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Effect of different levels of fly ash and nitrogen on growth and productivity of rice (*Oryza sativa* L.)

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Abstract
A field experiment entitled "Effect of different levels of fly ash and nitrogen on growth and productivity of rice (*Oryza sativa* L.)" was conducted during the *kharif* season of 2018 at Research Farm, Guru Kashi University, Talwandi Sabo, Bathinda (Punjab). The trail was laid out in split plot design with three levels of fly ash *viz.*, 0, 10 and 20 t ha^{-1} in main plot and five levels of nitrogen *viz.*, 90, 120, 150 and 180 kg N ha^{-1} in sub plot, replicated thrice. There is a good scope of increasing crop yields through the use of fly ash. It is extremely important for sustaining production and improving the fertility of soils. Fly ash significantly increased the plant growth *viz.*, plant height, dry matter and number of tillers/plant and yield attributing characters *viz.*, number of grains/panicle and test weight and seed cotton yield, straw yield and harvest index in rice. Application of fly ash @ 10 and 20 t/ha recorded 4.80 and 2.27% more grain yield than control. Nitrogen @ 180 kg ha^{-1} and 150 kg ha^{-1} resulted in the statistically similar plant growth, yield attributes and grain yield in rice. Nitrogen @ 180 kg N ha^{-1} and 150 kg N ha^{-1} recorded 6.97 and 6.19% higher grain yield than 90 kg N ha^{-1}, respectively.

Keywords: Fly ash, grain yield, rice, straw yield and test weight.

Introduction
Rice (*Oryza sativa* L.) is commonly known as Asian rice belongs to family poaceae. Rice originated as a wild grass species around 130 million years ago and south-east Asia was the first place where the cultivated rice was grown about 10,000 years ago. India comes among the biggest centers of rice growing countries. It covers around 44 million cultivated hectare of land. Only rice accounts around 40-42% of the India's total food production. Among the various rice growing countries across the globe, India is second largest producer and consumer of rice after China. In India, it is in cultivation since ages and is grown over an area of about 43.37 million ha with annual production of about 115.60 million tonnes of paddy and average productivity of 3.96 t ha^{-1}. In India, rice is grown in most of the states under various climatic conditions and different techniques of crop production. West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab, Tamil Nadhu, Orissa and Bihar are major rice producing states. West Bengal is the highest rice producing state with production of 15.7 million tonnes from the area of 5.5 million ha (Anonymous 2020) [1]. Fly ash an amorphous ferro-alumino silicate, physically fly ash occurs as fine particles (60-70%) which has a size below 0.075 mm is a by-product of pulverized coal fired thermal power station and has low to medium bulk density, high surface area and very light texture with pH varying from 4.5 to 12 depending upon S content in the coal (Lal *et al.* 2012) [4]. Being a vegetative fossil fly ash consist of mineral matter which plant have up taken 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) [7].

Materials and Methods
The field experiment study entitled, "Effect of different levels of fly ash and nitrogen on the growth and productivity of rice (*Oryza sativa* L.)" was conducted at research farm of Guru Kashi University, Talwandi Sabo (Bathinda) during *kharif* season 2018. It is situated at 29º 33' N latitude and 74º 38' E longitude at a height of 208 metres above the mean sea level. The experimental site belongs to semi-arid climate, where both summers and winters are acute. A maximum temperature of about 45ºC is common during summer, while freezing temperature accompanied by frost happening may be there in the months of December and January. The monsoon normally starts from the first week of July. The average annual rainfall at Bathinda is 500-750 mm, most of which is received during the rainy season from July to September due to the south-west monsoons. Often, scanty rainfall is received during winter months of December, January and February.

The collected data were statistically analyzed by using Fisher's ANOVA technique and Critical difference (CD) test at 5% probability level was used to compare differences among treatment.

Results and Discussion

Vegetative parameters of rice

The data pertaining to vegetative parameters (Table 1) of rice crop maximum plant height (131.3 cm) was recorded with the application of nitrogen @ 150 kg/ha followed by nitrogen @ 180 kg/ha (121.3 3 cm).

The Fly ash also differed significantly in plant height. Amongst different level of fly ash @ 10 t/ha (124.8 cm) show the maximum height. Maximum number of tillers/plant (12.7) was recorded with the application of nitrogen @ 150 kg/ha. The Fly ash also differed significantly in tillers. Amongst different level of fly ash @ 10 t/ha (13.0) showed the maximum number of tillers.

Table 1: Vegetative parameters of rice as influenced by different fly ash and nitrogen levels

Fly ash (t/ha)	plant height(cm)				number of tillers/plant				Dry matter accumulation (q/ha)				Leaf area index			
	Nitrogen levels (kg N/ha)				Nitrogen levels (kg N/ha)				Nitrogen levels (kg N/ha)				Nitrogen levels (kg N/ha)			
	90	120	150	180	90	120	150	180	90	120	150	180	90	120	150	180
0	116.6	113.6	124.3	5.93	5.93	5.93	5.93	12.7	83.1	82.7	84.9	88.6	5.93	5.88	5.95	5.76
10	114.5	118.0	147.1	5.99	5.99	5.99	5.99	12.9	88.6	92.0	88.6	93.2	5.99	5.83	5.85	5.79
20	117.6	117.7	122.5	5.77	5.77	5.77	5.77	12.1	85.7	82.8	91.2	94.8	5.77	5.92	5.86	5.79
Mean	116.2	116.4	131.3	5.90	5.90	5.90	5.90	12.6	85.8	85.8	88.2	92.2	5.90	5.88	5.88	5.78

The data pertaining to dry matter accumulation shows maximum (92.24 q/ha) with the application of nitrogen @ 180 kg/ha. The Fly ash also differed significantly in Dry matter accumulation. Amongst different level of fly ash @ 10 t/ha (90.65 q/ha) showed the maximum dry matter accumulation. Maximum result in leaf area index (5.90) was recorded with the application of nitrogen @ 90 kg/ha. The Fly ash also differed significantly in leaf area index. Amongst different level of fly ash, control (5.88) showed the maximum leaf area index. Data pertaining to panicle length shows maximum (25.75 cm) with the application of nitrogen @ 150 kg/ha. The Fly ash also differed significantly in length of panicle. Amongst different level of fly ash @ 10 t/ha (26.0 cm) showed the maximum panicles. Similar results were also reported by Nehra and Kumawat (2003) [6], Bhaskar *et al.* (1993) [2] and Devi *et al.,* (1995) [3].

Yield parameters of rice

The data pertaining to yield parameters (Table 2) of rice crop, Test weight shows maximum (27.60 g) by applying nitrogen @ 150 kg/ha. The Fly ash also differed significantly in test weight. Amongst different level of fly ash fly ash @ 10 t/ha (26.8) showed the maximum test weight. Similar results were also reported by Nehra and Kumawat (2003) [6], Bhaskar *et al.,* (1993) [2] and Devi *et al.,* (1995) [3].

Table 2: Yield parameters of rice as influenced by different fly ash and nitrogen levels

Fly ash (t/ha)	Test weight (g)				Panicle length (cm)				Number of grains per panicle			
	Nitrogen levels (kg N/ha)				Nitrogen levels (kg N/ha)				Nitrogen levels (kg N/ha)			
	90	120	150	180	90	120	150	180	90	120	150	180
0	25.23	26.50	27.43	26.73	24.26	25.60	24.40	24.86	120.00	123.53	126.46	126.06
10	25.00	25.86	29.20	27.13	25.46	25.33	26.98	26.24	126.66	128.93	123.40	133.86
20	24.86	25.16	26.16	27.60	25.33	25.86	25.89	25.00	125.33	124.46	127.93	128.20
Mean	25.05	25.84	27.60	27.15	25.02	25.59	25.75	25.36	124.00	125.64	125.93	129.37

Table 3: Productivity of rice as influenced by different fly ash and nitrogen level

Fly ash (t/ha)	Grain yield (q/ha)				Straw yield (q/ha)				Harvest index (%)			
	Nitrogen levels (kg N/ha)				Nitrogen levels (kg N/ha)				Nitrogen levels (kg N/ha)			
	90	120	150	180	90	120	150	180	90	120	150	180
0	65.24	67.96	72.61	74.19	141.22	151.52	155.96	168.69	31.64	31.27	32.06	30.79
10	71.13	70.13	74.91	74.91	149.66	149.38	162.05	184.58	32.28	32.24	31.78	29.57
20	69.47	72.61	71.08	71.08	146.85	149.83	157.77	169.63	32.12	32.67	31.18	30.38
Mean	68.61	70.23	72.86	73.39	145.91	150.24	158.59	174.30	32.02	32.06	31.67	30.25

Maximum number of grains/panicle (129.37) was recorded under application of nitrogen @ 180 kg/ha. The Fly ash also differed significantly in number of grains per particle. Amongst different level of fly ash @ 10 t/ha (128.21) showed the maximum grains per panicle. Similar results were also reported by Nehra and Kumawat (2003) [6], Bhaskar *et al.,* (1993) [2] and Devi *et al.,* (1995) [3].

Productivity of rice

The data pertaining grain yield (Table 3) was found maximum (72.86 q/ha) with the application of nitrogen @ 180 kg/ha. The fly ash also differed significantly in grain yield. Amongst different levels of fly ash, 10 t/ha (73.37 q/ha) showed the maximum grain yield. Maximum straw yield (174.30 q/ha) was recorded with the application of nitrogen @ 180 kg/ha has maximum straw yield. The Fly ash also differed significantly in straw yield. Amongst different level of fly ash, fly ash @ 10 t/ha (161.41 q/ha) showed the maximum straw yield. The data pertaining to harvest index shows maximum (32.06) by applying nitrogen @ 120 kg/ha followed by nitrogen @ 90 kg/ha (32.02). The Fly ash also differed significantly in harvest index. Amongst different level of fly ash, 20 t/ha fly ash (31.59) showed the maximum harvest index. Similar results were also reported by Nehra and Kumawat (2003) [6], Bhaskar *et al.,* (1993) [2] and Devi *et al.,* (1995) [3].

It is clearly concluded that there is a good scope of increasing crop yields through the use of fly ash. It is extremely important for sustaining production and improving the fertility of soils. Application of fly ash @ 10 and 20 t/ha recorded 4.80 and 2.27% more grain yield than control. Nitrogen @ 180 kg N ha^{-1} and 150 kg N ha^{-1} recorded 6.97 and 6.19% higher grain yield than 90 kg N ha^{-1}, respectively.

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