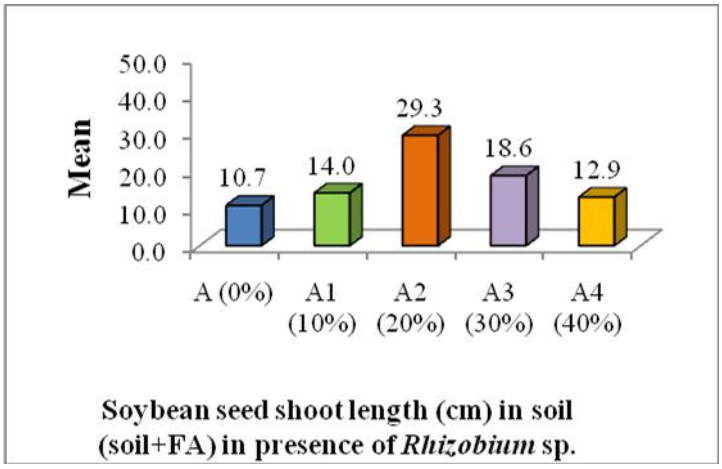

Fig. 2: Soybean plant shoot length (cm) in soil (soil+FA) in presence of *Rhizobium* sp.

Root length (cm)

Table 3: Soybean plant root length (cm) in soil (soil+FA) in presence of *Rhizobium* sp

Treatment (Soil+FA)	N	Mean	SD	SE	Min.	Max.	F	P
A (0%)	3	5.0	±0.2	0.1	4.8	5.2	17.143	<0.05
A1 (10%)	3	6.0	±2.0	1.2	4.0	8.0		
A2 (20%)	3	9.9	±0.1	0.1	9.8	10.0		
A3 (30%)	3	8.0	±0.3	0.2	7.7	8.3		
A4 (40%)	3	4.8	±0.2	0.1	4.6	5.0		
Total	15	6.7	±2.2	0.6	4.0	10.0		

SD: Standard Deviation; **SE**: Standard Error; **Min**.: Minimum; **Max**.: Maximum; **F**: 'f' ratio, P= Probability

Above table presents results pertaining to the plant root length of soybean studied under various soil matrix containing Fly Ash (FA) and microorganisms (*Rhizobium* sp.) as an amendment. Overall there are five different soils, identified as A (soil with no FA), A1 (soil with 10% FA), A2 (soil with 20% FA), A3 (soil with 30% FA) and A4 (soil with 40% FA). The experiment revealed that there is a significant (P<0.05) difference in the root length of soybean as a function of different FA addition to the soil. Specifically, for A, 5.0cm shoot length was recorded while for A1, A2, A3 and A4 root length showed significant increase viz. 6.0cm, 9.9cm, 8.0cm, 4.8cm respectively. The study results indicated that highest shoot length was obtained when the soil contained 20% FA and *Rhizobium* sp. amendment followed by A3, and A4. Thus, it is concluded that the presence of *Rhizobium* and percentage of FA does play role in root length.

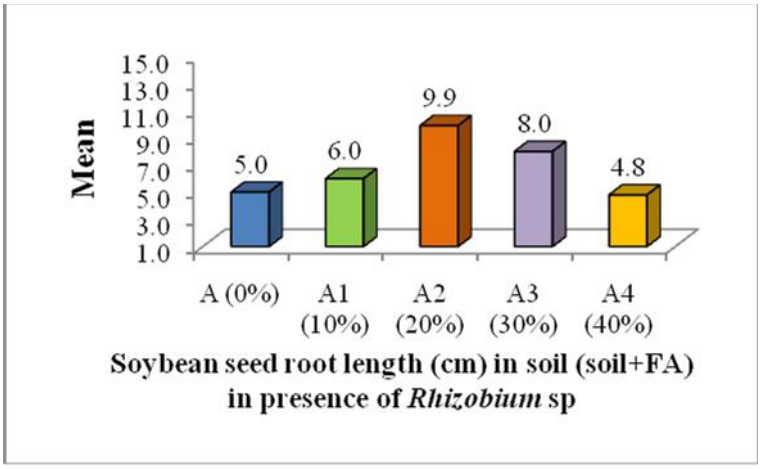

Fig. 3: Soybean plant root length (cm) in soil (soil+FA) in presence of *Rhizobium* sp

Conclusion

In present study we found that judicious use of fly ash in agriculture was recommended. Fly ash amendment can change the physico-chemical properties of soil and provides micro and macro nutrients to the plants. In present work, highest root and shoot length of soybean plant was recorded in soil amended with *Rhizobium sp*. and 20% fly ash. High rate of seed germination was recorded in 20% fly ash amendment with rhizobium sp. Rhizobia can fix atmospheric nitrogen and by that increase the plant growth. Growth response of plant was showed significant increase in growth parameters as compared over the control i.e. at 0%. Fly ash and *Rhizobium sp.* has been played a vital role in degraded agricultural soils for reclamation process.

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