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USE OF FLYASH AS A SUPPLEMENT TO BIOFERTILIZER: A REVIEW

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Fly ash (FA), a by-product of coal combustion, can be used in improving the soil's physical, chemical and biological properties. It is helpful in the nutrient enrichment in crops. Currently, the use of chemical fertilizers and pesticides is being done at high levels to meet the growing demand for food according to the growing population. The use of synthetic chemical fertilizer is responsible for the pathological condition in human and animals. To overcome this problem, nowadays biofertilizer is being used instead of chemical fertilizer. Biofertilizer is supposed to be a safe alternative to chemical fertilizer to minimize the ecological disturbance. This review explores the possibility of using fly ash as a supplement to biofertilizer to improve the soil, environment and enhance the growth & yield of plants.

Keyword: Biofertilizer; Cyanobacteria; Fly ash (FA).

Introduction

There are about 125 thermal coal – fired power plants in India for electricity generation. the major. Pulverized coal is used as a fuel source for generating power in thermal power plants which can be anthracite, bituminous or lignite type. Coal contains high ash content. Residue of coal combustion comprises of both bottom ash and fly ash. Being light the ash that enters flue gas stream in combustion set up is known as fly ash (FA). This fly ash is produced as a by-product of coal combustion in coal – fired power plants. The fly ash production is increasing every year. The current production of fly ash is about 176 Million tons[1].

Year Description	2011-12	2012-13	2013-14	2014-15	2015-16
Flyash generation (Million tons)	145.42	163.56	172.87	184.14	176.14

Fig. 1a Flyash Generation Report

Physico-chemical properties of fly ash-

Fly ash production depends on the quality of the coal, which contains a relatively high production of ash that leads to 10-30% fly ash formation[2]. The mineralogy and specific properties of fly ash depends on the nature

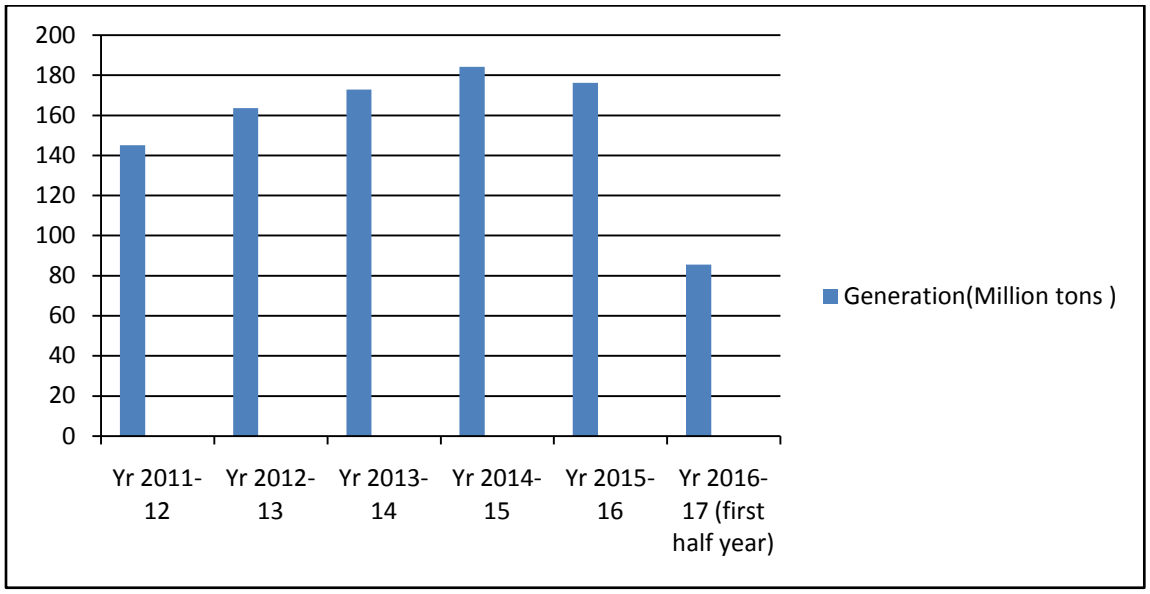


Fig. 1.b Graphic representation for flyash generation

Fig. 2. A Thermal Power Plant

of parental coal used for combustion and conditions of combustion[3]. Physically, fly ash is comprised of very fine glass-like particles that are 0.01–100 mm in size [4,5.] These fly ash particles have specific gravities of 2.1–2.6 gm^3, low to medium bulk density, a large surface area, very light texture and 50-60% porosity [6,7]. Chemically,90-99% of fly ash is composed of silicon-Si, aluminium-Al, iron-Fe,

calcium-Ca, magnessium-Mg, sodium-Na and potassium-K with Si and Al forming the major matrix[3,7].

Fig. 3. Flyash sample

Fly ash contains both major and trace elements. The fly ash also contains a high concentration of toxic heavy metals such as copper-Cu, zinc-Zn, cadmium-Cd, lead-Pb, nickel-Ni, chromium-Cr etc.[8,9,10] .The pH ranged from 4.5 to12.0 depending on the Sulphur content of parent coal[11,12]. Flyash consists of SiO_2 (49–67%), Al_2O_3 (16–29%), Fe_2O_3 (4–10%), CaO (1–4%), MgO (0.2–2%), and SO_3 (0.1–2%). [13,14] FA consists of all the elements similar to soil except nitrogen-N and with negligible organic carbon[7] . Therefore, except Nitrogen, all important metals essential for plant growth and metabolism are present in flyash. The reason FA lacks any or much N is because it is volatilized from the coal[15].

Uses of FA

Though the beneficial use of fly ash has been recognized in various areas like in concrete cement industry, construction of road embankments and manufacture of bricks and soil stabilization treatment[16]. Fly-ash, having both the soil amending and nutrient-enriching properties, is helpful in improving crop growth and yield in low fertility acidic lateritic soil in agriculture. A gradual increase in fly ash concentration in the normal field soil (0,10,20 up to 100%v/v) was reported to increase the porosity and water holding capacity[17]. Similar elements of soil are found in flyash with lack of nitrogen. To meet the shortage of nitrogen, biofertilizer is mixed with fly ash in the soil.

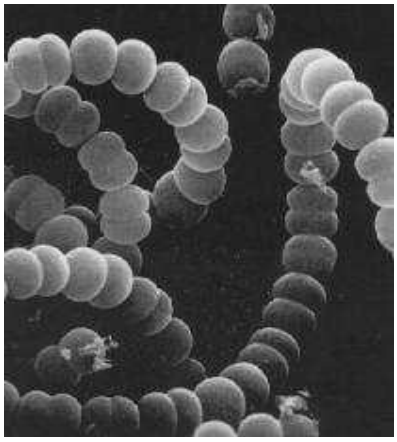
Potential use of FA with Biofertilizer

Biofertilizers are preparations containing efficient strains of micro organisms that help uptake of nutrients by crop plants when applied to soil. When biofertilizer is applied to seeds, a plant surface, or soil, colonizes the rhizosphere or the interior of the plant and then biofertilizer promotes growth by increasing the supply or availability of primary nutrients to the host plant. Bio-fertilizers add nutrients through the natural processes of nitrogen fixation, solubilizing phosphorus and stimulating plant growth. The microorganisms in bio-fertilizers restore the soil's natural nutrient cycle and build soil organic matter. Biofertilizers neither pollute the soil nor disrupt the ecological balance, and hence are environment-friendly. The micro-organisms which act as bio-fertilizers are bacteria like *Rhizobium, Azotobacter, Azospirillium*, and Cyanobacteria such as *Anabaena, Nostoc, Plectonema* etc.

Some researchers have used bacteria, fungi, and Cyanobacteria as biofertilizer on different plants which has a very good result on the productivity of crops. Cyanobacteria are more used as biofertilizer because it taps the sun’s energy captured during photosynthesis to fix nitrogen from the air and turn it into a form which plants can use. Cyanobacteria are ubiquitous, primitive and photosynthetic micro-oraganisms which can easily survive on bare minimum requirement light, CO_2 and water[18] .They are quite small and usually unicellular, though they often

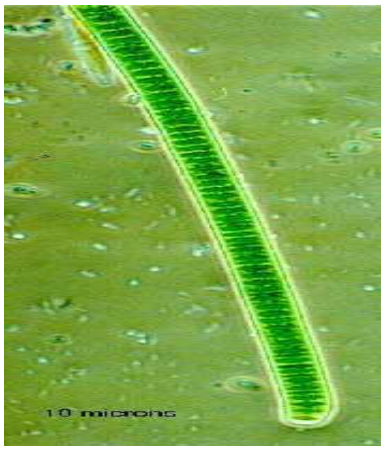
grow in colonies. Cyanobacteria are also known as blue-green algae. Blue-green algae or Cyanobacteria are free-living and prokaryotic organisms which can fix nitrogen asymbiotically but some Cyanobacteria are known to form symbiotic associations. The nitrogen fixation in Cyanobacteria occurs in specialized structures called heterocysts with the help of nitrogenase.

Beggiatoa alba

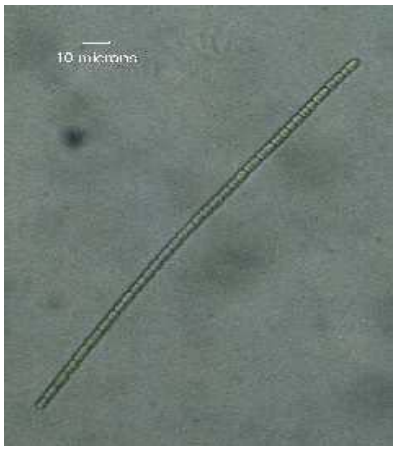


Anabaena flos-aquae

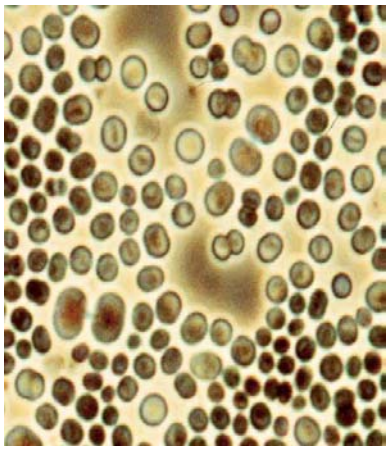
Nostoc species



Phormidium uncinatum



Cylindrospermum muscicola



Microcystis

Fig. 3. Microphotographs of some genera of Cyanobacteria.
(Source[19]: http://www-cyanosite.bio.purdue.edu/image html)

Researchers covered the valuable role of fly ash as a supplement to biofertilizer in development of sustainable agriculture and environment. Soil amended with fly ash increases the water holding capacity of soil. Biofertilizers mixed with flyash can be recommended for the sake of achieving the higher quality production. Cyanobacterial biofertilizer also helps in the stabilization of soil, add organic matter, release growth promoting substances and improve the physiochemical properties of

soil by solubilizing the insoluble phosphate. There is considerable potential in agriculture due to modification by the fly ash in soil health[7]. Flyash increases the height of plants, metabolic rate and photosynthetic pigment in maize and soybean crops[20]. Beneficial effects of cyanobacterial inoculation were also reported on a number of other crops such as barley, oats, tomato, radish, cotton, sugarcane, maize, chili and lettuce[21]. Fly ash with its amendments like soil, wood mulch and leaf mulch have a positive effect on a plant like *Brassica juncea* and *Zea mays.* Both plants germinate well in wood mulch amended with fly ash, but soil amended with 90% soil and 10% fly ash produce taller plants, greater mass, more pods and more leaves and increased soil fertility[22] .

The different physio-chemical properties silt-sized particles, low bulk density (BD), higher water holding capacity (WHC), favorable pH presence of plant nutrients in fly ash, make it a prospective amendment of soils. Fly Ash application improves the physical, chemical and biological qualities[23]. Fly ash-based bio-fertilizer and bio-pesticide formulation show slightly better result compared to a routine lignite formulation because fly ash improves the plant water and nutrient uptake protect the soil from borne disease and detoxifies contaminated soil[24]. When fly ash is added in B, Mo and Se deficient soils, it acts as an excellent source of these elements. Fly ash could be a source of a plant nutrient and it could be in use in any agricultural soil for production of crops. Fly ash could be applied safely to tropical agro eco-systems for retaining productivity of the acid laterite soil[25]. Lee *et al*.,[9] have reported that the application of fly ash increased Si, P and K uptake in the rice plants (*Oryza sativa*). Kumpiene *et al*.,[26] reported that Cu and Pb

mobility and bioavailability in the soil can be lowered by the addition of coal fly ash and natural organic matter (peat), which may increase seed germination rate, reduce metal accumulation in plant shoots, and decrease toxicity to plants.

Pandey *et al.,*[27] have reported phytodiversity on flyash *Typha latifolia* L., *Cynodon dactylon* L., *Saccharum spontaneum* L., *Saccharum bengalense* Retz. (Syn. *Saccharum munja*), *Prosopis juliflora* (Sw.), *Ipomoea carnea* and *Acacia nelotica* L. are identified as potential plant species for fly ash deposits restoration. The addition of fly ash at lower doses also improves physical, chemical and biological properties of soil and enhances the growth of a number of plants[5].

Conclusion

Besides being an industrial by-product and being used in cement industry, fly ash can also be used as amended with soil along with fertilizers in different crops when used with some biological component. Fly ash cannot be used as a substitute to soil but FA when amended with soil, increases the pH and water holding capacity of soil. To minimize the disposal of FA and maintain the ecosystem, a combination of FA, soil and biofertilizer can have positive effect on the productivity of the soil & crops. In addition to the crops as discussed above, the possibility of flyash to be used with some other mocots and dicots can also be explored to meet the rising demands for food.

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