

# USE OF FLY ASH IN AGRICULTURE: REVIEW PAPER

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**Abstract** - FA is the by product which is obtained from the thermal power plants by the combustion of coal which is in pulverized form after the combustion of coal. At the first the duo rocks, clay and vegetation contain varietal inorganic issues. FA plays a significant role in agriculture, because it has unique physical and chemical properties. It contains almost all the essential nutrients which are beneficial for plant growth and development. In the sector of agriculture, for buffering of the soil pH particular amendment is used which is known as fly ash. Fly ash is the residual component of thermal power plants and it remains stored in ash ponds where it leads to undesirable environment. In recent scenario the main objective is to make use of the fly ash in the agriculture sector and to find out its effect on the health of the soil. The main aim is to recognize the effect of this amendment on the physico chemical, biochemical, properties of the soil and what are the changes produced by fly ash on the productivity of agricultural sector. This investigation should be beneficial for various health organizations in mitigating the contamination which results from solid waste contamination.

**Key Words:** Fly ash, waste management, agriculture, nutrients and environment.

## 1. INTRODUCTION

**Fly ash (FA):** FA is the by product which is obtained from the thermal power plants by the combustion of coal which is in pulverized form. There is a chamber called as dust collection system which separates the FA as particulate residue from the gases that are later discharged into the atmosphere. The particles of FA are mostly spherical in nature and their diameter (<1 to 150 micrometer). According to the recent data 100,000 megawatt is the electricity production capacity of India and 73% is the generated through thermal power plants. Indian coal reserve accounts up to 180 billion metric tons. This rich source is used as a raw material by 88% of the thermal power plants. From all the power generation model of our country 85 units are dependent on the natural resource coal. The Indian coal has calorific value range of 2800-4200 Kcal/kg and is abundant in the FA 35 to 50%. The main and the fundamental motive of the mission were the safe and nontoxic consumption and disposal of the coal ash. As by this strategy the thermal power plant must consume 20 % of FA within three years and in 15 years period it should be up to 100%. For the new established plants the guidelines are to achieve 30% consumption within three years and 100% only within 9 years. FA primary consumptions consist of making compact ridges and fills. Glogowski et al., (1992) considered the EPRI handbook and stated that in the northern region of

the united states 31 fills and 33 ridges were made using FA. Porbaha et al., (2000) calculated that in Japan FA was used as the source for the construction of landfills. FA has effectively contributed in the area of development of fills and ridges. In the sector of fills and for construction purposes FA has been accepted on a large scale. Vittal (2001) stated that pond ash has been used to construct embankment in India. IRC 2001 (working wing of government of India) has put further the idea of utilization of FA as building material for construction of roads. This is possible due to self-hardening nature of FA due to presence of lime by which it can be used for large scale construction.

### 1.1 Characteristics features of FA:

Ojha et al., (2004) founded that FA obtained as coal by product is enriched in SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> and a few amount of Fe<sub>2</sub>O<sub>3</sub> and also consist of Ca, Mg, and P and Ti oxides. Major components of ash are includes of crystalline quartz and mullite. Kumar et al., (2005). FA is the by product which is obtained from the thermal power plants by the combustion of coal which is in pulverized form after the combustion of coal. At the first the duo rocks, clay and vegetation contain varietal inorganic issues. Physically it occurred in particles of spherical nature ranging from few microns to 100 microns in diameter, having a low to medium bulk density and texture of sandy silt to sandy loam. Chemically the FA is an amorphous ferroaluminosilicate mineral with major elements like Si, Al and Fe and good amount of Ca, Mg, P, K and S. The physio-chemical properties which are trace/heavy metals and radioactivity along with the texture acquaint with most of filed soils. Kumar *et al.*, (2005) separately conducted that FA enriches in macro and micro vitamins and all the mineral of coal after combustion resides in the ash. This potential has the ability to alter the physical properties of the soil also will act as good soil conditioner. Aggarwal *et al.*, (2009) found that bulk density (B.D) of FA once was 1.01Mg/m<sup>3</sup> the organic carbon amounts to 0.36 and WHC was 56%. Although, the pH and EC ranges should be varied 6.98 and 0.65 dS/m respectively. Rai *et al.*, (2011) calculated B.D is one of the most important parameter for vegetation. BD decreases with the multiplied greatly of manure usage. The BD ranges from 0.92 to 0.94 g cm<sup>3</sup>. WHC of the FA assorted from 73.3 - 75.8 % through 74.7% as intersection value. The percentage of sand, silt, clay ranges from 63 to 66.2, 31.7 to 36, and 0.2 to 1.1 respectively, in the observed samples. FA composition varies with the coal sample. Das *et al.*, (2011) investigated that FA and pond ash sample of Kathara contains large amount of trace metals as Fe, Ni, Mn, Cu, Zn, N and Pb. The amount of available phosphorus was negligible in both the samples. The Fe

content in both the sample was high in FA it was 8.831 ppm and in pond ash it was 8.768 ppm. Kumar and Patra (2012) found that pH of FA once was 8.98. It consists of 1.06% of carbon, 0.04% Nitrogen and 0.15% of Phosphorous. Also calculated heavy metals (Zn, Ni, Cd, Cu, Mn, Cr, Fe and Pb) are present in more amounts as compared to soil. The basicity of FA is due to Na, Mg, OH ions along with various trace metals. FA enriches in heavy metals (Zn, Fe, Ni, Mn, Pb, Cu, Cr, B, Al, and Si) in addition to many more. This ion adds up to the higher electrical conductivity of the FA. Vitekari *et al.*, (2012) stated that FA has another name coal combustion product (CCP) is the finely divided by product of pulverized coal in electrical generating crops. A FA component depends upon the source and type of coal being used. In general all the FA consist of both crystal and amorphous form of silicon oxide and calcium oxide each being integral part of coal bearing strata.

## 2. Effect of FA on physicochemical properties of soil

A number of experiments have been conducted in various part of the country which states the application of FA for agriculture purposes. For estimate the physical properties of soil such as soil texture, structure, consistency, temperature, colour, B.D, particle density, pore space and WHC many experiment were done at global level. The physical properties of soil depend on the amount, size, shape, arrangement and mineral composition of its particle, kind and amount of organic matter and the volume and form of its pores and the way they are occupied by water, air at a particular time. FA application is enhancing the yield and productivity and increment has come in the amount of moisture and land fertility. Chang *et al.*, (1977) stated if the FA is incorporated in soil the B.D will be lowered which will enhance the two important properties such as WHC and hydraulic capability. In general many properties varies along with time on addition of 25-50% FA improved the B.D adding more reduced it. Experiments conducted by Sale *et al.*, (1996) studied that most of cases B.D was reduced. The further studies revealed that there are more important parameters which differentiate in FA and mine soil plots. The soil of mine plots has more B.D (1.25-1.45) g/cm<sup>3</sup> and contrary to this low porosity (38 to 46%) when compared to FA plots. Gorman *et al.*, (2000) particle density and B.D can be minimized by application of FA and increment can be done in both WHC as well as porosity. Soyabean plants showed better growth and yield in rainy period (Thakare *et al.*, 2014) as on addition of FA there was decrease in B.D which affected the porosity and there was an increment in both macro and micro pores of soil. There is an increase in WHC of soil with increment in pore space and reverse is also true examined by Yeledhali *et al.*, (2008). By the application of pond ash at the rate of 40t/ha the WHC changed from 64 to 67.5. The physio-chemical properties of soil were marginally altered by fly and pond ash. The FA has greater alkaline capacity and lower WHC as compared to pond ash which make it usage less efficient when compared to pond ash. Not restricted to WHC as a parameter for good crop production but it also provide good aeration and drainage

excess water which are consider as physical properties of fine textured soil. The clay soils having the fine texture and poor infiltration rate may become the reason of water logging conditions and also reduces the biological activity of the soil. Water logging conditions can be overcome in clay soil by application of FA and contrary to this WHC of sandy soil is enhanced by application of FA determined by Dhindsa *et al.*, (2016). FA has excellent potentiality in agriculture because of its efficiency in change soil health and crop performance. But numerous studies proposed that FA may be used as a soil ameliorate that may enhance the physical, chemical and biological properties of the degraded soils and is a source of readily available plant macro and micro nutrient. The excessive concentration of macro and micro elements in FA increases the yield of many agricultural crops. According to the USDA textural class, application of FA @200 tonnes per hectare enhanced the physical properties of soil and changing the textural class from sandy loam to silt loam Sahu *et al.*, (2017). Generally FA is a coal combustion residue of thermal power plants that has been appeared as a problematic solid waste all around the world. Disposal of high amounts of FA from thermal power plants absorb large amount of water, energy and land area through ash ponds. In India total 80% of power production covers by thermal power plants and these coal combustion produces lots of by product and disposal is a grow to be unsolved problem. Proper disposal or its utilization for alternate purpose specific method should be observed. Various studies had been proven that FA can be used as a good soil modification as it contains essential macro and micro nutrients. In the present study different type of physicochemical characters are determined such as B.D, particle density, porosity, water holding capacity, pH, total dissolved salts, electrical conductivity were studied under the effect of coal FA having distinct ranges of coal FA taken in this experiment 0%(Control), 5%, 10%, 15%, 20%, 30%, 50%, 75%, 100% and explores the ability of FA can be used as amelioration agent for agricultural purposes. The study of FA can be effectively used as soil amendment and fertilizers resulting in enhance the soil fertility. Their usage also solves the dumping problem of FA and also helps in planning future strategies for its utilizations (Mishra *et al.*, 2017).

Chemical properties of soils include inorganic matters of soil, organic matters of soil, colloidal properties of soil particles, soil reactions and buffering action, acidic soils, basic soils which can be directly and indirectly affected by application of FA and other organic and inorganic amendments. Chemical nature of FA depends on parent material of FA used for combustion. Application of basic nature of FA is invariable increase the level of pH in soil. Use of 30% FA drastically change the level of pH from higher level to lower level as compare to control (Sharma and Kalra, 2006). Invigoration of soil with fresh FA is more effective on soil pH for increasing alkalinity and for achieving more plant growth and development as compare to dump one from long time. Mainly the physicochemical and mineralogical properties of FA range depending on the source of coal and thermal plant. FA contains lots of elements which can be observed in earth

crust such as ferroaluminosilicate mineral (Bhaisare *et al.*, 1999) and used as a soil amendment (Adriano *et al.*, 1980) includes supplementary sources of Ca, Mg, K, Na and other trace elements to soil carried by (Fisher *et al.*, 1978). The physical, chemical and biological properties of the degraded soils can be improved by the addition of FA as an amendment. FA is one of the major sources of easily available macro and micro plant nutrients. As the FA can enhance the health of soil along with the positive crop response it has a major role in the field of agriculture examined by Kishor *et al.*, (2009). The combustion of coal in the thermal power plants produces a residue called FA which is rich in minerals and vitamins like calcium, magnesium, sodium, potassium, and sulphur along with the heavy metals which include boron, mercury, lead, chromium, cadmium and arsenic etc.

### 3. Effect of FA on biological properties of soil

Various experiments stated that by incorporating the FA in the soil altered the micro-organism properties. When the FA was added in the soil it was observed that the process of nitrification and the respiration of microbes were hindered in soil having sandy and silt type texture. The FA is rich in the toxic elements which decreased the microfloral population of fungi, bacteria and Actinomycete and also hindered the enzymatic activities namely dehydrogenase, phosphates, sulphatase and invertase. When a combination of FA was used with the organic matter it reduced the nutrient level and also slows down the natural process of the decomposition. The overall respiration activity was enhanced by the application of FA at the rate of 112.5 and 225 t/ha in the experiment conducted in the soil of Gulawathi and Muthani respectively (Sharma and Kalra, 2006). In the case of sandy soil when non-weathered FA was applied it restricted the major activities of the soil such as mineralization, nitrification, enzymatic activity and respiration of the microbes. These results were mainly due to FA having more concentration of trace elements and soluble salts. Some of the enzymatic activities namely amylase, invertase, protease and dehydrogenase got enhanced as the dose of FA got increased up to a level of 10 t ha<sup>-1</sup> but on further increase of their doses of FA these activities were hindered. The application of the FA did not mark a particular effect on the Catalase activities. In the case of acidic soil when a combination of FA and earthworm was used in lower concentration it enhances the biological activity of the soil and also improves cycling of soil nutrients. If FA and soil mixture is incorporated along with the sludge there was a boost in the enzymatic activities Sahu *et al.*, (2017). During the natural process of leaching the amount of the trace element along with the soluble salt got reduced due to weathering of the FA. A study stated that there was a reduction in the microbial population of bacteria, fungi, Actinomycete by 57, 86, 80% respectively by the application of 20% of FA. The enzymatic activities like dehydrogenase, amylase, invertase and protease were enhanced by the use of FA at the rate of 15 t ha<sup>-1</sup> but the same got reduced by the further application of FA. A better compost mixture was

obtained when FA was composted for 90 days along with straw of wheat and rock phosphate 2%. The physical and chemical properties of soil can be enhanced by the application of FA stated by Vitekari *et al.*, (2012). The soil microbial population, amount of nutrient and the soil enzyme activity was increased by the use of FA. The usage of coal FA which was graded with or without the application of recommended dose of fertilizer enhanced the macro and micronutrient status along with the organic carbon content of the soil. The concentration of fungi was decreased while there was an increase in the bacterial and Actinomycete. The additional use of NPK fertilizers enhanced the alkaline phosphate activity along with an increase in the number of microbes and Actinomycete. When the graded FA was used the microbiological balance got disturbed along with the enzymatic activity and the Alfisol type of soil was amended and there was an increase in the content of nutrients like N, P, K, S, Ca, Mg, Zn and Cu by Yeledhali *et al.*, (2007). The crop productivity as well as the soil quality was improved by the application of FA. The properties which make the FA a good soil amendment include particles of silt size, lesser bulk density, good water holding capacity, presence of micro and macro nutrients along with the favorable pH. The study revealed the various applications of FA which enhance the wasteland, mined soils, landfills and the cultivable land. It also stated that agriculture and forestry can be also practiced on the abandoned FA ponds. The application of FA as an amendment enhances the physical, chemical and biological properties of the soil. A study stated that the release of the soluble salts and the trace elements from the FA can be manipulated as per the need. The usage of the FA as an amendment depends upon its restoration, phytoremediation and a source of economic fertilizer for agriculture purpose (Pankaj kumar and khusboo chaudhary 2015).

### 4. CONCLUSIONS

FA plays a significant role in agriculture, because it has unique physical and chemical properties. It contains almost all the essential nutrients which are beneficial for plant growth and development. The inclusion of FA improves the soil physical and chemical properties such as soil texture, WHC, increasing buffering capacity, soil aeration, percolation, and water retention capacity, optimizes pH value, reduces macro and micro nutrients, reduces mobility and availability of heavy metals and has insecticidal properties as well. Also it increases soil quality and the crop yield. In spite of that the amount and method of FA depends upon its type of crops, climatic conditions and the properties of fly ash. While FA utilization in agriculture has many advantages and disadvantages. The major factor is that FA contains toxic elements (heavy metals, radioactive isotopes) and large amounts of dissolved salts. It can be leached from FA. Leaching can cause soil and water salinity, increase of heavy metals mobility and availability and their accumulation in plants. Most of the FA soil treatment studies proved that amelioration of FA affects the microbial properties of the soil. Because soil microbes are adversely affected while using an excessive level of the amendments,

usually with the application of alkaline FA. On the other hand physiological and biological properties enhanced growth and yield in crop plants due to application of FA. Biochemical constituents in plants had both positive and negative impact, because of FA application. In soil we are applying different types of fertilizer like organic and inorganic fertilizer. In case of organic amendments include compost which can enhance soil fertility and biochemical properties. However, household composts amendments significantly high microbial biomass C and N. In this review we are briefly summarizing soil physical, chemical, biological, properties playing a very important role for enhancing soil quality and crop yield.

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