Original Article

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Impact of Fly Ash amended Soil on Germination & Growth and Yield of Chick Pea (*Cicer Arietinum* Linn)

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Abstract

The present investigation was carried out at find out the impact of fly ash amended soil on germination, growth and yield of chick pea (*Cicer arietinum* Linn). The soil having pH around 5.8 was used for the study. The growth of chickpea plants was significantly affected by different fly ash amendments. The maximum response was induced by a 60% level (600 g) of fly ash, where an increase in all the parameters of growth were recorded. Fly ash at 100%level (1000 g) was harmful for plant growth. The result was quite promising **as** germination was found to be highest in 40% level(400g) of fly ash amendment and all other characters of growth and yield suggested 60% amendments was the best amendment over control.

Keywords: Fly ash; Kolaghat Thermal Power Plant; Chick Pea; DAS; Germination.

Introduction

Fly ash, a finely divided residue resulting from the combustion of coals in the thermal power plants is regarded as an amorphous ferro-alumina-silicate mineral containing the naturally occurring essential elements similar that of soil except humus and nitrogen (Tripathi *et al* 1997) The huge quantity of fly ash produced due to burning of coals creates problems not only for its safe disposals but also the rising problems of air pollution due to its fine particle size and water pollution due to the leaching effects. Every year Indian thermal power plants produces more than hundred million tons of fly ash, which is expected to reach 175 million tons in near future (Nidhi, 2003). This large volume of fly ash occupies large area of land and possesses threat to environment (Sharma and Kalra 2006). However a judicious amendment strategy has to be developed to abate the land pollution from the heavy metal incorporation in the fly ash (Sikkar and Kansal 1995). Fly ash threatening the environment due to presence of organic carbon & toxic substance ,although now fly ash is used as an agricultural inputs (Jala and Goyal 2006) due to availability of different macro and micro elements which are very important for growth of the plants. Use of fly ash in agriculture provides a feasible alternative for its safe disposal to improve the soil environment and enhance the crop productivity. Among the pulses chickpea (*Cicer arietinum* L.) is an important one which is also known as gram, Bengal gram or Chola. It is the earliest domesticated crop in the Mediterranean and Middle Eastern Region (Vavilov 1951). On the basis of cultivated area chickpea stands for 19th position amongst the important crops and is grown in 34 countries of the world. In Bangladesh it is the third major pulse crop after grass pea (*Lathyrus sativus* L.) and lentil (*Lens culinaris* L.) (Islam 1981). In the Indian subcontinent the crop is grown during winter on the soil conserved from the preceding monsoon season (Ali, 1986). The utility of fly-ash as a soil amendment has been so far tested for various crops. Here is an attempt has been

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Table 1: Characteristic of fly ash used in the experimental plot

Chemical Properties	%
Silica	52.68
Total Sulphur	0.070
Organic Carbon	2.06
pH	7.7
Major elements	%
Fe	1.42
S	0.070
P	0.015
N	0.059
Minor elements	ppm
As	1.23
Cd	0.21
Co	2.24
Cu	21.50
Ni	1.95
Mn	209.3
Zn	63.6

taken to conduct the study of the effect of fly ash as a potential sources of soil amendment, on germination %, growth and yield of Chick pea.

Materials and Methods

Fly ash sample collected from dumping area of thermal power plant, Kolaghat, Purba Medinipur, West Bengal was used for study. These power plant uses bituminous coal as a fuel which contains high amount of ash (upto 40%), sulpher and heavy metals in varying proportions. Characteristics of fly ash including different elemental compositions used in the experimental plot are given below.

Available nitrogen was estimated by alkaline potassium permanganate method (Subbiah and Asija, 1956). pH was estimated following the method of Jackson (1967). Organic carbon was determined by Walkley and Black method (1934). Available micronutrients (DTPA extractable) Fe, Mn, Cu and Zn and other heavy metals were analyzed by DTPA method using atomic absorption spectrophotometer (Lindsay and Norvell, 1978).

Amendment of soil with fly ash- The soil having a pH of 5.8 of the experimental site mixed with compost manure (Soil: Manure = 3:1) was dried under shed. The experiment was carried in earthen pots (30 cm diameter).Experimental set up included five treatments with three raplcations. Different amendments of fly-ash and soil were prepared by mixing of these two in proportionate ratio viz 0%, 20%, 40%, 60% and 100% to make different treatments coded as T_0,T_1,T_2,T_3,T_4 respectively. Soil devoid of fly ash 0% (1000gm. soil) was treated as control. Rest of the pots received 20% Fly ash (800gm. soil+ 200gm. fly ash), 40% fly ash (600gm. soil+400gm. fly ash), 60% fly ash (400 gm soil+600gm. fly ash and 100 % fly ash (devoid of soil). Total 15 pots were prepared for the experiments, each pot filled with 2 kg of each type of amended soil. Seeds of chickpea were obtained from local market. Ten seeds of Bengal gram were sown in each pot and watered at regular interval and kept under sun for further study. Data of germination % and survival of seedlings were taken into consideration; four plants of uniform size were maintained in each pot. Periodic observation of plant growth, yield and yield attributes following the germination of

seeds were recorded, all those collected data were statistically analyzed for each character separately.

Results and Discussion

Effect of Fly ash on vegetative growth of Chick pea (Cicer arietinum Linn.) - 5 DAS

The germination % of chickpea seeds showed that fly ash (FA) amended soil played a significant role over control soil in pot culture study. However highest germination recorded in 40% Fly ash amended soil Suppression occurred at 100% fly ash level where seeds were inhibited for germination. Result was quite encouraging as fly ash (FA) amendment soil favoured the gradual increase in percent survival of seedlings. Highest root and shoot length was observed 60% fly ash (FA) amended soil over control soil in the experimental pot (Table 2).

Effect of Fly ash on vegetative growth of Chick pea (Cicer arietinum Linn)- 60DAS

Analyzed data in respect of all the morphological characters like, number of nodes, leaf area, root length and height of the plants raised in experimental pot under different doses of FA amended soil revealed that treatments (0%, 20%, 40%, 60%, 100%) differed significantly with each other. However plants in 60 days of maturity showing more or less highest results in relation to the growth in all respect with 60% FA amended soil (Table 3).

Effect of Fly ash on yield and yield attributes of Chick pea (Cicer arietinum Linn)- 90DAS

Effect of fly ash amendment was studied

Table 3: Effect of Fly ash on vegetative growth of Chick pea (*Cicer arietinum* Linn.) - 60DAS*

Treatments Fly ash (%)	Number of nodes	Leaf area (sq.cm)	Root Length (cm.)	Height of the Plant (cm)
T_0 (0%)	8	1.26	14	21
T_1 (20%)	10	1.34	13	25
T_2 (40%)	9	1.85	18	30
T_3 (60%)	11	1.99	15	33
T_4 (100%)	-	-	-	-
CD at 5%	3.67	0.22	2.38	4.04
CD at 1%	5.34	0.32	3.47	5.88

Table 4: Effect of Fly ash on yield and yield attribute of Chick pea (*Cicer arietinum* Linn.)- 90 DAS*

Treatments (Fly ash %)	Days to fruiting	No. of pods /plant	Pod weight (mg.)	Seed yield/plant (gm.)	Weight of 100 seeds (gm.)
T_0 (0%)	32	19.4	72	11.39	26
T_1 (20%)	30	22.6	78	12.45	27
T_2 (40%)	31	24.2	80	14.29	29
T_3 (60%)	29	30.2	85	16.75	32
T_4 (100%)	-	-	-	-	-
at 5%	4.23	3.93	8.90	3.97	2.60
CD at 1%	6.16	5.72	12.95	5.78	3.78

*DAS=Days After Sowing

with respect to the different yield and yield attributes in 90 days mature plants (Table 4). Results indicated that the fly ash (FA) amended soil showed an early fruiting tendency where the plants in control pot it was delayed. Similarly a gradual increase in number of pods, individual pod weight and seed yield in each plant was observed with the application of higher grades of fly ash and which was highest with 60% amendment at the ninety days. The weight of 100 seeds varied 26-32gm which was highest (32gm) in 60% FA amendment. All the characters regarding yield and yield attributes showed distinct significant difference among all the doses. The highest pod number 30.2 was obtained in the plants treated with 60% Fly ash and the lowest was 19.4 in the control pot.

In the present study suppression occurred at very high ash level where seeds were inhibited for germination corroborated the findings of Singh *et al* (1997) who observed that lower application of fly ash to the soil stimulated seed germination as well as seedling growth although higher doses either delays or drastically inhibits plant growth along with other specific parameters. However in the present study the results in relation to the suppression in seed germination vis a vis death of plant at 100% fly ash level also coincides with the findings of Chou *et al* (2005) as they recorded the death of chrysanthemum at 75 % and 100% F.A amendments. Singh and Siddiqui (2003) studied that the adverse effect due to higher level of ash application was attributed to salinity caused by higher levels of sulfate, chloride, carbonate and bicarbonate in fly-ash amended soil. The increase in available major nutrients status in soil due to fly ash application was reported by Khan and Quasim (2008) and Ram *et al* (2011) although the increase availability major nutrients except K, concluded by Dey *et al* (2012).However in the present study the better germination of chickpea seeds in FA amended soil over control perhaps due to the enhancement of soil pH and similar observation was recorded by Moliner and street (1982) who reported that addition of fly ash to the soil neutralizes the acidity to a level suitable for agriculture, depending on the initial pH of the soil. Elsccwi *et al* (1981), Druzinal *et a*l (1983) and Wong and Wong (1989) observed that fly ash incorporation in the soil also increased the availability of sodium, potassium, calcium, magnesium, boron, sulphates and other nutrients excluding nitrogen. It was recorded by Karmakar *et al* (2009) that organic carbon was increased with the application of FA and FYM (Farm Yard Manure). The beneficial effect of fly ash on improvement of soil health in respect of physico-chemical parameters, nutritional status and microbial population may be due to the cumulative effect of improvement in individual physico-chemical characteristics (Yeledhalli *et al,* 2008). Khan and Khan (1994) observed that a gradual increase in the concentration of fly ash from 40-80% induced an appreciable increase in the number of flower/plant compared to the control. The present study was more or less similar with above findings. Mittra *et al* (2003) recorded that application of FA reduced bulk density which helped better pegging in soil and enhance pod formation. The positive effect of fly ash on yield was also reported by Aggarwal *et al* (2009) in wheat and sorghum and by Arivazhagan *et al* (2011) in rice, wheat, maize, ragi. The present observation on Fly ash application in respect to yield and yield attributes of chickpea with proportionate level of soil also was in the same agreement.

Conclusion

The present study revealed that the fly ash could be beneficial for enhancing the soil quality and plant growth. Although higher ash amendments (60%,100%) might have produced adverse effect in terms of inhibition on the germination of the chickpea seed, still the most suitable treatment for improvement

of plant growth and crop yield was 60% fly ash with the proportionate level of soil, as it recorded the maximum crop yield (maximum number of pods). Since chickpea grows well in fly-ash it can be used judiciously as an ideal soil ameliorates in acid lateritic soil for augmenting yield of gram.

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