PHYSICO-CHEMICAL CHARACTERIZATION OF FLY ASH AND ITS EFFECT ON THE GROWTH OF SOYABEAN PLANT (GLYCINE MAX.)

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ABSTRACT: The physico-chemical characterization of fly ash, three different soils and irrigation water was carried out. The growth of soyabean plants was studied in 0%, 2%, 5%, 10%, 15%, 20%, 25% fly ash blended soils. Growth of plants was monitored regularly after every month up to three months from the date of sowing for all the three blended soils in rainy season of the year 20010. Based on the data obtained it is found that 5% - 10% fly ash- soil blending concentrations improved the physical properties of soil and also contributed to better growth and yield of soyabean plants in rainy season. The present work shows the utilization of fly ash in agriculture may provide a feasible alternative for its safe disposal without serious deleterious effects and may save the cost of fertilizers and elevates the economy of farmers if used in proper ratio by blending.

KEY WORDS: Blended soil; Fly ash; soyabean plant growth; physico-chemical characterization

Introduction:

In the developing countries like India, the disposal of domestic and industrial waste is becoming a problem of great concern, which may cause land, water and air pollution. Soil contamination by industrial effluents has affected both soil health and crop productivity.

Many untreated and contaminated sewage and effluents may have high concentration of several heavy metals such as Cd, Ni, Pb and Cr [1,2] which get accumulated in the living cells causes the decrease in cell

activities, inhibition of growth and various deficiency/ diseases in plants [3].

The nutritional status is a major determinant of the productivity of a soil. Many waste materials containing essential plant nutrients are available in huge quantities which when applied at appropriate rates can enhance the nutrient status as well as other soil properties. Out of these solid wastes, fly ash is the major waste produced in thermal power stations. Every year thermal power plants in India produce more than 100 million tons of fly ash, which is expected to reach 175 millions in the near future [4]. Due to the absence of well planned strategy in India for the disposal of this fly ash, it is posing serious health and ecological hazards [5]. It has been reported [6,7] that the fly ash has a potential to improve the contents of nutrient elements of soil required for healthy plant growth. It contains [8] useful components such as Ca, Mg, Fe, Cu, Zn, Mn, B, S and P along with appreciable amounts of toxic heavy metals such as Cr, Pb, Hg, Ni, V, As, and Ba. The toxic heavy metals hinder the nutrient utilization by plants and adversely affect the microbial population and hence soil fertility. Many workers [9, 10, 11] also found increases in yields in several crops by addition of fly ash which was attributed to the correction of nutrient deficiencies in plants although the response varied from soil to soil.

The present investigation is a part of systematic work undertaken to study the effect of fly ash on the growth of soyabean plants and thereby to control the pollution load.

Materials and Methods:

The fly ash was obtained from RPL Urja limited, at Wani in Yavatmal District of Maharashtra (India). Seeds of soyabean (of make Eagle) were collected from the market. Three different soil samples were taken at 25cm depth from the surface and sampling was carried out by quartering method. These soils were air dried and powdered. These soils were

blended with fly ash in % by weight as 0%, 2%, 5%, 10%, 15%, 20% etc. and were kept in clean polyethylene bags. Two seeds of soyabean were sown in each bag.

The physico-chemical characteristics of fly ash and soils were analyzed by the standard methods, [12,13]. The physical and chemical properties of irrigation water were analysed by following the standard procedures [14]. All chemicals used were of AR/GR grade.

All plants were watered equally with same period and with the same irrigation water. The height, number of leaves, number of flowers, number of fruits were recorded for each soyabean plant after every month from the date of sowing up to the three months and dry weights were recorded at the end of the season. The observations were taken in rainy (June- Sept.) of the year 2010.

Results and Discussion:

The physico-chemical characteristics and elemental analysis of fly ash and three different soils are presented in table-1. Similarly, the analysis of irrigation water is shown in table-2. The results of fly ash analysis showed pH of 7.63, electrical conductivity (EC) of 0.55mS/cm which may be due to the presence of high concentration of oxides of Ca and Mg [15]. Also, it contains high concentration of P, K, Ca, Mg, Fe and Mn. Various studies [16,17,18,19] conducted in India and abroad have indicated that application of fly ash to soil reduce bulk density and dry density and increase the water holding capacity and porosity.

In the ***rainy*** season (June10 – September10), the plant height (17.5 inch), number of leaves (99), flowering (27), number of fruits (25) and dry weight (7.8 g) in soil S_1 were recorded maximum at 5% blending concentration. In case of soil S_2, the highest values of plant height (20 inch), leaves (101), flowering (41), fruits (30) and dry weight (10.6 g) were observed at 10% concentration. Similarly, in soil S_3 also, the optimum values of growth parameters were reported at 10% blending concentration as plant height (19 inch), leaves (99), flowering (40), fruits

(31) and dry weight (10.3 g). Figures (1), (2) and (3) show the variation of height, no. of fruits and dry weights of soyabean plant in different soil-fly ash blending concentrations respectively after three months from sowing (Sept'2010). Thus in rainy season 2010, 5% for S1 and 10% for soils S_2 and S_3 were found to be the optimum blending for soyabean plant. The fairly good values of growth parameters in S_2 may be attributed to the fact that the it has higher values of W.H.C., pH, K, Mg, Cu and Mn than S_1 and S_3. However, optimum blending at lower concentration (5%) in S_1 than S_2 & S_3 may be due its higher porosity and W.H.C.

It can be seen from the figure that control or higher or lower blending concentrations of the fly ash than these in respective soils decreased the growth parameters of soya bean plant. These findings are in accordance with the earlier observations [20] in jowar, bajra and rice. Increase in growth and yield was also reported [21] under fly ash application in the soil up to 10 tons/ha and was interpreted as due to improved soil structure and enhanced nutrient availability. Crops like rice, wheat, gram etc. were grown on varying level of fly ash encouraging the crop growth and subsequently its yield. The corroborative results were reported by [22], where they found an increase in yield of wheat up to 20t/ha fly ash dosing to soil and decline thereafter but still higher than the yield under no ash addition. They reported moisture retention of soils on fly ash treatment. Thakare et al [23], reported similar results in soya bean (Glycine Max) by using soyawaste blended soil and found maximum growth and yield at 10% blending concentration. The possible reason for this is may be the role of growth regulators and the balance between promoters and inhibiters, which shift due to the trace element composition of fly ash. Some negative effects were also reported but these may be due to excessive concentrations of industrial waste which may lead to nutrient toxicity and other soil disorder [24]. This shows that the nutrients like available nitrogen, phosphorous and potassium in fly ash are sufficient which can correct the deficiencies of these in soils. Thus at

5% to 10% blending concentrations of fly ash with soil, the soyabean plant are able to absorb maximum amount of nutrients from blends resulting in good yield.

Conclusion:

Thus overall, 5 - 10% flyash-soil blending concentrations were found beneficial for the growth and yield of soyabean plant. That means fly ash acts as an excellent soil modifier, conditioner and a source of essential nutrients for appreciably improving the texture and fertility with significant increase in crop yield over the control at a particular concentration only and is supportive to plant growth. However, other blending concentrations may lead to reduction in growth and yield parameters of crop. Thus utilization of fly ash in agriculture may provide a feasible alternative for its safe disposal without serious deleterious effects and may save the cost of fertilizers and elevates the economy of farmers if used in proper ratio by blending. However there is a need of detail and time series study to declare flyash totally safe and eco-friendly to be used as fertilizer.

Table 1: physico-chemical characteristics of three soils and flyAsh

Sr. No.	Parameters	S1	S2	S3	Fly ash
1	Bulk density (g/cc)	1.49	1.61	1.78	1.43
2	W.H.C. (%)	75.83	75.83	58.42	62.50
3	pH	7.63	7.70	7.65	7.63
4	Conductivity (mS/cm)	0.51	0.53	0.50	0.55
5	Available P (kg/ha)	16	18	20	24
6	Available K (kg/ha)	552	625	298	456
7	Na (%)	0.52	1.78	0.63	0.67
8	Organic C (%)	0.39	0.34	0.49	0.48
9	Ca (%)	36.0	27.0	29.2	23.6
10	Mg (%)	3.7	9.2	3.7	19.2
11	Porosity (%)	60.05	54.52	35.63	46.59
12	Moisture (%)	8.99	7.16	10.02	7.02
13	Zn (ppm)	0.25	0.48	0.47	1.37
14	Cu (ppm)	1.16	2.84	1.41	0.98
15	Fe (ppm)	0.29	0.56	0.64	2.91
16	Mn (ppm)	2.04	5.21	1.62	2.77

Table 2: Physico-chemical characteristics of irrigation water

Sr. No.	Parameters	Irrigation Water
1	TDS	906 ppm
2	pH	7.44
3	Conductivity	3.18 mS/cm
4	Calcium	4.9 meq/l
5	Magnessium	2.4 meq/l
6	Sodium	0.78 meq/l
7	Potassium	0.41 meq/l
8	Bicarbonates	2.3 meq/l
9	Chlorides	2.3 meq/l
10	Sulphates	1.52 meq/l

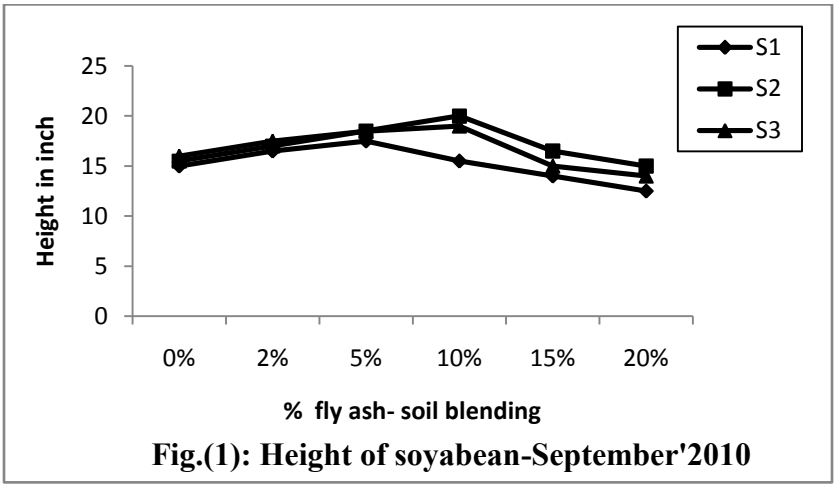

Fig.(1): Height of soyabean-September'2010

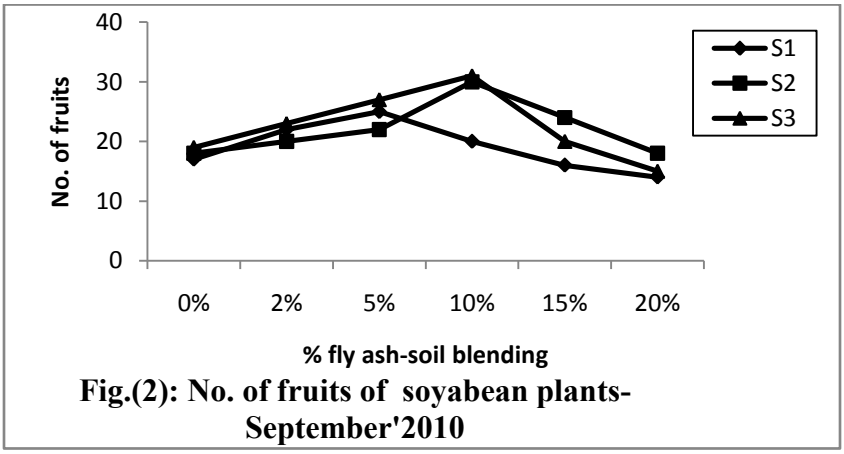

Fig.(2): No. of fruits of soyabean plants-September'2010

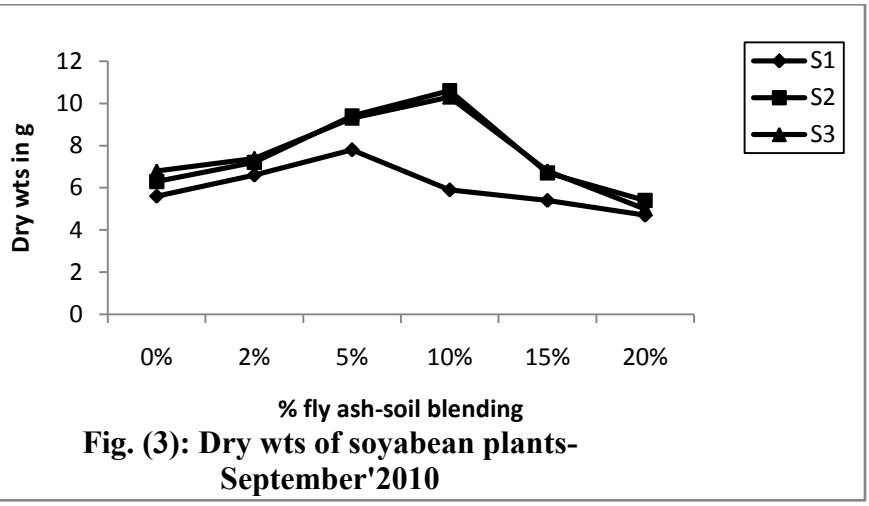

Fig. (3): Dry wts of soyabean plants-September'2010

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