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Effect of fly ash, phospho-gypsum and chemical fertilizers on growth, yield and nutrient uptake of wheat (*Triticum aestivum* L.) in inceptisol

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Abstract
The experiment was conducted to know the effect of Fly ash, Phospho-gypsum and chemical fertilizers on Growth parameters, Yield attributes, Yield and Nutrient Uptake of wheat (*Triticum aestivum* L.) in Inceptisol of Varanasi district (U.P.) during the year 2014-15 and 2015-16 at the Agriculture Research Farm, Institute of Agriculture Science, Banaras Hindu University, Varanasi (India). The influence of fly ash (FA) and Phosphogypsum (PG) with fertilizers applied in soil that improved the yield and nutrient uptake of wheat. The results showed that 15 t FA ha^{-1} and 2 t PG ha^{-1} with 75% Recommended dose of fertilizers significantly increased grain yield and yield attributes viz; Number of tillers m^{-1}, Plant height, and Chlorophyll content of wheat. The maximum N, P, K, Ca, Mg and S uptake in seed and straw of wheat were observed significantly superior with application of treatment i.e. 75% RDF + 15 t FA ha^{-1} + 2 t PG ha^{-1}.

Keywords: Fly ash, phospho-gypsum, wheat, growth, yield and nutrient uptake

Introduction
Fly ash is a resultant waste produced in thermal power plant from the combustion of coal for energy purpose, is a major concern. Recently, more than 175 million tons of fly ash is generated annually in India thermal power plants and it is expected about 300 million tons of fly ash will be generated in the near future (Pani *et al*., 2015) [10]. The FA is a rich source of macronutrients including P, K, Ca, Mg and S and micronutrients also present in various amount Fe, Mn, Zn, Cu, Co, B and Mo. Coal fly ash major constituent are CaO, MgO, SiO_2 and Fe-Mn oxides. Coal fly ash because of this alkaline pH, available macro and micro nutrients, increases soil pH and also concentrations of essential macro and micro-nutrients in the soil (Adriano and Weber, 2001) [1] and water holding capacity also increased. Phosphogypsum (PG) is a waste by-product which generated during fertilizer production from phosphate rock by the use of wet acid method, which currently accounts for more than 90% of phosphoric acid production. In India about 11 million tons of PG is generated from fertilizer industry per year which create a serious problem at the plant site (Nayak *et al*. 2013; Parreira *et al*., 2003) [11].
Instead of dumping of these waste material, the utilization of fly ash and phosphogypsum can be both economically viable and environment friendly (Mohan *et al*., 2012). Great emphasis is given to the ways and means of utilizing fly ash and phosphogypsum in various fields. The application of fly ash and phosphogypsum in agriculture to produce various crops provides a attainability replacement for safe disposal of fly ash to improve the soil domain and enhance the productivity of crops. The disposal of fly ash and phospho-gypsum by ordinary methods leads to fertility loss of productive land and being made impure of ground water. Therefore it is necessary for management of suitable method for disposal of fly ash and phospho-gypsum waste in an eco-friendly approach becomes indispensable to achieve maximum benefit from its diverse nature, because fly ash and phosphogypsum contains available essential macro and micronutrients in large quantities. The application of fly ash and phosphogypsum with organic manure and chemical fertilizers can be used for increased productivity of crops and also help in improving soil physico-chemical properties and enriching its fertility status.

Methods and Material
A field experiment was conducted at Agriculture Research farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (India) in three replications with RBD during the year 2014-2015 and 2015-2016. The experiment included the following factors (a) Dose of coal fly ash (2.5, 5, 10 and 15 t ha^{-1}), (b) Dose of Phosphogypsum (0.5, 1, 1.5 and 2 t ha^{-1}) with

chemical fertilizers. 5t FYM ha^{-1} was also applied in each treatment except control. The test crop was wheat (*Triticum aestivum*) cv. HUW-234. The application of fertilizers for wheat was 120:60:60 N: P_2O_5: K_2O kg ha^{-1}. The plough layer 0-15 cm of soil fly ash and phospho-gypsum were characterized for various parameters. The soil of experiment field was slightly alkaline in reaction (pH 7.8), organic carbon (0.33%), available N 197.40 kg ha^{-1}, available P 23.80 kg ha^{-1} and available K 166.4 kg ha^{-1}.

Fly ash (FA) from the Singrauli Super Thermal Power Station, Shakti Nagar, Sonebhadra, Uttar Pradesh was collected for the experiment. The fly ash having pH (8.2), EC (0.58 dS m^{-1}) and organic carbon (0.12%). Phosphogypsum used in the experiment was having pH 4.28, EC (2.82 dS m^{-1}), organic carbon (0.62%). The plant growth parameters viz; plant height, number of tillers m^{-1} and yield attributes at different growth stage were recorded. Grain and straw yield of wheat after harvest were obtained from the plot area. Nutrient content and uptake of N, P, K, Ca, Mg and S by seed and straw of wheat were estimated.

Results and discussion

Effect on crop growth and yield of wheat crop

The data on the effect of fly ash, phosphogypsum and chemical fertilizers treatment on the growth, yield attributes and yield of wheat (*Triticum aestivum*) cv. HUW-234 are presented in Table 1. The data related to yield and yield parameters as influenced by different treatments indicated that there was significant influence of FA, PG and chemical fertilizers on various growth parameters of wheat. The grain and straw yield were ranges from 37.39 to 54.73 q ha^{-1} and 55.79 to 79.56 q ha^{-1}, respectively. The highest grain yield (54.73 q ha^{-1}) and straw yield (79.56 q ha^{-1}), test weight (40.13%) were recorded in T_{15} (75% RDF + 15t FA ha^{-1} + 2t PG ha^{-1}). Significant difference was also observed in yield attributes viz. Plant height, Number of tillers m^{-1} and Chlorophyll content. The treatment T_{15} was observed significantly superior to T_1 (control) and T_3 (75% RDF), T_8 (75% RDF + 0.5t PG ha^{-1}), T_9 (75% RDF + 1.0t PG ha^{-1}), T_{10} (75% RDF + 1.5t PG ha^{-1}) and T_{11} (75% RDF + 2t PG ha^{-1}) among the phosphogypsum with chemical fertilizer. But the treatment T_2 (100% RDF), T_4 (75% RDF + 2.5t FA ha^{-1}), T_5 (75% RDF + 5t FA ha^{-1}), T_6 (75% RDF + 10t FA ha^{-1}), T_7 (75% RDF + 2.5 t FA ha^{-1}) showed statistically at par during both the year and in pooled mean, respectively. The maximum plant height (91.40 cm) and Number of tillers m^{-1} (89.38) at harvest and chlorophyll content (37.04, SPAD value at 60 DAS), harvest index (40.13%) were recorded in T_{15} (75% RDF + 15t FA ha^{-1} + 2t PG ha^{-1}). The nutrient availability from fly ash, phosphogypsum and chemical fertilizers was slowly and adequately to plant during entire growth period. Similar finding were also reported by the many workers Khan *et al*. (2008) [6], Aggarwal *et al.* (2009) [2], Tripathi *et al*. (2009) [14], Rehman *et al.* (2010) [13] and Masto *et al.* (2013) [8].

Effect on Nutrient uptake

The data pertaining to the effect of fly ash and phosphogypsum with chemical fertilizers treatment on the nutrient uptake of seed and straw of wheat are presented in Table 2. The application of fly ash, phosphogypsum and chemical fertilizers were significantly influenced the nitrogen uptake in seed of wheat crop during both the years and pooled analysis. The N uptake in seed and straw was varied between 54.51 to 88.00 and 23.71 to 39.86 kg/ha during the pooled mean analysis, respectively. The maximum nitrogen uptake in seed and straw 88.00 kg/ha and 39.86 kg/ha were observed with application of treatment T_{15} (75% RDF + 15 t FA ha^{-1} + 2 t PG ha^{-1}), which were increased by 54.51 kg/ha over control (T_1) during both the years 2014-15, 2015-16 and in pooled mean analysis. A similar result was also finding by Jeena and Manorama (2007) [5] and Pani *et al*. (2015) [10].

The uptake of P, K, Ca, Mg and S by wheat seed were varied between 6.73 to 17.48, 13.44 to 25.36, 15.89 to 28.27, 6.06 to 10.40 and 28.19 to 46.35 kg ha^{-1} during the pooled mean analysis, respectively. The maximum P, K, Ca, Mg and S uptake in seed 17.48, 25.36, 28.27, 10.40 and 46.35 kg ha^{-1} were observed significantly superior with application of treatment T_{15} (75% RDF + 15 t FA ha^{-1} + 2 t PG ha^{-1}) over T_1 (control), T_3 (75% RDF), T_4 (75% RDF + 2.5 t FA ha^{-1}), T_5 (75% RDF + 5 t FA ha^{-1}), T_6 (75% RDF + 10 t FA ha^{-1}), T_7 (75% RDF + 2.5 t FA ha^{-1}), T_8 (75% RDF + 0.5 t PG ha^{-1}), T_9 (75% RDF + 1.0 t PG ha^{-1}), T_{10} (75% RDF + 1.5 t PG ha^{-1}), T_{11} (75% RDF + 2 t PG ha^{-1}). However, T_{15} statistically at par with the treatment T_2 (100% RDF), T_{12} (75% RDF + 2.5 t FA ha^{-1} +0.5 t PG ha^{-1}), T_{13} (75% RDF + 5 t FA ha^{-1} + 1 t PG ha^{-1}) and T_{14} (75% RDF + 10 t FA ha^{-1} + 1.5 t PG ha^{-1}) at harvest of the crop during the pooled analysis of the year 2014-15, 2015-16. It is apparent from the data (Table 2) revealed that the P, K, Ca, Mg and S uptake by straw of wheat crop were found ranged from 5.02 to 13.05, 71.61 to 113.22, 6.30 to 10.98, 4.02 to 7.56 and 31.58 kg ha^{-1} during the pooled mean analysis, respectively. The maximum P, K, Ca, Mg and S uptake in straw 13.05, 113.22, 10.98, 7.56 and 31.58 were also observed with application of treatment T_{15} (75% RDF + 15 t FA ha^{-1} + 2 t PG ha^{-1}) during both the years and in pooled mean analysis. Similar results were reported by Tsadilas *et al*. (2009a) [15] Tripathi *et al*. (2009) [14] and Das *et al*. (2013) founded that application of fly ash, phosphogypsum and chemical fertilizers were significantly increased the nutrient uptake in seed and straw of wheat. The result was further confirmed by Mahmoud *et al*. (2017) [7] and Rakhimova *et al*. (2017) [12].

Table 1: Effect of fly ash, phosphogypsum and chemical fertilizers on growth, yield attributes and yield of wheat of wheat crop (pooled mean)

Treatments	Plant height (cm)	Number of tillers m^{-1}	Chlorophyll content (SPAD value at 60 DAS)	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
T_1	60.95	54.66	30.20	33.48	37.39	55.79	93.18	40.13
T_2	86.2	85.84	35.63	39.08	52.87	76.97	129.84	40.72
T_3	70.29	65.93	32.42	35.45	42.88	63.89	106.77	40.16
T_4	79.99	77.48	34.83	37.04	49.03	73.26	122.29	40.10
T_5	80.74	78.27	34.99	37.17	49.32	73.54	122.86	40.14
T_6	81.3	78.59	35.07	37.26	49.53	73.73	123.26	40.18
T_7	81.73	79.11	35.13	37.41	49.64	74.12	123.76	40.11
T_8	72.88	69.78	32.93	35.84	44.84	69.25	114.09	39.30
T_9	73.38	71.01	33.07	35.96	45.12	69.50	114.62	39.36

T_{10}	73.91	71.27	33.18	36.04	45.29	69.82	115.11	39.35
T_{11}	74.18	71.99	33.29	36.17	45.46	70.04	115.50	39.36
T_{12}	89.9	87.71	36.25	39.63	53.89	78.06	131.95	40.84
T_{13}	90.84	88.34	36.88	39.85	54.24	78.31	132.55	40.92
T_{14}	91.11	88.98	36.94	39.99	54.47	78.80	133.27	40.87
T_{15}	91.4	89.38	37.04	40.13	54.73	79.56	134.29	40.75
SEm±	3.79	4.3	1.12	1.23	2.30	3.58	6.26	1.98
CD(p=0.05)	10.97	12.46	3.25	3.57	6.66	10.37	18.14	NS
CV (%)	8.21	9.65	5.63	5.72	8.20	8.20	8.58	8.97

Treatment: T_1-Control, T_2-100% RDF, T_3-75% RDF, T_4-75% RDF + 2.5t FA ha^{-1}, T_5-75% RDF + 5t FA ha^{-1}, T_6-75% RDF + 10t FA ha^{-1}, T_7-75% RDF + 15t FA ha^{-1}, T_8-75% RDF + 0.5t PG ha^{-1}, T_9-75% RDF + 1t PG ha^{-1}, T_{10}75% RDF + 1.5t PG ha^{-1}, T_{11}-75% RDF + 2t PG ha^{-1}, T_{12}-75% RDF + 2.5t FA ha^{-1} + 0.5t PG ha^{-1}, T_{13}-75% RDF + 5t FA ha^{-1} + 1t PG ha^{-1}, T_{14}-75% RDF + 10t FA ha^{-1} + 1.5t PG ha^{-1}, T_{15}-75% RDF + 15t FA ha^{-1} + 2t PG ha^{-1}. FA= Fly ash, PG= Phospho-gypsum. 5t FYM ha^{-1} applied in all treatment except control.

Table 2: Effect of fly ash, phosphogypsum and chemical fertilizers on Nutrient uptake by seed and straw of wheat crop (pooled mean)

Treatments	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)		Ca uptake (kg/ha)		Mg uptake (kg/ha)		S uptake (kg/ha)	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T1	54.51	23.71	6.73	5.02	13.44	71.61	15.89	6.30	6.06	4.02	28.19	31.58
T2	83.59	37.14	14.96	11.70	23.53	108.29	26.38	10.35	9.78	6.89	44.28	49.18
T3	63.98	27.98	8.53	6.52	16.45	83.25	19.02	7.51	7.27	4.86	33.43	37.28
T4	75.70	34.06	10.22	8.53	20.81	100.69	22.19	8.75	8.83	6.12	39.76	45.16
T5	76.56	34.53	10.65	8.75	21.11	101.49	22.59	8.86	8.93	6.25	40.41	45.60
T6	77.21	34.80	11.14	8.96	21.40	102.56	22.86	9.07	8.96	6.27	40.78	45.93
T7	77.73	35.21	11.52	9.38	21.54	103.40	23.03	9.15	9.06	6.37	40.97	46.47
T8	67.19	30.68	11.50	9.59	17.69	91.44	21.28	8.79	7.69	5.44	35.27	41.13
T9	68.24	31.10	11.78	9.77	18.18	92.54	21.64	8.97	7.78	5.53	35.87	41.60
T10	68.73	31.66	12.05	9.92	18.50	93.27	21.83	9.08	7.88	5.59	36.44	42.06
T11	69.17	32.01	12.21	10.02	18.62	93.99	22.09	9.14	7.96	5.64	36.82	42.48
T12	85.95	38.29	15.81	12.34	24.41	110.34	27.29	10.62	10.08	7.18	45.32	50.31
T13	86.75	38.65	16.41	12.53	24.76	110.97	27.63	10.73	10.17	7.36	45.75	50.63
T14	87.42	39.28	17.05	12.85	25.08	111.82	27.97	10.84	10.29	7.41	46.05	51.34
T15	88.00	39.86	17.48	13.05	25.36	113.22	28.27	10.98	10.40	7.56	46.35	52.15
SEm±	4.44	1.94	1.84	0.54	1.22	5.79	1.30	0.52	0.44	0.31	2.27	2.52
CD(p=0.05)	12.86	5.62	5.22	1.57	3.52	16.78	3.75	1.50	1.27	0.89	6.58	7.31
CV (%)	10.20	9.90	9.9	9.44	10.16	10.11	9.62	9.68	8.69	8.68	9.90	9.75

Treatment: T_1-Control, T_2-100% RDF, T_3-75% RDF, T_4-75% RDF + 2.5t FA ha^{-1}, T_5-75% RDF + 5t FA ha^{-1}, T_6-75% RDF + 10t FA ha^{-1}, T_7-75% RDF + 15t FA ha^{-1}, T_8-75% RDF + 0.5t PG ha^{-1}, T_9 -75% RDF + 1t PG ha^{-1}, T_{10}75% RDF + 1.5t PG ha^{-1}, T_{11}-75% RDF + 2t PG ha^{-1}, T_{12}- 75% RDF + 2.5t FA ha^{-1} + 0.5t PG ha^{-1}, T_{13}-75% RDF + 5t FA ha^{-1} + 1t PG ha^{-1}, T_{14}-75% RDF + 10t FA ha^{-1} + 1.5t PG ha^{-1}, T_{15}-75% RDF + 15t FA ha^{-1} + 2t PG ha^{-1}. FA= Fly ash, PG= Phospho-gypsum. 5t FYM ha^{-1} applied in all treatment except control.

Conclusions

The application of fly ash and phosphogypsum with chemical fertilizer in soil increased the soil physico-chemical properties and increased yield and quality of wheat crops. From this experiment it can be concluded that treatment T_{15} (75% RDF + 15t FA ha^{-1} + 2t PG ha^{-1}) in the soil is useful to increase the growth, yield attributes and nutrient uptake of wheat.

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References

1. Adriano DC, Weber JT. Influence of fly ash on soil physical properties and turf grass establishment. J. environ. Qual. 2001; 30:569-601.
2. Aggarwal S, Singh GR, Yadav BR. Utilization of fly ash for crop production: effect on the growth of wheat and sorghum crops and soil properties. Journal of Agricultural Physics. 2009; 9:20-23.
3. Das BK, Choudhury BH, Das KN. Effect of integration of fly ash with fertilizers and fym on nutrient availability, yield and nutrient uptake of rice in Inceptisols of Assam, India. International Journal of Advancements in Research & Technology. 2013; 11(2):190-208.
4. Das A, Jain MK, Singh G. Comprehensive characterization of coal fly ash for beneficial utilization towards environment. International J. of Environmental Science. 2011; 5(3&4):127-130.
5. Jeena Mathew, Manorama Thampatti KC. Suitability of phosphogypsum as an ameliorant for soil acidity in Laterite soil. Journal of the Indian Society of Soil Science. 2007; 55(3):313-316.
6. Khan MJ, Qasim M. Integrated use of boiler ash as organic fertilizer and soil conditioner with NPK in calcareous soil. Songklanakarin J of Science Technology. 2008; 30(3):281-289.
7. Mahmoud E, Ahmed B, Nasser A, Othman S, Rasha E. Effects of Phosphogypsum and Biochar Addition on Soil Physical Properties and Nutrients Uptake by Maize yield in Vertic Torrifluvents. International Journal of Scientific & Engineering Research. 2017; 8(8):1-23
8. Masto RE, Ansari MA, George J, Selvi VA Ram. Co-application of biochar and lignite fly ash on soil nutrients

and biological parameters at different crop growth stages of Zea mays. Ecological Engineering. 2013; 58:314-322.
9. Mohan SKR, Jayabalan KP, Rajaraman A. Properties of Flyash based coconut Fiber Composite. American Journal of Engineering and Applied Science. 2012; 5:29-34.
10. Pani NK, Samal P, Das, Sahoo S Effect of fly ash on growth and yield of sunflower (*Helianthus annuus* L.). International Journal of Agronomy and Agricultural Research. 2015; 7(2):64-74.
11. Parreira AB, Kobayashi Jr, ARK Silvestre OB. Influence of Portland cement type on unconfined compressive strength and linear expansion of cement-stabilized phosphogypsum. Journal of Environmental Engineering. 2003; 129:956-960.
12. Rakhimova A, Khussainov A, Grinfelde I. Impact of Coal Ash and Phosphogypsum application on Soil Fertility of Chernozem Soils of North Kazakhstan. Eng. Rural Development http://www.tf.llu.lv/conference/proceedings 2017/Papers/pp-1047-1051.
13. Rehman S, Khalil S, Muhammad F, Rehman A, Khan AZ, Amanullah Saljoki *et al*. Phenology Leaf area index and grain yield of rainfed wheat influenced by organic and inorganic fertilizer. Pak. J. Bot. 2010; 42(5):3671-3685.
14. Tripathi RC, Masto RE, Ram LC. Bulk use of pond ash for cultivation of wheat maize-egg-plant crops in sequence on a fallow land. Resour. Conserv. Recyc. 2009; 54:134-139.
15. Tsadilas CD, Shaheen SM, Samaras V. Influence of coal fly ash application individually and mixing with sewage sludge on wheat growth and soil chemical properties under field conditions. In: 15th International Symposium on Environmental Pollution and its Impact on Life in the Mediterranean Region. October, 7-11, 2009a. Bari, Italy, 145.
16. Yang J, Liu W, Zhang L, Xiao B. Preparation of load-bearing building materials from autoclaved phosphogypsum. Construction and Building Materials. 2009; 23:687-693.