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Effect of fly ash, organic manure and fertilizers on macro nutrient uptake in grain and straw in rice-wheat cropping system in alfisols and vertisols

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Abstract
Field experiment was conducted at KVK, Farm Katghora, Korba under Alfisols and Instructional Farm under Vertisols at Indira Gandhi Krishi Vishwavidyalaya, Raipur during 2011 and 2012.To assess the effect of different doses of fly ash alone or in combination with manure and fertilizers in rice–wheat cropping system with Sixteen treatments (i.e. T_{1}- Control, T_{2}- 10tFA ha^{-1}, T_{3}- 20tFA ha^{-1} T_{4}- STCR (based fertilizer recommendation), T_{5}- 75% NPK ha^{-1}, T_{6}- 100% NPK (100:60:40), T_{7}- 75% NPK ha^{-1} + 10tFA ha^{-1}, T_{8}- 75% NPK ha^{-1} + 20tFA ha^{-1}, T_{9}- 100% NPK ha^{-1} + 10tFA ha^{-1}, T_{10}- 100% NPK ha^{-1} + 20tFA ha^{-1}, T_{11}- 75% NPK ha^{-1} + 5tFYM ha^{-1}, T_{12}- 100% NPK ha^{-1} + 5tFYM ha^{-1}, T_{13}- 75% NPK ha^{-1} + 5tFYM + 10tFA, T_{14}- 75% NPK ha^{-1} + 5tFYM + 20tFA ha^{-1}, T_{15}- 100% NPK ha^{-1} + 5tFYM + 10tFA ha^{-1} and T_{16}- 100% NPK ha^{-1} + 5tFYM + 20tFA ha^{-1}) under Split Plot Design with factorial arrangment of crop and soil in main plot and treatment in sub plot.The higher nitrogen uptake in rice grain and straw under alfisol and wheat grain and straw under vertisol. Interaction of both the crop and soil, crop x soil x treatment, T_{16} recorded highest nitrogen uptake in grain and straw. The higher phosphorous uptake was recorded in rice and wheat grain under alfisol whereas higher phosphorous uptake was recorded in rice and wheat straw under vertisol. In case of grain the interaction effect, rice x vertsol x treatment, wheat x alfisol x treatment and wheat x vertisol x treatment, T_{16} recorded highset phosphorous uptake. Incase of straw, rice x vertisol x treatment, T_{16}, wheat x vertisol x treatment, T_{15} recorded higher phosphorous uptake whereas, rice x alfisol x treatment, wheat x alfisol x treatment, T_{12} and T_{16} recorded highest phosphorous uptake in straw respectively. The highest potassium uptake was recorded in rice grain and straw under alfisol and wheat grain and straw under vertisol. In case of grain, interaction effect of rice x vertisol x treatment, wheat x vertisol x treaatment, wheat x alfisol x treatment, T_{16} recorded highest potassium uptake whereas rice x alfisol x treatment, rice x vertisol x treatment, T_{4} recorded highest potassium uptake. In case of wheat straw, wheat x alfisol x treatment, wheat x vertisol x treatment, T_{16} recorded highest potassium uptake.

Keywords: Fly ash, macro nutrient uptake, rice-wheat cropping system

Introduction
In the world, the major source of electrical energy is coal based thermal power plant, which produce 175 million tonnes, fly ash which would require about 40,000 hectares of land for the construction of ash ponds (Lal *et al.*, 2012) [5]. The Ministry of Power and Planning Commission estimates that the coal requirement and generation of fly ash during the year 2031- 32 would be around 1800 million tonnes and 600 million tonnes respectively (Kanungo, 2013) [4]. The fly ash utilization in the country is estimated to be about 59% only (Kanungo, 2013) [4].

In Chhattisgarh produces fly ash to the tone of about 26880 metric tons per day i.e. nearly 9.7 million tons of fly ash annually, out of which the four major Thermal Power Plants in Korba district alone generate about 24000 metric tons per day. Fly ash consists of mineral matter which was uptake by plant from the soil. It can act as a secondary source of fertilizer nutrients like P,K, Ca, Mg, S, Cu, Fe, Zn, Mn, Mo etc. (Totawat *et al.*, 2002) [10].

Materials and Methods
The nitrogen content analysis of grain and straw sample was done by taking 0.5 gm uniform prepared sample in digestion tube to which 1 gm salt mixture (K_2SO_4 and $CuSO_4.5H_2O$

in the ratio of 10:1) and 10 ml. of concentrated H_2SO_4 acid was added and material was digested at 350 ºC in digestion block till the solution becomes colorless. Then the nitrogen in digested material was distilled by automatic KEL plus system. The phosphorus content was determined by vanadomolybdo-phosphoric acid yellow color complex method as described by Jackson (1967) [2]. The potassium content was determined by flame photometer as described by Chapman and Pratt (1961) [1]. The uptake of macro, nutrient in grain and straw was estimated by using the following formula. Nutrient uptake by grain ($kgha^{-1}$) = grain yield (qha^{-1}) x Nutrient content (%) and nutrient uptake by straw ($kgha^{-1}$) = straw yield (qha^{-1}) x Nutrient content (%).

Result and Discussion

1. Nitrogen uptake in grain and straw

The nitrogen uptake in grain was significantly influenced due to application of fly ash alone or in combination with organic manure and fertilizers is shown in (Table 1). The higher nitrogen uptake in grain was recorded in rice under *Alfisol* during 2011, 2012 and pooled data. However, higher nitrogen uptake was recorded in wheat grain under *Vertisol* during 2011- 12, 2012- 13 and pooled data. The uptake of nitrogen in rice grain was higher than wheat.

Interaction between crop × soil × treatments reveals (Table 2) that, rice × *Vertisol* and *Alfisol* × treatment T_{16} recorded significantly highest nitrogen uptake in grain among all the treatments and the lowest nitrogen uptake were recorded in treatment T_1. It was at par with Treatment T_{15} and T_4 in *Vertisol* and T_{14} and T_{15} in *Alfisol*. In case of wheat × *Vertisol* × treatment and wheat × *Alfisol*× treatment, T_{16} recorded significantly higher nitrogen uptake in grain it was at par with T_{15}.

Table 2 shows that the higher nitrogen uptake in straw was recorded in rice under *Alfisol* during 2011, 2012 and pooled data. However, in *Vertisol*, the higher nitrogen uptake was recorded in wheat straw during 2011- 12, 2012- 13 and pooled data. The uptake in rice straw was higher than wheat

Interaction between crop × soil × treatments reveals (Table 2.) that, rice × *Vertisol* × treatment and rice × *Alfisol* × treatment, T_{16} recorded significantly highest nitrogen uptake in straw among all the treatments and lowest nitrogen uptake was recorded in treatment T_1. It was at par with treatment T_{15} in rice × *Vertisol* × treatment and T_4, T_{15}, T_{10}, T_{14} and T_{12} in rice × *Alfisol* × treatment. In case of wheat × *Vertisol* × treatment, and wheat× *Alfisol*× treatment, T_{16} recorded significantly higher nitrogen uptake in straw. It was at par with T_{15}.

Addition of fly ash alone or in combination with 100% NPK ha^{-1} + 5tFYM + 20tFA ha^{-1} had increased N content in grain and straws. Treatment 100% NPK + 5tFYM + 20tFA ha^{-1} recorded higher nitrogen uptake in grain and straw under *Alfisol*. Whereas, in *Vertisol*, the N- uptake was higher in wheat grain and straw. This might be due to complimentary effect on N availability to rice and wheat through its growth. This could also be attributed to good soil physical environment, thereby better root prolification due to fly ash addition. This enhanced the uptake of nitrogen. Singh and Singh (1986) [9] observed increased N uptake by rice plant due to application of fly ash. Similar results were also reported by Jambagi *et al.* (1995) [3] and Selvakumari *et al.* (2000) [8].

Table 1: Effect of fly ash alone or in combination with organic manure and fertilizers on nitrogen uptake in grain and straw in rice-wheat cropping system in Alfisol and Vertisol at harvest

Particular	Nitrogen uptake in grain (kg ha^{-1})						Nitrogen uptake in straw (kg ha^{-1})					
	2011-12		2012-13		Pooled		2011-12		2012-13		Pooled	
	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol
Rice	47.54	48.93	48.56	50.10	48.05	49.51	30.97	34.85	31.82	36.26	31.39	35.50
Wheat	44.09	35.33	45.94	38.41	45.01	36.87	19.27	16.45	20.12	17.98	19.69	17.21
	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%
A	0.226	0.781	0.526	1.816	0.310	1.070	0.172	0.593	0.302	1.043	0.170	0.587
B	0.226	0.781	0.526	1.816	0.310	1.070	0.172	N/A	0.302	1.043	0.170	0.587
A×B	0.320	1.104	0.744	2.56	0.438	1.513	0.243	0.838	0.427	1.475	0.240	0.830

Table 2: Effect of fly ash alone or in combination with organic manure and fertilizers on nitrogen uptake in grain and straw in rice-wheat cropping system in Alfisol and Vertisol at harvest

Treatments	Nitrogen uptake in grain (kg ha^{-1})				Nitrogen uptake in straw (kg ha^{-1})			
	Rice		Wheat		Rice		Wheat	
	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol
T_1 - Control	23.24	16.68	19.56	11.33	16.69	12.00	8.41	4.76
T_2 - 10tFA ha^{-1}	27.72	21.45	20.68	13.48	20.16	16.71	9.39	6.75
T_3 - 20tFA ha^{-1}	28.66	27.24	22.62	18.16	20.86	20.51	12.19	9.08
T_4 - STCR	60.65^a	60.72^b	53.67	46.71^c	39.74^b	44.09^a	23.42^b	22.80^a
T_5 - 75%NPK ha^{-1}	44.11	45.63	41.67	31.71	27.52	32.47	17.77^e	15.78^e
T_6 - 100% NPK ha^{-1}	49.13	52.71	51.15	40.17^e	30.72	36.48^e	21.32^c	17.20^d
T_7 - 75%NPK ha^{-1} + 10tFA ha^{-1}	44.73	48.87	42.27	33.76	28.21	36.78^e	18.34^e	15.96^e
T_8 - 75%NPK ha^{-1} + 20tFA ha^{-1}	46.47	49.83	44.80	35.93	29.37	37.57^d	18.35^e	16.23^e
T_9 - 100%NPK ha^{-1} + 10tFA ha^{-1}	52.32	54.82	52.37	41.62^d	34.34	39.35^c	22.48^c	17.78^d
T_{10} - 100%NPK ha^{-1} + 20tFA ha^{-1}	54.18	55.84	54.79	44.54^c	35.19	43.02^a	22.80^c	19.41^c
T_{11} - 75% NPK ha^{-1} + 5tFYM ha^{-1}	48.01	50.58	46.48	36.34	31.26	33.04	19.07^d	17.88^d
T_{12} - 100%NPK ha^{-1} + 5tFYM ha^{-1}	53.86	59.43^c	54.53	43.49^d	35.21	42.52^a	23.32^b	19.52^c
T_{13} - 75%NPK ha^{-1} + 5tFYM + 10tFA ha^{-1}	54.43	56.27	48.19	44.80^c	34.62	41.59^b	23.08^c	20.57^b
T_{14} - 75%NPK ha^{-1} + 5tFYM + 20tFA ha^{-1}	56.81	63.70^a	49.16	46.78^b	35.13	42.84^a	23.32^b	22.19^b
T_{15} - 100%NPKha^{-1} + 5tFYM + 10tFA ha^{-1}	61.89^a	63.69^a	58.09^a	49.87^a	40.52^a	43.99^a	25.63^a	24.68^a
T_{16} - 100%NPK ha^{-1} + 5tFYM + 20tFA ha^{-1}	62.61^a	64.77^a	60.18^a	51.24^a	42.76^a	44.99^a	26.18^a	24.82^a
S.Em±	1.124				0.903			
CD at 5% level	3.147				2.529			

2. Phosphorous uptake in grain and straw

Table 3 shows that the higher phosphorous uptake in grain was recorded in rice under *Alfisol* during 2011, 2012 and pooled data. However, higher phosphorous uptake was recorded in wheat grain under *Vertisol* during 2011- 12, 2012-13 and pooled data. The uptake of phosphorous in rice grain was higher than wheat.

Interaction between crop × soil × treatments reveals (Table 4) that, rice × *Vertisol* × treatment T_{16} recorded significantly highest phosphorus uptake in grain among all the treatments and lowest phosphorus uptake was recorded in treatment T_1. It was at par with treatment T_{15} and T_4. In case of rice × *Alfisol* × treatment, T_{14} recorded significantly highest phosphorous uptake in grain among all the treatments and lowest phosphorous uptake was recorded in T_1. It was at par with treatments T_{16}, T_{15} and T_4. In case of wheat × *Vertisol* × treatment and wheat × *Alfisol* ×treatment, T_{16} was recorded significantly higher phosphorous uptake in grain. It was at par with T_{15}. The lowest phosphorus uptake was recorded in T_1.

The phosphorous uptake in straw was significantly influenced due to application of fly ash alone or in combination with organic manure and fertilizers is shown in (Table 3). The higher phosphorous uptake in straw was recorded in rice under *Alfisol* during 2011, 2012 and pooled data. However, higher phosphorous uptake was recorded in wheat straw under *Vertisol* during 2011-12, 2012-13 and pooled data. The uptake of phosphorous in rice straw was higher than wheat.

Interaction between crop × soil × treatments reveals (Table 4.) that, rice × *Vertisol* × treatment, T_{16} recorded significantly highest phosphorus uptake in straw among all the treatments and lowest phosphorous uptake was recorded in treatment T_1. It was at par with Treatment T_{15}.In case of rice × *Alfisol* × treatment, treatment, T_{12} recorded significantly highest phosphorus uptake in straw among all the treatments and lowest phosphorous uptake was recorded in treatment T_1. In wheat × *Vertisol* × treatment, treatment T_{15} recorded significantly highest phosphorus uptake in straw among all the treatments and lowest phosphorous uptake was recorded in treatment T_1. It was at par with treatments T_{16}. T_{10}, T_{13}, T_9, T_{12} and T_{15}. In case of wheat × *Alfisol* × treatment, treatment T_{16} recorded significantly higher phosphorous uptake in straw. It was at par with T_{15} and T_{14}.

Application fly ash alone or in combination with FYM and fertilizers significantly increased phosphorus content in grain and straw in wheat under vertisol. However, higher phosphourus uptake in grain and straw was recorded in rice under *Alfisol*. This might be due to the supply of these nutrients by fly ash and P fertilizer. This could also be due to fly ash addition which might have further helped in creating soil favorable physical condition for root prolification and also solubilization of phosphorus due to spurt in biotic activity in soil. Similar findings were also reported by Selvakumari *et al.* (2000) [8] and Warambhe *et al.* (1993) [11].

3. Potassium uptake in grain and straw

The potassium uptake in grain was significantly influenced due to application of fly ash alone or in combination with organic manure and fertilizers as shown in (Table 5). The higher potassium uptake in grain was recorded in rice under *Alfisol* during 2011, 2012 and pooled data. However, higher potassium uptake was recorded in wheat grain under *Vertisol* during 2011-12, 2012-13 and pooled data. The uptake of potassium in rice grain was higher than wheat.

Interaction between crop × soil × treatments reveals (Table 6) that, rice × *Vertisol* × treatment, T_{16} recorded significantly highest potassium uptake in grain among all the treatments and lowest potassium uptake was recorded in treatment T_1, which was at par with treatment T_4 and T_{15}. In case of rice ×*Alfisol* × treatment T_4 recorded significantly highest potassium uptake in grain among all the treatments and lowest potassium uptake was recorded in T_1. It was at par with treatments T_{16}. In case of wheat × *Vertisol* × treatment, T_{16} recorded significantly higher potassium uptake in grain. But it was at par with T_{15}. In case of wheat × *Alfisol* × treatments, T_{16} recorded significantly higher potassium uptake in grain. The lowest phosphorus uptake was recorded in T_1. It was at par with T_{15} and T_4.

Table 5 show that the higher potassium uptake in straw was recorded in rice under *Alfisol* during 2011, 2012 and pooled data. However, higher potassium uptake was recorded in wheat straw under *Vertisol* during 2011-12, 2012-13 and pooled data. The uptake of potassium in rice straw was higher than wheat.

Table 3: Effect of fly ash alone or in combination with organic manure and fertilizers on phosphorous uptake in grain and straw in rice-wheat cropping system in Alfisol and Vertisol at harvest

Particular	Phosphorous uptake in grain (kg ha^{-1})						Phosphorous uptake in straw (kg ha^{-1})					
	2011		2012		Pooled		2011		2012		Pooled	
	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol
Rice	10.67	10.91	10.95	10.96	10.81	10.94	3.59	4.11	3.58	4.40	3.59	4.26
Wheat	9.05	7.07	9.54	7.79	9.29	7.43	2.38	1.89	2.62	2.23	2.50	2.06
	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%
A	0.107	0.371	0.089	0.307	0.067	0.230	0.059	0.204	0.067	0.231	0.051	0.174
B	0.107	0.371	0.089	0.307	0.067	0.230	0.059	N/A	0.067	N/A	0.051	N/A
A×B	0.152	0.524	0.126	0.435	0.094	0.326	0.083	0.288	0.095	0.327	0.071	0.247

Table 4: Effect of fly ash alone or in combination with organic manure and fertilizers on phosphorus uptake in grain and straw in rice-wheat cropping system in Alfisol and Vertisol at harvest

Treatments	Phosphorous uptake in grain (kg ha^{-1})				Phosphorous uptake in straw (kg ha^{-1})			
	Rice		Wheat		Rice		Wheat	
	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol
T_1 - Control	4.52	3.23	3.71	2.01	1.71	0.83	0.69	0.32
T_2 - 10tFA ha^{-1}	5.89	4.22	4.01	2.46	2.24	1.56	0.81	0.48
T_3 - 20tFA ha^{-1}	6.00	5.49	4.43	3.34	2.61	2.05	1.15	0.77
T_4 - STCR	14.26^a	14.23^a	11.68^b	9.50^b	3.98	4.37	2.36^c	2.27^b
T_5 - 75%NPK ha^{-1}	9.41	9.08	8.11^g	5.90	2.95	3.17	2.05^c	1.72^d

T_6 - 100% NPK ha^{-1}	11.39	11.37	10.42^{d}	7.80^{e}	2.84	4.20	2.42^{c}	2.08^{c}
T_7 - 75%NPK ha^{-1} + 10tFA ha^{-1}	9.99	10.26	8.42^{g}	6.27	2.64	4.13	2.26^{c}	1.57^{d}
T_8 - 75%NPK ha^{-1} + 20tFA ha^{-1}	10.27	10.79	8.87^{f}	7.33^{f}	3.11	4.54	2.48^{b}	1.84^{c}
T_9 - 100%NPK ha^{-1} + 10tFA ha^{-1}	11.52	12.57	10.93^{c}	8.33^{d}	3.10	5.01	3.18^{a}	2.42^{b}
T_{10} - 100%NPK ha^{-1} + 20tFA ha^{-1}	12.30	12.82	10.95^{c}	9.02^{c}	3.74	4.74	3.28^{a}	2.47^{b}
T_{11} - 75% NPK ha^{-1} + 5tFYM ha^{-1}	10.49	10.98	9.61^{e}	7.39^{f}	3.82	5.09	2.44^{c}	2.17^{c}
T_{12} - 100%NPK ha^{-1} + 5tFYM ha^{-1}	12.10	13.73^{b}	11.51^{b}	9.05^{c}	4.23	6.61^{a}	3.17^{a}	2.64^{b}
T_{13} - 75%NPK ha^{-1} + 5tFYM + 10tFA ha^{-1}	12.41	12.31	10.27^{d}	9.42^{c}	4.42	5.28	3.19^{a}	2.56^{b}
T_{14} - 75%NPK ha^{-1} + 5tFYM + 20tFA ha^{-1}	13.23	14.80^{a}	10.53^{d}	9.94^{b}	4.50	5.21	3.15^{a}	2.94^{a}
T_{15} - 100%NPKha^{-1} + 5tFYM + 10tFA ha^{-1}	14.57^{a}	14.59^{a}	12.27^{a}	10.31^{a}	5.62^{a}	5.40	3.73^{a}	3.20^{a}
T_{16} - 100%NPK ha^{-1} + 5tFYM + 20tFA ha^{-1}	14.60^{a}	14.49^{a}	12.94^{a}	10.79^{a}	5.86^{a}	5.90	3.56^{a}	3.52^{a}
S.Em±	0.301				0.250			
CD at 5% level	0.843				0.699			

Interaction between crop × soil × treatments reveals (Table 6) that, rice × *Vertisol* × treatment, T_4 recorded significantly highest potassium uptake in straw among all the treatments and lowest potassium uptake was recorded in treatment T_1. It was at par with Treatment T_{16} and T_{15}.In case of rice × *Alfisol* × treatment, T_4 recorded significantly highest potassium uptake in straw among all the treatments and lowest potassium uptake was recorded in treatment T_1 and it was at par with treatment T_{16} and T_{12}. In case of wheat × *Vertisol* ×treatment, T_{16} recorded significantly highest potassium uptake in straw among all the treatments and lowest potassium uptake was recorded in treatment T_1. It was at par with T_{15}, T4 and T_{12}. In case of wheat × *Alfisol* × treatment, T_{16} recorded significantly higher potassium uptake in straw. It was at par with T_{15} and T_4 and lowest potassium uptake was recorded in T_1.

Incorporation of fly ash, alone or in combination with FYM and fertilizers significantly increased potassium content and uptake in rice grain under *Vertisol* and *Alfisol*, respectively. However, 100% NPK ha^{-1} + 5tFYM and STCR based fertilizer recommendation recorded higher potassium content and uptake in wheat straw under *Vertisol.*

The higher potassium content in grain and straw in rice under *Alfisol* responsible for supply of sufficient amount of nutrients and uptake was responsible for higher yield of crops. Similar finding have been reported by Sajwan (1995) [6] and Sarangi *et al.* (1997) [7].

Table 5: Effect of fly ash alone or in combination with organic manure and fertilizers on potassium uptake in grain and straw in rice-wheat cropping system in Alfisol and Vertisol at harvest

Particular	Potassium uptake in grain (kg ha^{-1})						Potassium uptake in straw (kg ha^{-1})					
	2011		2012		Pooled		2011		2012		Pooled	
	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol
Rice	22.81	23.47	23.33	24.37	23.07	23.92	80.84	87.87	83.60	91.48	82.22	89.67
Wheat	11.82	9.31	12.44	10.15	12.13	9.73	50.94	44.25	53.31	48.69	52.12	46.47
	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%
A	0.103	0.355	0.195	0.671	0.125	0.432	0.428	1.478	0.570	1.966	0.369	1.273
B	0.103	0.355	0.195	0.671	0.125	0.432	0.428	N/A	0.570	N/A	0.369	N/A
A×B	0.146	0.502	0.275	0.950	0.177	0.612	0.606	2.091	0.805	2.780	0.522	1.081

Table 6: Effect of fly ash alone or in combination with organic manure and fertilizers on potassium uptake in grain and straw in rice-wheat cropping system in Alfisol and Vertisol at harvest

Treatments	Potassium uptake in grain (kg ha^{-1})				Potassium uptake in straw (kg ha^{-1})			
	Rice		Wheat		Rice		Wheat	
	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol	Vertisol	Alfisol
T_1 - Control	10.21	6.98	5.34	2.89	44.06	28.76	25.20	14.08
T_2 - 10tFA ha^{-1}	12.42	10.14	5.54	3.54	52.76	40.12	26.94	18.94
T_3 - 20tFA ha^{-1}	12.77	12.34	6.16	4.73	55.22	49.42	33.77	25.92
T_4 - STCR	30.09^{a}	31.87^{a}	15.02^{b}	12.85^{a}	109.09^{a}	115.36^{a}	63.22^{a}	63.87^{a}
T_5 - 75%NPK ha^{-1}	21.18	22.71	10.85^{g}	8.10^{f}	74.10	84.19^{g}	48.83^{e}	43.21^{e}
T_6 - 100% NPK ha^{-1}	24.23	25.46	13.54^{d}	10.25^{d}	82.00	98.24^{d}	55.09^{c}	45.86^{e}
T_7 - 75%NPK ha^{-1} + 10tFA ha^{-1}	21.75	24.17	11.63^{f}	8.73^{e}	76.31	92.93^{e}	49.54^{d}	43.34^{e}
T_8 - 75%NPK ha^{-1} + 20tFA ha^{-1}	23.13	25.32	11.83^{f}	9.30^{e}	78.67	95.07^{e}	49.95^{d}	45.45^{e}
T_9 - 100%NPK ha^{-1} + 10tFA ha^{-1}	24.28	25.92	14.12^{c}	10.71^{c}	90.30	101.84^{c}	59.04^{b}	49.20^{d}
T_{10} -100%NPK ha^{-1} + 20tFA ha^{-1}	26.58	27.11	14.70^{c}	11.69^{b}	93.89	106.48^{b}	59.50^{b}	52.38^{c}
T_{11} - 75% NPK ha^{-1} + 5tFYM ha^{-1}	22.14	23.43	12.12^{e}	9.58^{d}	81.12	88.73^{f}	50.54^{d}	47.82^{d}
T_{12} - 100%NPK ha^{-1} + 5tFYM ha^{-1}	26.11	29.36^{c}	14.82^{b}	11.57^{c}	92.50	109.41^{a}	61.56^{a}	52.01^{d}
T_{13}- 75%NPK ha^{-1} + 5tFYM + 10tFA ha^{-1}	26.24	26.84	12.75^{e}	11.91^{b}	87.92	102.20^{c}	59.53^{b}	54.38^{c}
T_{14} -75%NPK ha^{-1} + 5tFYM + 20tFA ha^{-1}	27.69	30.06^{b}	13.33^{d}	12.50^{b}	88.93	102.99^{c}	59.54^{b}	58.28^{b}
T_{15} - 100%NPKha^{-1} + 5tFYM + 10tFA ha^{-1}	29.77^{a}	30.12^{b}	15.94^{a}	13.50^{a}	103.47^{a}	107.90^{b}	65.20^{a}	63.96^{a}
T_{16} - 100%NPK ha^{-1} + 5tFYM + 20tFA ha^{-1}	30.51^{a}	30.87^{a}	16.43^{a}	13.78^{a}	105.18^{a}	111.13^{a}	66.54^{a}	64.85^{a}
S.Em±	0.440				2.199			
CD at 5% level	1.231				6.159			

References

1. Chapman HD, Pratt PF. Soil water and plant analysis. In. Univ. California Agri. Div. Publisher 1961.
2. Jackson ML. Soil chemical analysis, pentice hall of India Pvt. Ltd., New Delhi 1967.
3. Jambagi AM, Patil CV, Yeledhalli NA, Prakash. Growth and yield of safflower grown on fly ash amended soils. In abstracts, National Seminar on use of lignite fly ash in agriculture, held at Annamulainagar 1995;17.
4. Kanungo SP. Laboratory studies and field application of fly ash in forest nurseries and plantation at CSIR- IMMT, National workshop on use of fly ash in forestry and development of degraded/wasteland, held during 2013, P23-33.
5. Lal K, Chhabra R, Mongia AD, Meena RL, Yadav RK. Release and uptake of potasium and sodium with fly ash application in rice on reclaimed alkali soil. Journal of the Indian Society of Soil Science 2012;60:181-186.
6. Sajwan KS. The effect of fly ash/sewage sludge mixture and application rates on biomass production. J Environment Science Health. A 1995;30(6):1327-1337.
7. Sarangi PK, Mishra TK, Mishra PC. Soil metabolism, growth and yield of *Oryza Sativa* L. in fly ash amended soil. Indian Journal of Environment Science 1997;1(1):17-24.
8. Selvakumari G, Baskar M, Jayanthi D, Mathan KK. Effect of integration of fly ash with fertilizers and organic manures on nutrient availability, yield and nutrient uptake of rice in Alfisols. J Indian Soci. Soil Sci 2000;48(2):268-278.
9. Singh NB, Singh M. Influence of fly ash on nitrogen, phosphorous and potassium contents and their uptake by rice grown in saline soil at different fertility. Banaras Hindu University J 1986;23(3):145-151.
10. Totawat KL, Nagar GL, Jat SL, Jangir RK. In: Symposium on Effect of fly ash on the performance of wheat on ustochrepts of sub humid plains of India, held during 14- 21 August 2002, Thailand, Symposium no. 24, 2002, Paper no 215, P1-11.
11. Warambhe PE, Kene DR, Thakare KK, Darange OG, Bhoyar VS. Evaluation of physic chemical properties of fly ash of thermal power station, Koradi (Nagpur) for its likely use in agriculture. Journals of Soil and Crops 1993;3(1):75-77.