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# VALUE ADDITION TO FLY-ASH THROUGH BLUE-GREEN ALGAL INOCULANTS AND ITS EFFECT ON GROWTH AND FLOWER IN *Polyanthes tuberosa*

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## ABSTRACT

Management of fly-ash, a major environmental concern, involves disposing it in huge amounts near thermal power plants in settling ponds or landfill dykes. Nearly 70% of the total amount of residue generated during combustion of coal thermal power plants constitutes the fly-ash. Fly-ash is a potential source of many macro and micro elements to the plants including many toxic metals. Heavy metal contents of fly-ash are widespread pollutants of great environmental concern, as they are non-degradable and thus persistent. Cyanobacteria offer the advantages of having a high percentage of cell wall material which shows excellent metal binding properties. Use of algalization techniques have been utilized as an ideal alternate for decontaminations of metals.

Fly-ash from NALCO captive power plant, Anugul, Odisha( India) was used to reclaim fly-ash using Cyanobacteria, *Lyngbya semiplana* . For the study of their effects on growth dynamics and flowering responses of *polyanthes tuberosa.*Different concentration ( 5,10,20, 30, 40 and 50 %) of fly-ash and reclaimed fly-ash was used and their effect on plant growth parameters (% of germination, shoot and root length, root weight and shoot weight, leaf length and leaf width, plant height, chlorophyll a and b and flowering responses were studied.

Results showed potential of treated fly-ash in enhancing the growth, dynamic and flowering responses of *polyanthes tuberosa*

**Keywords: Algalization technique, Fly ash, Floriculture, *polyanthes tuberosa*, *Lyngbya semiplana***

## INTRODUCTION

Thermal power emission constitutes a major source of environmental pollution. Nearly 70% of the total amount of residue generated during combustion of coal in thermal power plants constitutes the fly-ash. The use of fly-ash as a source of macro and micronutrients ( Mishra and Shukla, 1986; Plank 1974; Andoyumpei et al 1986; Sims et al , 1995, Majumdar and Mukharjee 1983; Kumar et al, 2000; Haynes RJ, 2009; Behera et al , 2014) has great potential in development of floriculture. However, non-judicious application of fly-ash to soil deteriorates soil quality as well as depresses crop growth. Fly-ash contains almost all the essential plant nutrients but it is deficient in nitrogen and available phosphorus.

Heavy metal contents of fly-ash are widespread pollutants of great environmental concern as they are non-degradable and thus persistent. They are harmful for soil-microorganism ( Pitchel and Hays , 1990 ; Pitchel , 1990) which are beneficial for maintaining soil fertility in agricultural lands. Looking in to the increased environmental concern, treatments of fly-ash is of utmost important. Use of algalization techniques in the field of bio-sorption capacity of metals by some cyanobacteria suggestible an ideal alternate for decontamination of metal present in fly-ash. Among the trace metals Cu, and Zn are micronutrients (Ulysses 1979; Dinaurled 1972) useful for the healthy growth of plants and animals. Co is also regarded as essential element for animal’s health ( Trivedy and Goel, 1986) while As and Pb are regarded as phytotoxic metals. ( Dijkshoorn et al, 1979) and injurious for animals ( Underwood, 1971).

Therefore an approach that utilizes blue green algal inoculation for reclaiming fly-ash has been under taken as a eco-friendly and cost effective procedure for reclamation of fly-ash and application in a sustainable manners.

Floriculture is the sunshine industry of India as it offers excellent self employment and good remuneration for the small and marginal farmers. The world annual growth rate for this industry is 8% to 10% p.a. there are more than 120 countries who are active floriculture production on large scale, the world floriculture trade is characterized by a high degree of concentration by product and sources.

Fly-ash fine particles owing to their sufficiently small size ( ranging from 0.02 µm to over 300 µm ) and light weight get carried out via the flue gas from boiler chimneys ( Roy et al., 1981 ; Prakash et al., 2001). Use of high ash containing (30-50%) bituminous or sub-bituminus coal in thermal power stations, in addition to several captive power plants, contributes to indiscriminate disposal of this industrial waste every year (Jamwal N., 2003;Garg et al., 2005). The utility of fly-ash as a soil amendment has been so far tested for *Helianthus annus*( Pandey et al., 1994), *Lycopersicon esculentum* ( Khan et al., 1996), *Beta vulgaris*, *Trticum aestivum L., Esculentamoench, Oryza sativa* L. And Zea mays L. ( Kalra et al., 1997), *Cassia siamea*( Tripathi et al., 2005), *Prosopis juliflora* (Rai et al., 2004).

## MATERIALS AND METHODS

Fly-ash was collected in gunny bags from NALCO Captive power plant Anugul situated about 139 km. from Bhubaneswar. They are brought to the CES laboratory. The soil for experimental work was collected from agricultural field up to a depth of 20 cm after removing the surface litters. The soil was steam sterilized at 25 lb for 25 minutes in aautoclave. The autoclaved soil was dried and then mixed with both fly-ash and reclaimed fly-ash in different ratio.

The seed bulbs of *polyanthes tuberosa* sterilized in 0.01% $HgCl_2$ for 20 minutes were sown in 50×50 cm cement pots containing only sterilized soil and different proportion of fly-ash and reclaimed fly-ash. For the experiments fly-ash/reclaimed fly-ash (as carrier material of *Lyngbya semiplana* were mixed with autoclaved soil to obtain following levels (w/w).

F1 = Control = only autoclaved soil

F2 = 5% fly-ash (FA)/ Reclaimed fly (TFA)-ash + 95% autoclaved soil

F3 = 10% fly-ash (FA)/ Reclaimed fly (TFA)-ash + 90% autoclaved soil

F4 = 20% fly-ash (FA)/ Reclaimed fly (TFA)-ash + 80% autoclaved soil

F5 = 30% fly-ash (FA)/ Reclaimed fly (TFA)-ash + 70% autoclaved soil

F6 = 40% fly-ash (FA)/ Reclaimed fly (TFA)-ash + 60% autoclaved soil

F7 = 50% fly-ash (FA)/ Reclaimed fly (TFA)-ash + 50% autoclaved soil

The reclaimed fly-ash was prepared by mixing dried blue green algae (*Lyngbya semiplana* .) with fly-ash in the proportions of 1:9 (w/w).

## RESULTS

The effect of fly-ash &treated fly-ash on germination, shoot length and root tube length of *P.tuberosa*(30 days) was presented (**Table-1**). Each value represents the average of five individuals. The percentage of germination significantly increased than the control with increase in concentration of fly-ash up to 30% beyond that it gradually decreases. In case of treated fly ash the germination gradually increases at all fly ash combinations as compared to control set. Among fly-ash treated plants maximum germination was obtained (94±2.5%) with 20% and in treated fly ash maximum being (99±2.8%) at50%. The effect of fly-ash &treated fly-ash on shoot length and root length of *P.tuberosa* (30 days) was presented. The growth parameters significantly increased than the control with increase in concentration of fly-ash up to 20% beyond that it gradually decreases. In case of treated fly ash the germination gradually increases at all fly ash combinations as compared to control set. Among fly-ash treated plants maximum shoot length was obtained (48.5±3.5 cm) with 20% and in treated fly ash maximum being (60.5±5.4cm) at50%. Similarly in case of root tuber length fly-ash treated plants maximum root tuber length was obtained (9.94±3.31) with 20% and in treated fly-ash maximum being (13.3±4.7) at 50%.

Fig 1 shows effect of treated fly-ash on leaf length of *P.tuberosa* in 30 days. The growth of leaf length significantly increased than the control with increase in concentration. The growth in control, 5, 10, 20, 30, 40 and 50 % treated fly-ash were 32, 34.86, 38.45, 46.38, 49.21, 50.91 and 53.44.

Fig 2 shows effect of treated fly-ash on leaf width of *P.tuberosa* in 30 days observation. The growth of leaf width increased with the increase in concentration. The growth in control, 5, 10, 20, 30, 40 and 50 % treated fly-ash were 1.3, 1.5, 2.1, 2.2, 2.36, 2.55 and 2.91.

Fig 3 shows effect of treated fly-ash on shoot weight of *P.tuberosa* in 30 days observation. The growth of shoot weight increased with the increase in concentration. The growth in control, 5, 10, 20, 30, 40 and 50 % treated fly-ash were 206,220, 238, 246, 285.46, 310.68, and 384.56 mg respectively.

Fig 4 shows effect of treated fly-ash on root weight of *P.tuberosa* in 30 days observation. The growth of root weight increased with the increase in concentration. The growth in control, 5, 10, 20, 30, 40 and 50 % treated fly-ash were 52,58.46, 65.18, 72.21, 78.02, 81.85, and 85.28 mg respectively.

Fig 5 shows effect of treated fly-ash on plant height of *P.tuberosa* in 30 days observation. The growth of plant height increased with the increase in concentration. The growth in control, 5, 10, 20, 30, 40 and 50 % treated fly-ash were

38.4, 41.6, 48.61, 54.68, 58.54, 61.21, and 72.45 cm respectively.

Fig 6 represents effect of flowering on *P.tuberosa*. Time taken to flowering was decreased with the increased in concentration. The flowering in control, 5, 10, 20, 30, 40 and 50 % treated fly-ash were 145,120, 118, 100, 98, 96, and 95 days respectively. No. of flower per spike was increased with the increased in concentration. The no. of flower per spike in control, 5, 10, 20, 30, 40 and 50 % treated fly-ash were 42,52, 56, 60, 64, 68, and 72 in numbers respectively.

The effect of treated fly-ash on chlorophyll (a&b) of *P.tuberosa* was shown in fig. 7. The pigment parameters significantly increased than the control with increase in concentration of fly-ash. In control untreated plants maximum Chl-a was obtained 2.8 on 30 days of observation and in reclaimed plants maximum Chl-a was obtained 5.18 at 50%. In control untreated plants maximum Chl-b was obtained 1.5 on 30 days of observation and in reclaimed plants maximum Chl-b was obtained 2.40 at 50%.

**Table 1: Effect of fly-ash and treated fly-ash on germination, shoot length and root length in *P.tuberosa* (30 days)**

| Treatments % | % of germination | | Shoot length (cm) | | Root tuber(cm) | |
|---|---|---|---|---|---|---|
| | F.A | T.F.A | F.A | T.F.A | F.A | T.F.A |
| Control | 87±2.3 | 87±2.3 | 35±2.1 | 35±2.1 | 7.0±1.38 | 7.0±1.38 |
| 5 | 92±2.3 | 93±2.5 | 38.2±2.8 | 41.6±3.5 | 8.05±2.2 | 9.48±3.14 |
| 10 | 93±2.7 | 94±2.8 | 46.5±3.5 | 50.2±4.1 | 9.1±2.9 | 10.65±3.8 |
| 20 | 94±2.5 | 95±2.8 | 48.5±3.5 | 54.6±4.6 | 9.94±3.31 | 11.25±3.9 |
| 30 | 90±2.3 | 96±2.8 | 45.6±3.4 | 56.2±4.8 | 9.51±3.17 | 11.51±4.5 |
| 40 | 82±2.1 | 99±2.9 | 30.4±2.0 | 57.5±4.6 | 8.65±2.8 | 12.36±4.52 |
| 50 | 80±2.1 | 99±2.8 | 28.0±1.92 | 60.5±5.4 | 8.41±2.20 | 13.3±4.7 |

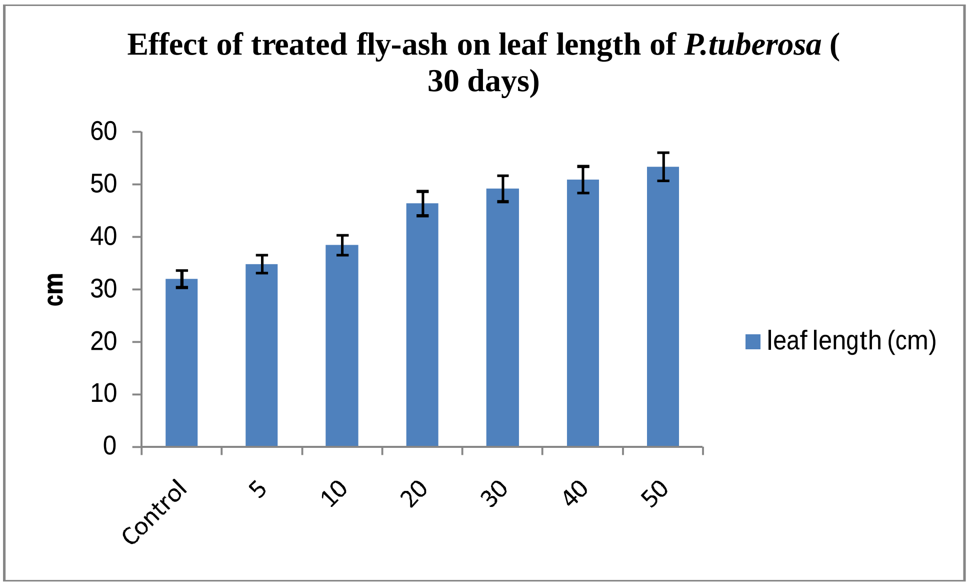


**Fig 1: Effect of treated fly-ash on leaf length of *P.tuberosa* in 30 days**

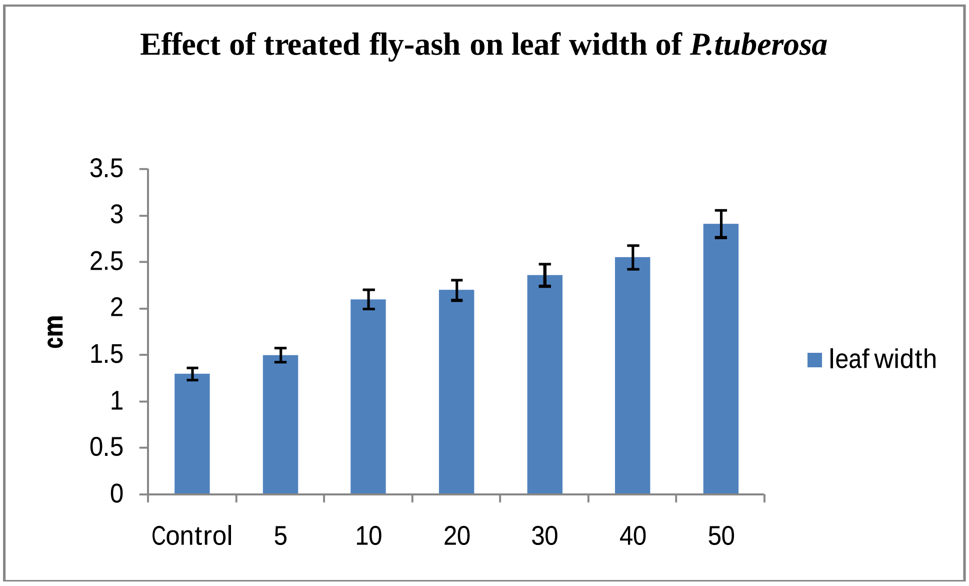


**Fig 2: Effect of treated fly-ash on leaf width of *P.tuberosa* in 30 days**

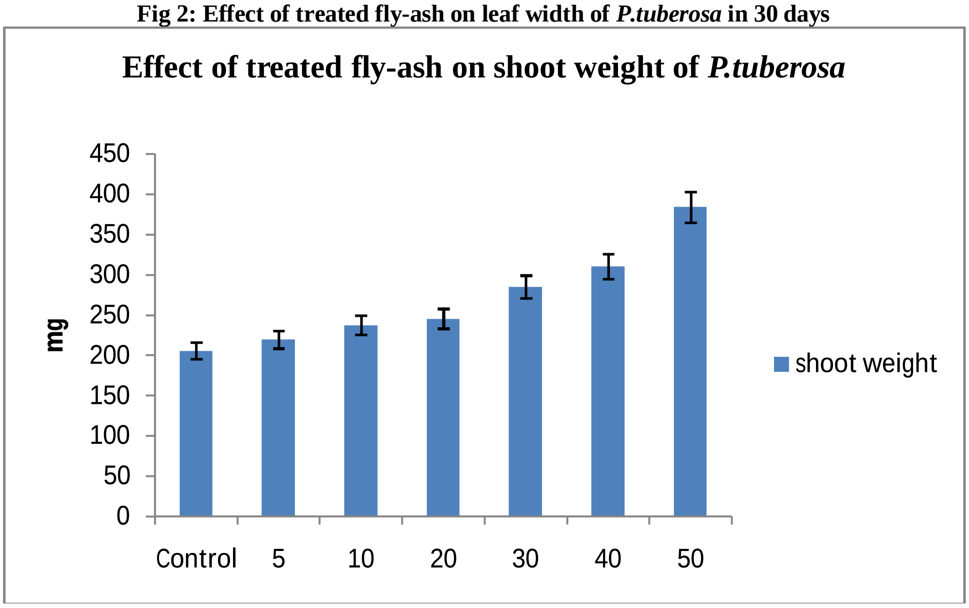


**Fig 3: Effect of treated fly-ash on shoot weight of *P.tuberosa* in 30 days**

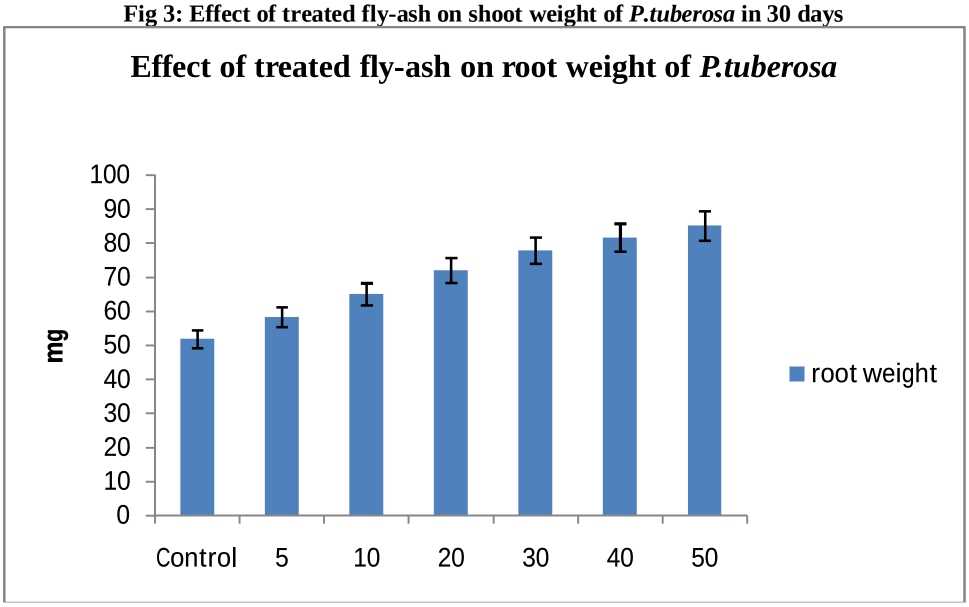


**Fig 4: Effect of treated fly-ash on root weight of *P.tuberosa* in 30 days**

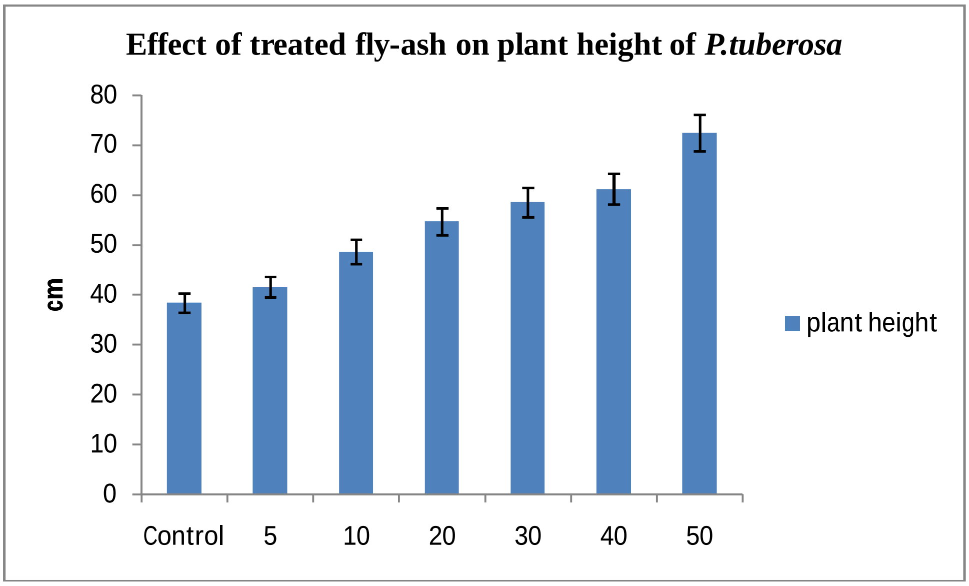


Fig 5: Effect of treated fly-ash on plant height of *P.tuberosa* in 30 days

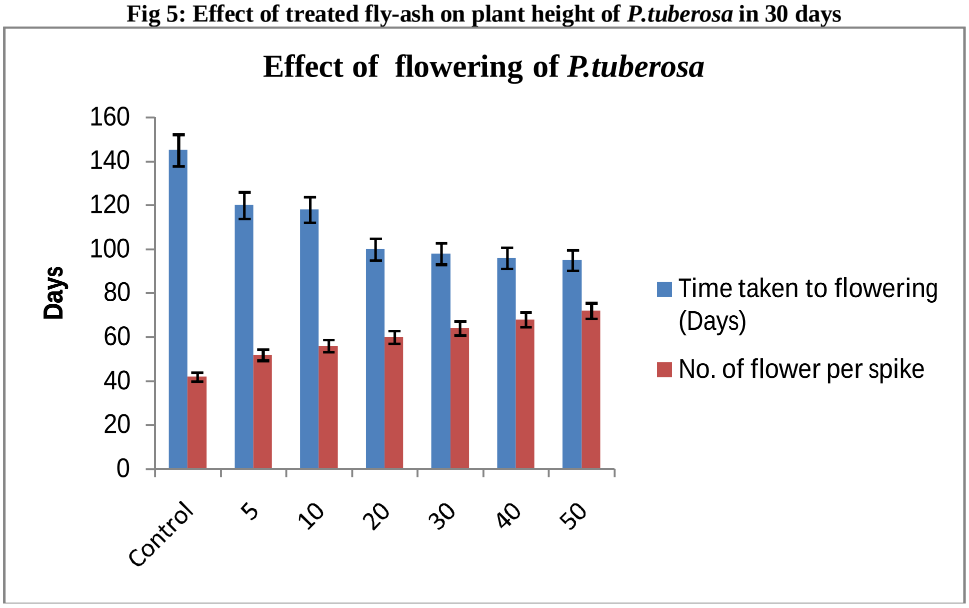


Fig 5: Effect of treated fly-ash on plant height of *P.tuberosa* in 30 days

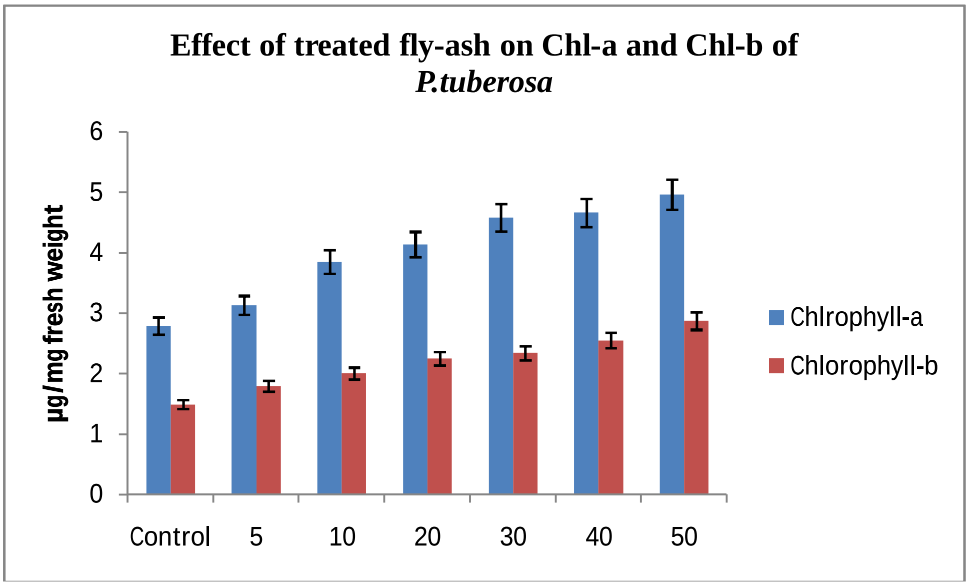


Fig 6: Represents effect of flowering on *P.tuberosa*

## DISCUSSION

All the parameters investigated using *lyngbya semiplana* a cyanobacterial isolates from the NALCO thermal power plant in the reclamation process have shown enhanced parameters than the control plants. The % of germination, morphological characteristics , flowering of *p. tuberosa* , chlorophyll contents growing in different concentrations of fly-ash and reclaimed fly-ash with *lyngbya semiplana* reveals an overall increasing response at 20% ( in normal fly-ash and up to 50% in reclaimed fly-ash. The results coincides with the findings of Niaz et al (2008) on *Eclipta alba* and others finding on different plants (Khan and Khan, 1996; Mishra and Shukla, 1986; Raghav and Khan, 2002, Singh 1989; Ram and Masto, 2010. The observation also coincides with the studies on *Helianthus annus* when reclaimed with seaweed liquid fertilizer (SLF) ( Ankita and Jeyoss, 2010) .

## CONCLUSION

Sustainable agriculture envisages use of less chemicals and more of organic inputs. The beneficial role of fly-ash in crop production and well documented. But the information on enhancing fly-ash with bio-fertilizers is measure, which was contemplated in this project. Hence the application of reclaimed fly-ash with *Lyngbya semiplana* at 50% level on *P.tuberosa* is an eco-friendly and cost-effective method, which can draw the attention of farmers for developing of floriculture in a cost effective way.

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