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Effect of Fly ash on Growth and Yield of Triticum aestivum L.

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Abstract

National thermal power plants utilize pulverized coal to produce electricity in India and other countries, where fly ash is a residue product after combustion of coil powder in boilers bottom. The generation of fly ash in India reached about 325 MT/Year in 2017 and currently in 2022-23 it reaches upto 500 MT/Year. If its huge amount not utilized properly then it would be cause of big land as well as air pollution. In present work it was observed that different ratio of fly ash with field soil enhance growth and yield in *Triticum aestivum* L. It was proved that use of fly ash as fertilizer with 75% soil ratio emerged as safe and yield gainer alternative of chemical fertilizers in previous studies. Fly ash addition in soil with different concentrations affects the chlorophyll contents in *Triticum aestivum* L. Present study helps in to understand that fly ash not only a kind of waste but it becomes effective manure for farming in present as well as in future .

Keywords: Chlorophyll, Fly ash, Manure, Seed germination, *Triticum aestivum* L.

Introduction

Fly ash is a waste product of NTPC power generation Plants which was considered as an air pollutant from last decade ago. Due to huge energy requirement, large population of India produces more than 70% electricity through coal combustion in NTPC Plants. Resulting India became 4th highest producer of fly ash on earth after Russia, America and China (Lokeshappa and Dikshit, 2011). So their disposal is a major concern for the environment. The huge amount of fly ash disposal completed by either wet slurry or wet process. For this purpose fly ash openly dumped on land areas and do air as well as water pollution which cause harmful affects to the food chain of related environment (Sharma SK , Kalra N, 2006). On the other hand presence of crystalline silica in fly ash produces harmful respiratory diseases to coal fired plants workers (Hicks and Yager, 2006). So the fly ashes considered as a problematic solid waste all over the world.

Although, fly ash is a particulate air pollutants but it contains various utilizable plant nutrient elements such as Ca, Mg, Fe, Zn, K, Mn, B etc (Adriano et l 1980). The response of plants to micro and macro nutrients in fly ash may vary from beneficial effects in small concentration to toxic effect in high concentrations of nutrient elements (Chang et al 1977). Many researches prove that fly ash become a future substitute of chemical fertilizer in agriculture.

So the present study was done for understand the effect of different concentrations of fly ash on the growth and yield of *Triticum aestivum* L. For this purpose seeds of *Triticum aestivum* L. have been examined under different concentrations of fly ash amended soil. Different plant parameters such as percent of seed germination, plant height

in terms of shoot and root length, fresh weight, dry weight, earring length and chlorophyll content along with crop yield have been analyzed.

Materials and method

Experimental site

Present agricultural work was conducted during Ravi season in the month of November 2019 to March 2020 near the field of Parichha Thermal Power Plant, Parichha away from 25 km from Jhansi through NH-27 as shown in the Fig-1. For the above mentioned purpose 6 field plots were prepared with 2×6 square feet area. After this 5 plots out of six were treated with different concentrations of fly ash such as 10% (T_1), 25% (T2), 50% (T3), 75% (T4) and 100% (T5) with total 10 kg weight of soil mixture and one plot was remain same and considered as control in which fly ash and soil were mixed by w/w. The seeds of *Triticum aestivum* L. have been procured from a certified seed center than every plot was sowed with 100 seeds of Wheat variety (WH-147 F_1) since 18 November 2019. Plants were observed daily and different growth parameters such as plant height, fresh and dry weight of shoot and leaves, chlorophyll amount and yield were measured at 30, 45, 60, 75, 90 and 120th days after sowing (fig 02).

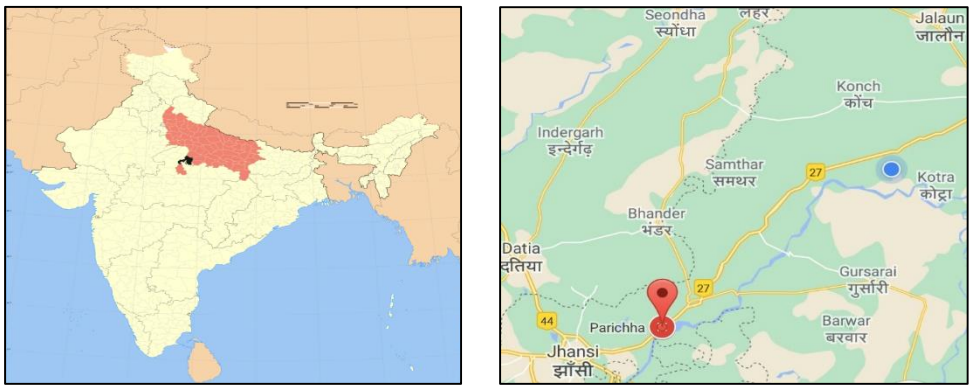

Fig-01: Map showing location of research area i.e. Parichha (Jhansi district) comes under Uttar Pradesh state of India.

Fig-02: Study site A, B and C represent different growth stages of *Triticum aestivum* L. crop with fly ash treated plots.

A. Seed germination

Germination percentage of seeds in each plot was recorded carefully after 15 days of sowing.

B. Plant height

Plant height was measured in terms of root and shoot length in cm at regular time intervals of 30 days, 45 days, 60 days, 75 days and 90 days.

C. Fresh weight and Dry weight

Freshly uprooted plants were washed thoroughly after that drying it with the help of filter paper and weigh the material on electronic balance in gm. Uprooted plant samples were kept at 80°C for 24 hours and then their weight has been recorded with electronic balance in gm for dry weight.

D. Estimation of chlorophyll amount

The chlorophyll pigment of plants leaves was assessed according to Arnon's (1949) method. For this purpose take 1gm of fresh leaves of wheat plants and crushed with the help of mortar and pestle and 10ml 80% acetone were added and then filtered with the help of whatmann no.1 filter paper. The extract was centrifuged at 5000 rpm for 5 minutes and the supernatants were collected. The absorbance was recorded at 645 and 663nm by using systronic UV-Visible spectrophotometer against 80% acetone.

Calculate the values for estimation of chlorophyll content-

Chl. a (mg/g tissue) $=12.7\ (A_{663}) - 2.69\ (A_{645}) \times \frac{V}{1000 \times W}$

Chl. b (mg/g tissue) $=22.9\ (A_{645}) - 4.68\ (A_{663}) \times \frac{V}{1000 \times W}$

Total chlorophyll (mg/g tissue) $= 20.2\ (A_{645}) + 8.02\ (A_{663}) \times \frac{V}{1000 \times W}$

Where,

V= Final volume of chlorophyll extract

A= Absorbance at specific wavelength

W= Fresh weight of leaves (tissue).

E. Length of wheat ear

Length of wheat ears was measured on different time intervals in terms of centimeters.

F. Crop yield

Crop yield was measured in terms of kg/sq feet from each treated plot including control.

Results and Discussion

A. Seed germination

The application of fly ash in agriculture resulted in higher germination rate because fly ash amended soil enhances water holding capacity and aeration as well as higher concentration of trace elements. Results presented in table 01 and fig. 03 showed that addition of fly ash enhances the seed germination percent. The maximum seed germination percentage was observed in T_1 and T_2 fly ash treated soil in comparison to control and other fly ash treated plots. Similar results were also reported by Aggarawal *et al*. (2004).

S. No.	Fly ash Treatments	Germination (%)
1	Control	82
2	T_1	91
3	T_2	95
4	T_3	79
5	T_4	77
6	T_5	72

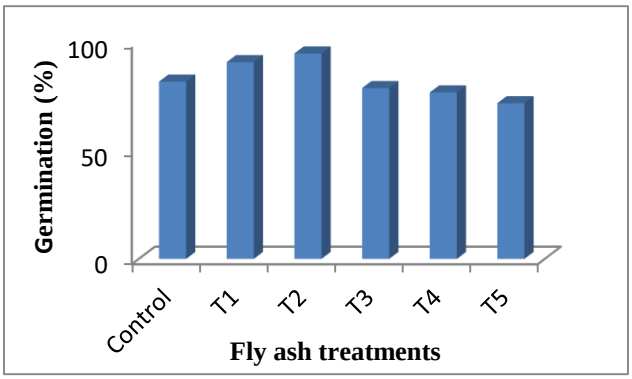

Table-01 & Fig-03: Seed germination of *Triticum aestivum* L. treated with different concentration of fly ash.

B- Length of Root and Shoot

Data presented in table 02 & 03 and fig. 04 & 05 shows that 25% fly ash treated soil have positive effect on the plant growth in terms of shoot and root length. Fly ash has some physical and chemical properties that might be useful in low level of soil amendment (Verma *et al*., 2014; Ram and Masto, 2014). Our findings are also similar to the findings of Khan (2001) who concluded that small amount of fly ash addition increases plant length, branches and flowers of plant where as higher percentage reduce them significantly.

No. of Days	Root Length (cm)					
	C	T1	T2	T3	T4	T5
30	7.9	8.1	8.9	7.5	7.1	5.8
45	12.9	13.1	13.4	12.4	12.1	11.3
60	16.8	17.3	17.5	16.2	15.8	15.5
75	18.0	19.3	19.7	19.4	18.2	17.5
90	18.6	19.8	20.2	19.6	18.7	17.4

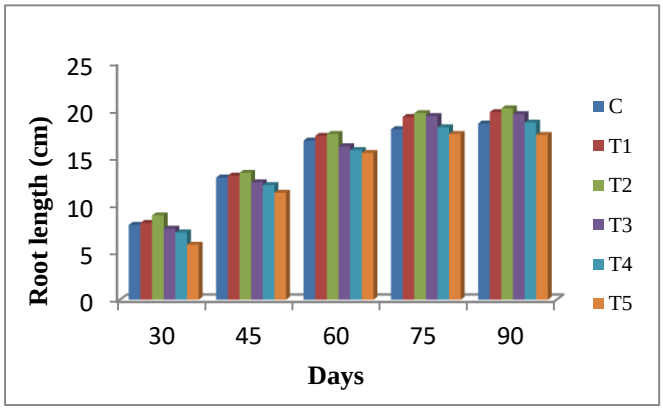

Table-02 & Fig-04: Effect of fly ash on length of root of *Triticum aestivum* L.

No. of Days	Shoot Length (cm)					
	C	T1	T2	T3	T4	T5
30	11.4	12.5	13.1	11.9	11.3	10.9
45	35.7	36.4	38.2	34.9	29.6	24.4
60	67.3	73.4	72.6	65.4	64.3	61.5
75	74.1	77.4	86.3	81.2	76.7	69.6
90	98.3	104.6	112.1	100.1	92.1	87.5

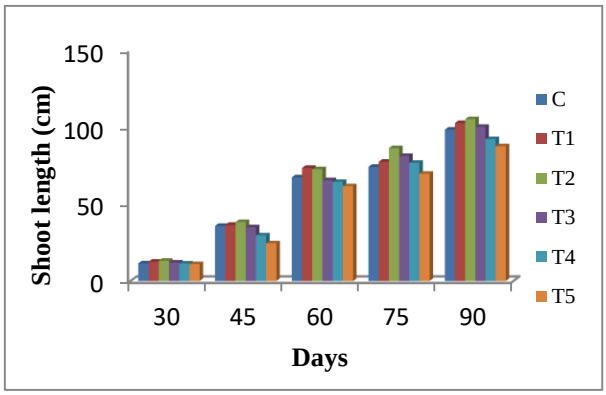

Table-03 & Fig-05: Effect of fly ash on length of Shoot of *Triticum aestivum* L.

C- Fresh and dry weight

Similarly, the maximum fresh and dry weight was observed from the plant grown in 25% fly ash treated soil as compare to other (table 04, 05 & fig 06, 07). The most suitable treatment for improving wheat growth was T_2. In this study we found that fly ash not only improved the physical properties of the soil but also gave the highest plant biomass to *Triticum aestivum* L. Singh *et al.*, (1997) also reported that lower application of fly ash to the soil stimulate the plant growth with respect of their fresh and dry weights.

No. of Days	Fresh weight (gm)					
	C	T1	T2	T3	T4	T5
30	1.394	1.488	1.604	1.449	1.394	1.364
45	3.906	4.786	5.764	4.984	4.763	3.465
60	7.206	7.943	8.214	7.874	6.743	6.313
75	15.647	17.468	19.747	15.986	14.974	14.580
90	20.320	23.711	25.033	21.657	19.004	17.886

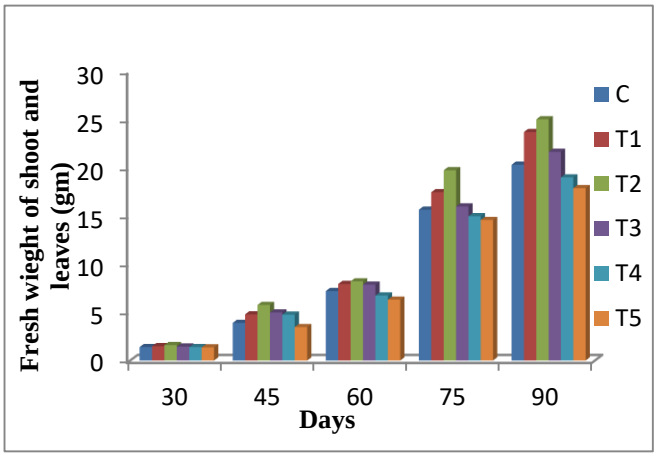

Table-04 & Fig-06: Effect of fly ash on fresh weight of Shoot and leaves of *Triticum aestivum* L .

No. of Days daysDays	Dry weight (gm)					
	C	T1	T2	T3	T4	T5
30	0.498	0.632	0.678	0.547	0.463	0.391
45	0.984	1.347	1.647	1.427	1.276	0.965
60	2.931	3.342	3.997	3.143	2.358	2.410
75	8.431	9.133	9.748	7.238	7.471	5.986
90	10.746	11.068	11.867	9.246	8.757	8.236

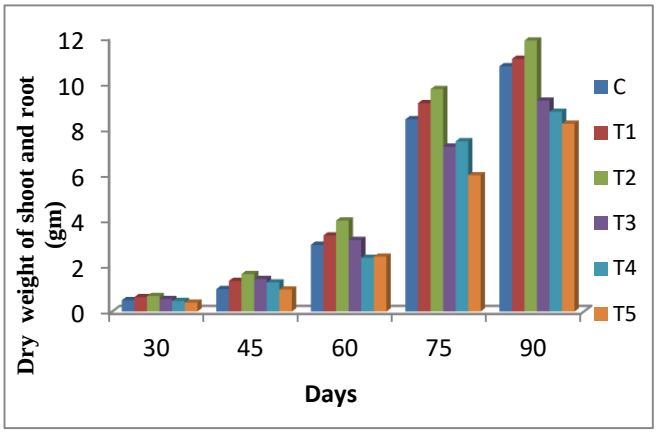

Table-05 & Fig-07: Effect of fly ash on dry weight of Shoot and leaves of *Triticum aestivum* L.

D- Chlorophyll amount

Total chlorophyll amount in the plants leaves have been shown in the table 06 and fig. 08.These results shows that addition of low amount of fly ash in the soil increases total chlorophyll contents with also length of wheat ear, fig - 9. Kumar and Kumar in 2017 also reported the similar results in *vigna mungo L.* during their research and concluded that this enhancement may be presence of sufficient concentration of macro and micro nutrients in the fly ash.

No. of Days	Chlorophyll amount (mg/gm)					
	C	T1	T2	T3	T4	T5
30	0.556	0.596	0.635	0.552	0.498	0.448
45	0.607	0.618	0.633	0.597	0.547	0.506
60	0.552	0.545	0.580	0.519	0.458	0.424
75	0.468	0.529	0.573	0.452	0.368	0.251
90	0.398	0.409	0.457	0.346	0.203	0.190

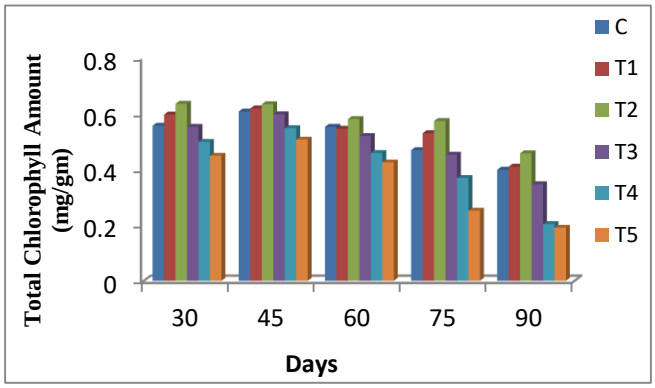

Table-06 & Fig-08: Effect of fly ash on total Chlorophyll amount (mg/gm) of *Triticum aestivum* L.

E- Ear length.

Treatments	90 Days	120 Days
C	14.8	15.2
T_1	16.4	16.5
T_2	17.6	17.7
T_3	15.3	15.4
T_4	14.4	14.6
T_5	14.2	14.4

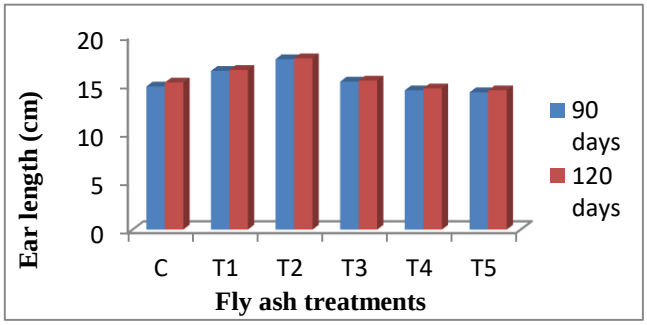

Table-07 & Fig-09: Effect of fly ash on ear length of *Triticum aestivum* L

F- Crop yield

Total yield of *Triticum aestivum* L. in present experiment with various fly ash treatments is decorated in the table 08 and fig. 10. During this research maximum yield were obtained when plants were grown in 25% fly ash amended soil (T_2) with 80-88 seeds in each ear while minimum no. of seeds were observed when plants were grown in totally fly ash amended soil (T_5).

S. No.	Treatments	Yield (kg/ sq feet)
1	C	0.0485
2	T_1	0.0502
3	T_2	0.0542
4	T_3	0.0435
5	T_4	0.0337
6	T_5	0.0248

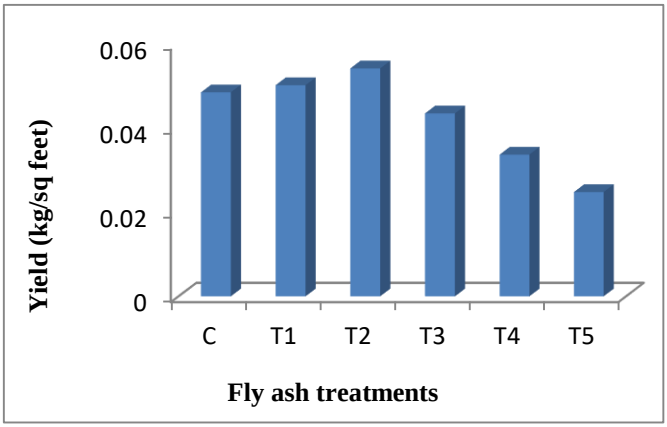

Table-08 & Fig-10: Total yield of *Triticum aestivum* L.

Conclusion

Fly ash, a by-product of coal combustion regarded as solid waste. But its application with determine ratio in agriculture fields due to the presence of some desired nutrients can help in crop plant growth and development. The present investigation show that small amount of fly ash amendment i.e. 25% in the soil is beneficial for plant growth in terms of plant height, fresh and dry weight, chlorophyll content and their yield production. Therefore present work supports that limited addition of fly ash i.e. 10-25% is beneficial for plant health also with yield of *Triticum aestivum* L. crop.

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