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STUDIES ON PHYSICAL PROPERTIES OF FLY ASH ON THE PLANT GROWTH RATE: A REVIEW

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***ABSTRACT**:* Fly ash constitutes the major portion of the total quantity of residues produced in power plants. The large amount of fly ash that is generated each year calls for a great deal of research to determine its feasibility for various potential uses. Of all the possible uses of fly ash in a productive manner, the best use is as a fertilizer either through soil amendment or reclamation of fly ash dumps by cultivating plants of value. Fly ash is not only a good growing medium, but also better soils ameliorate. Efforts have been made to modify the properties of agriculture soil by addition of fly ash, thus improving the soil fertility and crop yield. The effects on plants are primarily due to shifted chemical equilibrium induced by fly ash added to the soil. Phyto-extraction is a remediation technology that uses plants to remove heavy metals from soil. Studies show that various heavy metals and metalloids are available into the fly ash. Plant based approaches, such as phyto-remediation, are relatively inexpensive since they are performed in situ and are solar- driven. The specific advances in plant- based approaches for the remediation of wastes such as fly ash because fly ash contains lots of micro and macro elements, those can give positive or negative impact on plants as increase in crop yield, photosynthetic rate, biomass etc. Researches also suggest that abiotic factors may alter the production of bioactive compounds by changing aspects of secondary metabolism with the help of heavy metals uptake. This review represents that low concentration of fly ash is helpful to increase plant growth performance due to the presence of several beneficial elements or metals.

KEYWORDS:- Fly ash, heavy metals, plant growth and abiotic factors.

INTRODUCTION:-

The general composition of Fly ash is listed in Table 1. Fly Ash is collected by electrostatic precipitator or filter bags in thermal power plants. The particles of fly ash are spherical in shape (0.5 µm to 100µm). Depending upon the source of coal being burned, the component of the fly ash vary considerably, but all the fly ash contains substantial amount of silicon dioxide and calcium oxide, both are ingredients in many coal bearing rock strata. Due to heterogeneous characteristics, fly ash contains glassy particles as quartz, mullite and various iron oxides also. Fly ash also contains many elements like: arsenic, barium, beryllium, boron, cadmium, chromium, chromium VI, cobalt, copper, fluorine, lead, manganese, nickel, selenium, strontium, thallium, vanadium and zinc. All other physiochemical properties were reported as Table 2 and Table 3.

According to ASTM C618 fly ash is classified in two classes: Class F fly ash and Class C fly ash. The concentration of calcium, silica, iron and alumina gives differentiation in between these two classes: Class F fly ash-Anthracite and bituminous coal gives class F type fly ash. This fly ash contains 10% lime (CaO) and pozzolanic property. This fly ash requires cementing agents and water to prepare cementing products. Class C fly ash-Lignite and sub-bituminous coal gives class C type fly ash. In addition to pozzolanic property, fly ash has self-cementing property also. Class C fly ash contains 20% lime (CaO).

RESULTS AND DISCUSSION:-

As we all know there is always an impact of different elements in plant growth or other from the substrates. The influence of these elements or heavy metals has been studied in various aspects. The influence of Cd, Cu, Zn, and Fluoranthene (FLA), separately applied, and combinations of one of these heavy metals with FLA on the growth of soil bacteria were examined through a 90 day incubation period and compared with the behaviour of no treatment (control). In the soils amended with all doses of Cd, Cu and Zn alone and combination with FLA, total bacterial population was always significantly lower than those of the control soil. Significant reductions of bacterial counts were observed for both doses of heavy metals combined with FLA. Low concentration of heavy metals (50 mg kg-1) which was not affective when added separately was found to reduce bacterial growth when applied in combination with FLA. At higher levels of heavy metals (150 mg kg-1) addition of FLA also increased the toxicity of the metals.

This study revealed that J. curcas plants could gainfully utilize the nutrients available in fly ash by subsequently amending soil. Because of high concentration of many elements in fly ash, numerous studies have evaluated the usefulness of fly ash in nutrient deficient soil. It can be used as a source of B, Ca, Cu, K, Mg, Mo, S and Zn. The trace elements present in fly ash are potentially toxic due to their chemical limitations. These elements including As, B, Mo, Se and V are generally readily available to plant and tend to accumulate in plant tissue. If alkaline fly ash is used to treat acidic soil and it is also studied that the liming effect and the uptake of micro nutrients copper, zinc and manganese from fly ash can enhance plant growth. In sun flower plant the heavy metals (Cd, Cu and Zn) from fly ash have no significant effect on dry mass but gives good growth in plant parts, stem, leaves and roots. Fly ash can be used an amendment to increase Se uptake by crops serving as an essential micronutrient for many deficient soils and crops. Onions grown on coal fly ash contained a significantly high concentration of Se resulting in agricultural problems.

It is also studied that by using alkaline fly ash based product with soil for Zea mays plant the absorption of Cd, Ni or Mn was reduced as these are toxic and increased in other elements occurred in 5% w/w fly ash with soil. The phytoextraction of Mn, Cu, Ni, Pb and Zn has been studied by Scirpus littoralis (a wetland plant). It growth showed good performance after 3 months in 25% fly ash with soil. Sudan grass and oats showed low absorption of Fe, Cu, Mn and Zn from fly ash in Dadri, Gaziabad, Uttar Pradesh (India). The effect of organic wastes (biosludge and dairy sludge) and biofertilizer (Azotobacter chroococcum) on the growth conditions of Jatropha curcas in metal contaminated soils. All results showed that the plants survival rate in heavy metal contaminated soil increased with addition of amendments. Treatment T6 (heavy metal contaminated soils + dairy sludge + biofertilizer) observed to be the best treatment for growth (height and biomass) as compared to the treatment T5 (heavy metal contaminated soils + biosludge + biofertilizer). The result showed that the plant height and stem girth of unpruned Jatropha increased significantly in the years by the application of 5 kg FYM per plant compared to control. The plant height of pruned Jatropha was not influenced by this organic source of nutrients, while stem girth improved significantly only in the third year. The application of 46:50:25 kg ha-1NPK significantly increased the plant height and number of branches per plant of the pruned Jatropha compared to the organic source of nutrient supply in the third year. The response of unpruned crop to fertilizer application was of a higher magnitude. The integrated supply of nutrients by the application of 46:50:25 kg ha-1 NPK and 5 kg FYM per plant to the unpruned crop was the best. It maximized the plant height, number of branches per plant and the stem girth in the three years consistently.

The chlorophyll and carotenoid contents increased with an increase in the FA amendment ratio from 10% to 50% FA for all the exposure periods as compared to GS. In both roots and leaves, the level of protein content increased in all the amendments and 100% FA at 30 d as compared to GS. Thus, there is a balance in the level of MDA content and level of antioxidants in the plants at 90 d. In view of its tolerance, the plants may be used for phytoremediation of metals from fly ash contaminated sites and suitable species for plantation on fly ash landfills. Cotton and wheat grain yield with 20% fly ash which increased N, P and K nutrients and increased the growth and yield. Sunflower plant (Helianthus annus L.) plants treated with fly ash exhibited improved growth. Relative growth rate (RGR) and net assimilation rate increased by over 20% at low fly ash application rate.

The increase in chlorophyll content and photosynthetic rate of Jatropha curcus has been observed with low dose of fly ash (20%) with soil. Response of eggplant (Solanum melongena L.) with respect to fly ash was observed that its growth and yield were significantly increased in 5 to 30% fly ash with soil and same observations are also studied with Pisum sativum L. plant with 10% fly ash content. It is also observed that tomato plant grown in fly ash mixture showed luxuriant growth with bigger and greener leaves. Plant growth, yield, carotenoids and chlorophylls were enhanced in 40 - 80 % fly ash amended soils. At 100% fly ash, yield was considerably reduced. In drought conditions the plant growth of mustard also increased in 20% fly ash with soil as compared to 0%, 40%, 60% and 80% fly ash with soil. This was also reported that in low concentration of fly ash the plant growth of J. Curcas increased and its antibacterial activity also increased.

Table :1 The General Composition of Fly Ash

S. No.	Substituent (%)	Bituminous	Sub- bituminous	Lignite
1	Fe2O3	10-40	4-10	4-15
2	SiO2	20-60	40-60	15-45
3	Al2O3	5-35	20-30	20-25
4	CaO	1-12	5-30	15-40
5	LOI	0-15	0-3	0-5

Table 2 Physical Properties of Fly Ash

Particle size	0.5 µm to 100µm
pH	8.2 -12.8
Electrical conductivity	8.60- 8.70
Bulk Density	1.01- 1.43 gm/ cm3
Water retention (%)	6.1- 13.4
Organic carbon (%)	0.53- 0.85
Total Nitrogen (%)	0.0- 0.024
Total Phosphorus (%)	0.018- 0.02

Table 3 Trace And Major Elemental Composition of Fly Ash

Trace Elements	(µg/g)
Zn	20- 153.5
Fe	53- 4150
Ni	13- 296.2
Mn	12.1- 353.1
Cu	24.0- 170
Cd	42.3- 52.4
Pb	40.1- 115.2
Mo	33.4- 47.7
Cr	23.4- 152
Na	15- 98

Major Elements	(µg/g)
Ca	338- 177,100
Mg	116- 60,800
K	7,360- 22,400
B	143- 290
Al	4,615- 24,200

CONCLUSION:-

We can conclude that due to the presence of heavy metals in fly ash, it acts as fertilizer for the soil which increases the plant growth performance. But high concentration of fly ash inhibits the plant growth due to the toxicity of heavy metals. We can utilize several non edible plants for phytoremediation of fly ash dykes, which can be a sustainable approach for absorption of these metals to avoid toxicity in soil. Also plants can helpful for carbon dioxide sequestration and oxygen production.

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