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Fly Ash Foe or Friend of Soil - Need to Reassess its Role as Nutrients and Toxicant in Loss of Biodiversity

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Abstract: ***Humans are weird creatures, anthropogenic activities in the name of upgradation of technology had created problems of degradation of rural, urban, industrial, agricultural and non agricultural land and soil. Disposal of residual waste like fly ash had severely altered the physical, chemical and biota of soil throughout the world and also aquatic ecosystem. Asian and other countries must drastically reduce their populations as the agriculture sector has to bear the load of feeding the ever hungry human. Globally research on utility of fly ash for fertilizer for agriculture needs more research for various soil types which are unproductive and poor in nutrients. Fly ash don't add nitrogen, but other mineral metals reach in the soil from fly ash and reach ground water and other water bodies which get contaminated. The herbs, shrubs and trees and animals life dependent on vegetation get altered due to loss of vegetation, loss of trophic level organism of food chain and food web operating in forest, agro-bois (agriculture, orchards, floriculture, medicinal plant cultivation) and aquatic ecosystems. Fly ash metals destroy microbes which fix atmospheric nitrogen in soil and water resulting in infertility and finally loss of biodiversity; bioconcentration and biomagnification is the underlying mechanisms, cow dung and its powder reduce toxicity of metals present in fly ash which otherwise in proper dosage act as nutrients of soil. Growth of aloe-vera, wheat ,etc and toxicity effects of fly ash on terrestrial and aquatic molluscs, earthworms, guppy fishes and aquatic plants are being done experimentally in the present research on work. Fly ash use is related with socio- economic status of a country, it needs reassessment. Bio monitoring, agro-monitoring, toxicomonitoring, etc.***

Keywords: Fly ash, composition, biota, soil fertility, toxicity, growth.

I. INTRODUCTION

Coal ash and fly ash are effluents pollute soil, water, air. ground water also get polluted (D.R. Saxena,2021).Coal fly ash particles exhibit ranges of size, composition, contain metals, polyaromatics hydrocarbons and silica (quartz). According to P.J.A Born (1997) coal fly ash show genotoxic effect , lower toxicity , inflammatory potential and fibrin formation in respiratory organs. According to G.S.Tiwary (2021) due to geotaxis effect of heavy particles of coal fly ash (CFA) it accumulated inside plant's and organism's body (earthworms, aquatic animals) and shows the effect on behavioural changes. Earlier work reviews were compiled in 2002 by Rowe on environment degradation due to disposal of coal combustion residual (CCR). Field studies were done one in lentic habitat on fish and benthic organisms and ten in lentic habitat (Cherry et al.1979). Reasch et.al.,1988, lemly 1977, Lohler et.al .,2001a ,2001b,2001c . Smith 2003, Reasch 2004, Reasch 2012, Otter et. al., three lab work (Wang et.al.,2013 , Stanley et.al., 2013 ,Chan et.al., 2014) all of which were done in Tennessee, valley in 2018 by Tennessee Valley Authority Kingston Fossil Plant ash spill. Fly ash contains arsenic, mercury and selenium (Reasch, 2012). Of late selenium exhibit bioaccumulation in receptor tissues and to disturb reproduction also (Chapman 1999; Deforest Adams 1999); Fair brother et.al; 1999, Hamilton 1999, Lemly 1999, Ohlendorf 1999), and a Pelston workshop(Chapman et.al.,2010).

II. OBSERVATION

In the present investigation fly ash was collected from MIDC AREA BUTIBORI, NAGPUR. seed of wheat, mustard and black gram were shown on 29/03/2021 at 4:30 PM as control and test on 31/03/2021 morning slightly growth in the form of germination was recorded in control wheat and black gram, but slightly better germination in fly ash treated wheat, gram, and fly ash and cow dung treated wheat and gram was observed and both reached a length of 2 cm and 1 cm respectively in test experiments. On 05/04/2021 control experiment length recorded was wheat (13-14 cm) black gram 09 cm and mustard (01-02 cm). In the fly ash treated plants length measured on 05/04/2021 was wheat (09-10 cm), black gram (12-14 cm) and mustard 5 cm. Mustard seeds are somewhat recalcitrant germinated on 03/04/2021 in the fly ash soil, but no growth occurred in control and fly ash and cow dung soil. In the fly ash and cow dung treated plants growth measured on 05/04/2021 was wheat (09-12 cm) , black gram (12-13 cm) and mustard (04-05 cm). But the branches showed dense growth in the both test with fly ash with fly ash & cow dung for black gram (see table no. 1,2,3,4) .

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In the aquatic weeds similarly above experiments showed, two weeds, fly ash 16 weeds and fly ash and cow dung 12 weeds were kept in water on 08/04/2021. The control contained 3 weeds, fly ash 18 weeds and fly ash and cow dung 19 weeds. This means only one weed grew in control, two weeds grew in fly ash and 7 weeds grew in fly ash and cow dung. A long term experiment may help in knowing the growth trend of weeds. Work is in progress.

A. Observation Table

Table: 01
Report taken on :- 01/10/2020 to 15/04/2021 At temperature 36* C

Sr. No	Month	Dose fly ash	Watering	Temperature	Observation	
					Control	Test
1	October	30gram/kg	Daily	18 – 35*C	Green	Green
2	November	Nil	Daily	12 – 35*C	Green	Tip yellow loss of chlorophyll
3	December	Nil	Daily	08 – 33*C	One leaf dry	More less chlorophill
4	January	Nil	Daily	11 – 33*C	Other green	Two leaves drying
5	February	Nil	Daily	10 – 39*C	Other green	Two leaves dry and detach, mucus lysis
6	March	Nil	Daily	13 – 41*C	One leaf dry	Other green
7	April	Nil	Daily	19 – 42*C	Other green	Third leaf dry detach mucus lysis

Table:-02
Report taken on :31/03/2021
Growth noticed in Plumules & Radicals

	Soil	Cow dung + Fly ash	Fly ash
Wheat	Good growth	Good growth	Good growth
Mustard	No growth	No growth	Some growth
Black Gram	Some growth	Good growth	Good growth

Table: 03
Report taken on :- 05/04/2021 At temperature 31* C
Growth in Centimetres (plumules)

	Soil	Cow dung + Fly ash	Fly ash
Wheat	13-14	9-12	9-10
Mustard	1-2	4-5	5
Black Gram	9	12-13	12-14

Table: 04
Report taken on:- 05/04/2021 At temperature 31* C
Growth in stem, branches

	Soil	Cow dung + Fly ash	Fly ash
Wheat	Dense growth	Some growth	Dense growth
Mustard	Limited growth	Scattered growth	Dense growth
Black Gram	Some growth	Dense growth	Dense growth

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III. RESULT & DISCUSSION

In the present investigation, aloevera was exposed to fly ash 30gm in 1kg of soil to evaluate toxicity, it was observed that after treatment for 6 months, during this time after 28-30 days the fronds(leaves) started to wilted gradually and loss of chlorophyll occurred. But in out of 5 leaves and 3 leaves underwent lysis, mucilage was oozing its consistency was slightly watery and leaves become discoloured due to loss of chlorophyll breakage and lysis may be due to metals and metalloids absorption, the pore channels in plasma membrane of cells allowed entry is these toxicants, as a result of this enzymes from cell organelles caused destruction of chlorophyll,, breakage and release of gel or mucilage from damaged leaves. In animal cells in general lysosomes are implicated in cell autophagy due to exposure to toxicants. Silicosis and asbestoses are occupational hazards caused by silica and asbestos partials, these actually lead to hyperactivity of lysosomal hydrolytic enzymes and eventually damage to the human lungs, which becomes fatal later in life.

In the another set of experiments with wheat, mustard and black gram, the trend if germination was control: mustard no growth , wheat slight growth, black gram slight growth as on 31/03/2021.but on 01/04/2021 test fly ash : mustard no growth wheat better growth ,black gram better growth. Test fly ash and cow dung : mustard no growth, wheat 2cm,black gram 1cm . Trend of growth in length measured in cm in controls: Mustard < black gram < wheat . Trend in fly ash : mustard < black gram < wheat. Similarly on 05/04/2021 trend of growth in fly ash and cow dung was: Mustard < wheat < black gram. The mustard seeds showed very slow growth in control, fly ash and fly ash cow dung treated soil. Wheat seeds showed less growth then black gram until the end of experiment in fly ash, fly ash and cow dung treated soil because rhizosphere of black gram developed 2 nodules in fly ash and 5 nodules in fly ash and cow dung treated soil.

In the experiments with aquatic weed, the control, test containing fly ash and the test containing fly ash and cow dung growth of weeds after 6 days was control 1, fly ash 2, fly ash and cow dung 7. Greater number of weeds grew in fly ash and fly ash and cow dung containing water in comparison to control. In long term experiments in progress results are expected regarding nutrient property and toxicant of fly ash contents and also bioaccumulation in the aquatic weeds, which may depend on opening and closing of ion channels and their pore size. Biochemical estimation of crop plants, aquatic weeds and earthworms tissues respectively will shed light on these aspects. In a single experiment earthworms of 9-11 cm length was used to know LC50 value of fly ash toxicity. In one kilogram of soil 15 gm of fly ash added after 96 hour test killed 50 % of earthworms while in control there was no mortality. Selenium present in fly ash bio accumulate in receptor tissues and disrupts normal reproduction (Chapman 1999; Deforest and Adams 1999; Fairbrother et.at.,1999 , Lemly 1999, Ohlendorf 1999) and a Pelston workshop(Chapman et.al.,2010). A Preliminary observation on the toxicity of selenium dioxide to Vivipora bengalines was done by D.R. saxena and A.N.Lonkar , to know LC50 value. Vivipora bengalines developed yellow orange colour in its shall and mucous, it can be used as biological indicator of pollution. The colour was due to physical absorption and enzymatically reaction in mucus fly ash dust under humid conditions cause chemical & physical injuries in vegetative parts of plants in the form of smalls dark brown necrotic spots (beans) turnip, cabbage and tomato (Singh and Yunus,2000), fly ash added to soil in field and greenhouse studies reveal their nutritive properties (Chang et.al.,1997).

Seed germination and seedlings growth get enhanced at 5 - 10 % application of fly ash to soil but reverse trend can be observed at a dose of 20-30 % of fly ash application (Singh et.al.,1977) .some trend of high sugar synthesis by beta vulgarise roots at 2% (kg/m^2 plot) of fly ash application and low sugar production was recorded at doses of 4 and 8% of fly ash (Singh et.al.,1994 , Singh and Yunus,1994 ., Singh and Yunus,2000).in the present research work fly ash acted as nutrient for wheat, black gram but mustard showed slow growth, fly ash constituents when added to water bodies enhance gradually growth of weed, but it is toxic at a certain concentration to earthworms because they exhibit slow metabolism and reproduction. Long term effect of fly ash on invertebrates and fish is in progress in their soil/benthic habitat and in aquatic habitat respectively.

In 2014 R.M sherrard et. al., suggested that experiments on standard test species different results to coal ash toxicity and a generalised rule cannot be made, because in laboratory standard test species and resident species in natural habitat react differently to the same toxicant. Studies included

1) Dredging period
2) Post dredging residual ash period
3) Long term monitorning
4) ORNL studies done on column and benthic biota respectively

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These laboratory studies and a study with mussels exposed to fly ash (Wang et.al., 2013) support the finding that potential toxicity to benthic species (both in fauna and epi faunal) is minimal to moderate, depending upon the species and the percentage of ahs present in the sediment. According to baseline ecological risk assessment (BERA) in Wats Bar reservoir analysis revealed river sediments harbouring greater than 40% ahs may cause toxicity to benthic exposure and to a lesser degree because of co varying quantity of metal- metalloids in the fly ash sample. (Arcadis 2012, Stojak et.al.,)

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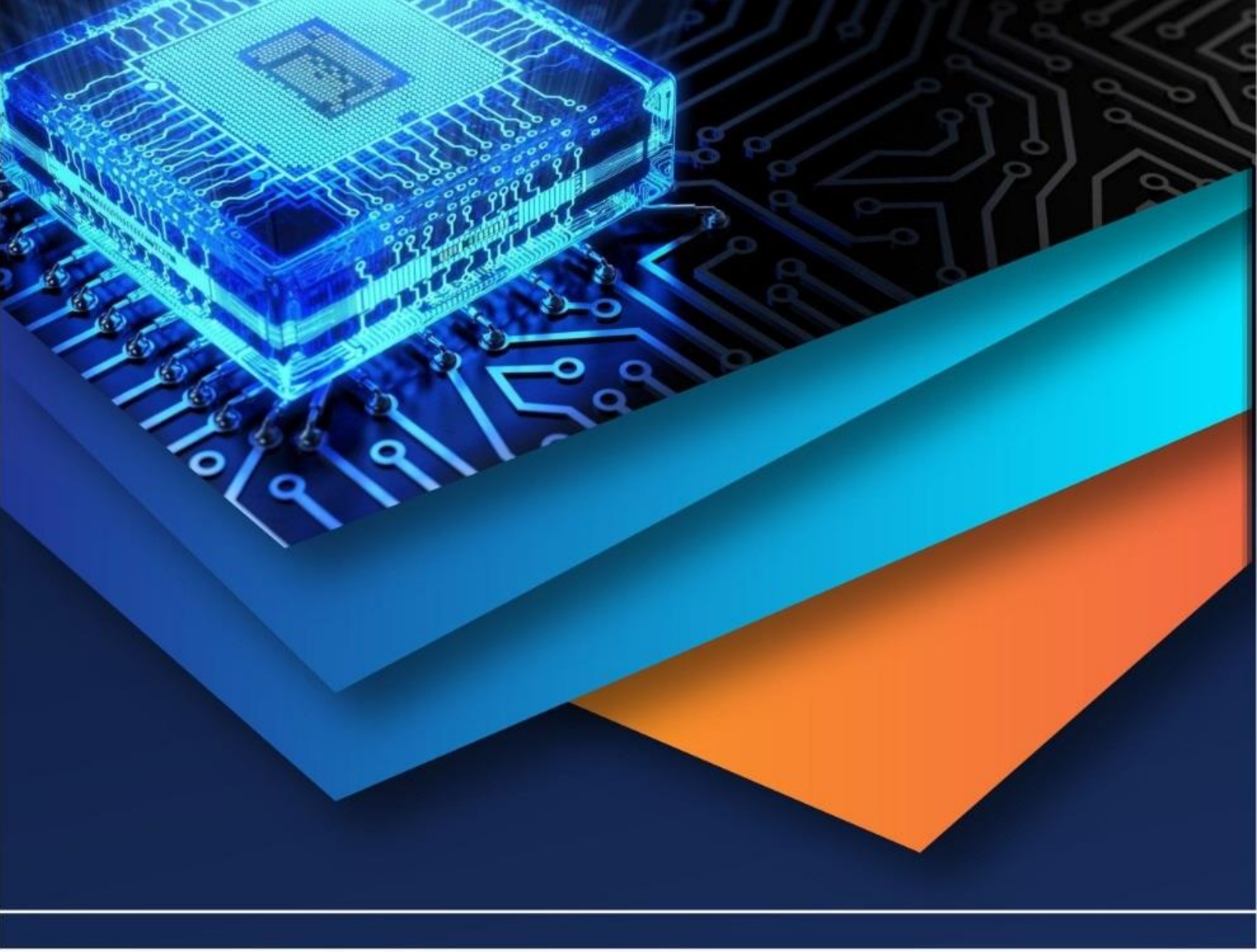

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