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Enhancing the Performance of Basmati Rice (*Oryza sativa* L.) through Fly Ash and Nitrogen Management

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A B S T R A C T

A field experiment entitled "Enhancing the performance of basmati rice (*Oryza sativa* L.) through fly ash and nitrogen management" was conducted during the *kharif* season of 2018 at Research Farm, Guru Kashi University, Talwandi Sabo, Bathinda (Punjab). The experiment was laid out in split plot design with combination of three levels of fly ash (control, fly ash @ 10 t ha^{-1}, fly ash @ 20 t ha^{-1}) in main plots and four levels of nitrogen (40 kg N ha^{-1}, 50 kg N ha^{-1}, 60 kg N ha^{-1} and 70 kg N ha^{-1}) in sub plots, replicated thrice. Among the fly ash levels, application of fly ash 20 t ha^{-1} resulted in significantly higher growth, yield attributes and grain yield of basmati rice than control and fly ash @ 10 t ha^{-1}. The application of 70 kg N ha^{-1} resulted in significantly higher growth, yield attributes and grain yield of basmati rice than other nitrogen levels. Fly ash @ 20 t ha^{-1} with 70 kg N ha^{-1} recorded maximum growth and productivity of basmati rice, which was significantly higher over all other treatments, but it was statistically at par with fly ash @ 20 t ha^{-1} and 60 kg N ha^{-1}.

Introduction

Basmati rice known as "Queen of Rice" (bas means aroma, mati means queen), occupies a special status in developing countries. It has great export potential due to its aroma, sweet taste, dry and soft texture and excellent cooking qualities (Sidhu *et al.*, 2004). Rice is highly nutritive crop and contains carbohydrate, protein, fat, minerals (phosphorus, calcium, iron etc.) and amino acids.

Fly ash is produced as a result of coal combustion in thermal power station and discharged in ash ponds. In India and most countries major source of electrical energy is coal based thermal power plants, which produces 175 million tonnes. Disposal of high amount of fly ash from thermal power plants absorbs huge amount of water, energy and land area by ash ponds. The fly ash utilization in the country is estimated to be about 59% only (Kanungo, 2013) Therefore fly ash management would remain a great concern of the century. However, several studies purposed that fly ash can be used as a soil ameliorant that may improve physical, chemical, biological properties of the soil and is a source of readily available plant micro and macro-nutrients. Addition of small amounts of fly ash to soil neutralizes the acidity to a level suitable for agriculture. Application of fly ash increased the yield in various crops with improvement in the physical, chemical and biological properties and found beneficial for soil and crop (Kohli *et al.*, 2010). Nitrogen is an essential constituent of proteins, chlorophyll and metabolites such as alkaloids, nucleotides, phosphatides, enzymes, vitamins and hormones etc. which have great importance in plant metabolism.

Nitrogen increase crop yield and protein content in grains. It also promotes the vegetative growth in rice. Nitrogen play a key role in plant physiological processes influenced the sink size thereby increasing the grain yield of rice (Somasundaram *et al.*, 2002). Application of nitrogen fertilizer to the basmati rice, leads to increase the plant height, leaf size, number of panicle, number of spikelet and grain yield (Balasubramanian 2002; Walker *et al.*, 2008). Nitrogen is an important component of rice production technology with high yielding cultivars and its important role in increasing rice productivity (Kumar and Prasad, 2004). Keeping in view the present study was planned to study the effect of different levels of fly ash and nitrogen on the performance of basmati rice.

Materials and Methods

The present investigation Enhancing the performance of basmati rice (*Oryza sativa* L.) through fly ash and nitrogen management was conducted at Research Farm, University College of Agriculture, Guru Kashi University, Talwandi Sabo, Bathinda during *kharif* season of 2018. Talwandi Sabo is located at 29^{o} 57 N latitude and 75^{o}7 E longitudes and altitudes (213 m above sea levels). The tract is characterized by semi-arid climate. Maximum temperature is about 45-47^{0}C is not uncommon during summer, while freezing temperature accompanied by frost occurrence may be witnessed in the month of December and January. The mean annual rainfall fluctuates around 150 mm, major part of which is during the month of July to November. The soil of experimental field was slightly alkaline (pH 7.8) with normal electrical conductivity (1.41 dSm^{-1}), low in organic carbon content (0.29%) and available nitrogen (233.7 kg ha^{-1}), medium in available phosphorus (15.0 kg ha^{-1}) and available potassium (216.8 kg ha^{-1}). The experiment was laid out in split plot design with three replications. The treatment comprising of three levels of *viz.*, control, fly ash @ 10 t ha^{-1}, fly ash @ 20 t ha^{-1} and four levels of nitrogen *viz.*, 40 kg N ha^{-1}, 50 kg N ha^{-1}, 60 kg N ha^{-1} and 70 kg N ha^{-1}.

The plant height, number of tillers and number of effective tillers was counted manually from randomly selected five plants at maturity in each plot. The panicle length from base of plant to tip of panicle from the five randomly selected plants in each plot was measured and average value was expressed in centimeters. The dry matter accumulation was recorded from each selected plants from each plot firstly sun dried and then kept it in oven for 24 hrs at 65^{0}C then weighing and expressed it in q ha^{-1}. The weight of total produce per plot was recorded after harvest of the crop with the help of spring balance. The bundle weight was taken before threshing and plot wise straw yield was obtained after deducting the grain weight from the whole bundle weight. The weight of randomly 1000-grains was recorded from each plot and expressed in g. The harvest index was calculated by using following formula:

$$\text{Harvest Index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Fisher's ANOVA technique and least

significant difference (LSD) test at 5% probability level was used to compare differences among treatment means (Steel and Torrie,1981).

Results and Discussion

Growth parameters of basmati rice

Amongst the fly ash levels, highest plant height (117.4 cm) was recorded with the application of fly ash @ 20t ha^{-1} which was significantly higher than other treatments (Table 1). Amongst the nitrogen levels, highest plant height (116.8 cm) was recorded with the application of nitrogen 70 kg N ha^{-1} which was significantly higher than other treatments. The lowest plant height was recorded with the application of 40 kg N ha^{-1}. Similar results were also reported by Reddy *et al.*, (2010) and Singh *et al.*, (2007)

Significantly higher number of total tillers m^{-1} row length (82.5) was recorded with the application of fly ash @ 20t ha^{-1} which was significantly higher than other treatments, whereas the lowest number of total tillers m^{-1} of row length (68.5) were recorded in control (Table 1). Amongst the nitrogen levels, the maximum number of tillers m^{-1} of row length (79.6) was recorded with the application of 70 kg N ha^{-1}. Similar results were also reported by Mittra *et al.*, (2005) and Sikdar *et al.*, (2006).

Significantly higher dry matter accumulation (143.3 q ha^{-1}) was recorded with the application of fly ash @20t ha^{-1} which was significantly higher than other treatments (Table 1). The lowest dry matter accumulation (104.8 q ha^{-1}) was recorded in 20 t fly ash ha^{-1} and 70 kg N ha^{-1}. The nitrogen application @ 70 kg ha^{-1} resulted in higher number of tillers m^{-1} of row length (137.6). Similar results were also reported by Deshmukh *et al.*, (2000) and Mannan *et al.*, (2010).

Yield attributes of basmati rice

The application of fly ash@20 t ha^{-1} with 70 kg N ha^{-1} recorded maximum number of effective tillers/m of row length (78.5) of basmati rice, which was significantly higher over all the treatments (Table 2). The lowest number of effective tiller/m of row length was recorded in treatment receiving no fly ash. Amongst the nitrogen levels the maximum number of effective tillers/m of row length (74.6) was recorded with the application of 70 kg N/ ha^{-1}. Similar results were also reported by Das *et al.*, (2013) and Sikdar *et al.*, (2006).

Maximum panicle length (27.1) of basmati rice was recorded in fly ash @ 20t ha^{-1} which was significantly higher than control and fly ash @ 10 t ha^{-1} (Table 2). Whereas, the minimum panicle length (24.8 cm) was recorded in control. The different levels of nitrogen influenced the panicle length of rice, Out of different levels of N, maximum panicle length (26.3 cm) observed in 70 kg N ha^{-1}, which was significantly higher than other N levels. The minimum panicle length (24.7 cm) was recorded in 40 kg N ha^{-1}. Similar result were also reported by Karmakar *et al.*, (2010) and Bhattacharya and Singh (1991).

Amongst the different levels of fly ash, the highest number of grains $panicle^{-1}$ (104.3) of basmati rice was recorded in fly ash @ 20 t ha^{-1}, which was significantly higher than control and fly ash @ 10t ha^{-1}. The lowest number of grains $panicle^{-1}$ (86.3) was recorded in control. The nitrogen levels also significantly increase the number of grains $panicle^{-1}$ of basmati rice. It was observed that the highest mean number of grains/panicle (100.4) was recorded in 60 kg N ha^{-1}, which was significantly higher than other N levels. The lowest number of grains $panicle^{-1}$ (88.1) was recorded in 40 kg N ha^{-1}. Similar results were also reported by Das *et al.*, (2013) and Mannan *et al.*, (2010).

Table.1 Growth parameters of basmati rice as influenced by different fly ash and nitrogen levels

Treatment	Plant height (cm)	Number of tillers m^{-1} row length	Dry matter accumulation (q ha^{-1})
Fly ash levels (t ha^{-1})			
Control	112.5	68.5	104.8
10	115.5	72.2	123.4
20	117.4	82.8	143.3
LSD (P=0.05)	0.1	0.9	1.06
Nitrogen levels (kg ha^{-1})			
40	113.3	68.1	109.1
50	114.7	73.5	119.7
60	115.6	76.8	128.8
70	116.8	79.6	137.6
LSD (P=0.05)	0.1	0.8	0.9

Table.2 Yield attributing characters of basmati rice as influenced by different fly ash and nitrogen levels

Fly ash	No. of effective tillers m^{-1} of row length	Panicle length (cm)	Number of grains $panicle^{-1}$	Test weight (g)
Fly ash levels (t ha^{-1})				
Control	63.1	24.8	86.3	20.8
10	67.3	25.1	92.8	21.1
20	78.5	27.1	104.3	20.9
LSD (P=0.05)	0.9	0.2	0.8	NS
Nitrogen levels (kg ha^{-1})				
40	63	24.7	88.1	20.6
50	68.3	25.4	91.7	20.7
60	72.7	26.1	100.4	21.3
70	74.6	26.3	97.8	20.9
LSD (P=0.05)	0.1	0.1	0.9	0.3

Table.3 Grain yield of rice as influenced by different levels of fly ash and nitrogen

Fly ash levels (t ha^{-1})	Grain yield (q/ha)				
	Nitrogen levels (kg ha^{-1})				Mean
	40	50	60	70	
Control	39.4	41.7	42.7	43.5	41.8
10	40.5	42.9	45.2	46.8	43.8
20	43.7	46.9	48.5	49.3	47.1
Mean	41.2	43.8	45.4	46.5	44.2
LSD (P=0.05)	Fly ash		Nitrogen		Interaction
	0.3		0.5		0.9

Table.4 Productivity of basmati rice as influenced by different fly ash and nitrogen levels

Treatment	Straw yield ($q\ ha^{-1}$)	Biological yield ($q\ ha^{-1}$)	Harvest index (%)
Fly ash levels ($t\ ha^{-1}$)			
Control	70.0	111.8	37.3
10	74.4	118.3	37.0
20	89.4	136.2	34.3
LSD (P=0.05)	1.1	1.4	0.7
Nitrogen levels ($kg\ ha^{-1}$)			
40	73.6	114.8	35.9
50	76.5	120.3	36.4
60	79.3	124.8	36.5
70	82.4	128.9	36.1
LSD (P=0.05)	1.1	1.0	0.6

Test weight of basmati rice does not differed significantly amongst fly ash levels (Table 2). The effect of the increasing fly ash levels on test weight was found be not significant. Amongst the different nitrogen levels, more 1000-grain weight (21.3 g) obtained in 60 kg N ha^{-1}, which was significantly higher over the other levels of nitrogen. The lowest 1000-grain weight (20.6 g) was obtained in 40 kg N ha^{-1}. Similar results were also reported by Singh *et al.*, (2011).

Productivity of basmati rice

The interaction effects on grain yield of rice were found to be significant (Table 3). Fly ash @ 20 ha^{-1} recorded highest grain yield (49.3q ha^{-1}) under 70 kg N ha^{-1}, which was statistically at par with fly ash @ 20 t ha^{-1} and 60 kg N ha^{-1} and minimum grain yield (39.4 q ha^{-1}) was recorded in control (no fly ash) and 40 kg N ha^{-1}**.**

The highest straw yield (89.1q ha^{-1}) of basmati rice was observed with the application of fly ash @ 20 t ha^{-1}, which was significantly higher than control and fly ash @ 10 t ha^{-1} (Table 4). The lowest straw yield (70.0 q ha^{-1}) of basmati rice was recorded in control. The different levels of N also increased the straw yield of basmati rice. The highest straw yield (82.4 q ha^{-1}) was observed in 70 kg N ha^{-1}, which was significantly higher than other levels of N. The lowest straw yield (73.6 q ha^{-1}) was recorded in 40 kg N ha^{-1}.This finding was in conformity with that of Reddy *et al.*, (2010) and Islam *et al.*, (2008).

The highest biological yield (136.2 q ha^{-1}) was recorded in fly ash @ 20t ha^{-1}) which was significantly higher than control and fly ash @10 t ha^{-1} (Table 4). The lowest biological yield (105.6 q ha^{-1}) was recorded in control. The different N levels also increased the biological yield of rice. Amongst the different N levels the highest biological yield (128.9 q ha^{-1}) was recorded in 70 kg N ha^{-1}) which was significantly differed than other levels of N. The lowest yield (114.8 q ha^{-1}) was recorded in 40 kg N ha^{-1}.

Amongst the fly ash levels, the maximum harvest index (37.3%) was observed in control which significantly higher than fly ash @10 t ha^{-1} and fly ash @ 20 t ha^{-1}. The lowest harvest index (34.3%) was recorded in fly ash @ 20 t ha^{-1}. The N levels also influenced the harvest index percentage. The highest harvest index (36.1%) was recorded in 60 kg N ha^{-1}

which significantly higher over other N levels. The lowest harvest index (35.9%) was recorded in 40 kg N ha^{-1}.

In conclusion, application of fly ash @ 20 t ha^{-1} resulted in maximum growth parameter, yield attributes and grain yield, which was significantly higher than control and fly ash @10t/ha. Among the different nitrogen levels, application of 70kg N ha^{-1} recorded the maximum growth parameters, yield attributes and grain yield of basmati rice than the lower levels of N. The maximum grain yield recorded with the application fly ash @ 20 t ha^{-1} and 70 kg N ha^{-1} which significantly higher but at par with fly ash @ 20 t ha^{-1} and 60 kg N ha^{-1}. The data recommended that the integration of fly ash @ 20 t ha^{-1} and 60 kg N ha^{-1} is sufficient to get optimum yield of basmati rice.

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