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# Effect of Fly Ash and Nitrogen on the Growth and Productivity of Oat

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**ABSTRACT**

A field experiment was conducted to assess effect of fly ash and nitrogen on the growth and productivity of oat. The results showed that the fly ash @ 10 t ha$^{-1}$ gave maximum growth characters and yield attributes *viz.*, number of grains/spikelet, test weight and grain yield. The percent increase in grain yield (24.2 q ha$^{-1}$) at 10 t fly ash ha$^{-1}$ was 3.41 and 18.0 over 5 t fly ash ha$^{-1}$ application and control, respectively. Among nitrogen management, 112.5 kg N ha$^{-1}$ application gave higher growth parameters and yield attributes i.e. test weight as compared to other nitrogen levels. The percent increase in grain yield with 112.5 kg N ha$^{-1}$ was 4.60, 11.60 and 28.8 over 75 kg N ha$^{-1}$, 37.5 kg N ha$^{-1}$ and control, respectively.

## Introduction

Oats (*Avena sativa* L.) are a diploid species with chromosome number (2n=2x=14) belongs to the family of Poaceae or Gramineae. Cereals for human nutrition are on the first place in the world and in our country. The oat plant in cereals for animal feed is also healthy and useful addition to the human diet (Peterson *et al.*, 1998). In recent years, because of health benefit claims of oat diet, its importance is gradually increased and gave rise to breakfast, snacks, biscuits and baby foods industries (Guler, 2011). Oat has been cultured for about 2000 years, and is used as animal feed and human food.

The use of mineral fertilizers is the quickest and surest way of boosting crop production. However, their cost and other constraints frequently deter farmers from using them in recommended quantities and in balanced proportions. Complementary use of plant nutrients from waste materials along with mineral fertilizers is of great importance in the maintenance of farm productivity and profitability. Fly ash, a major industrial waste and byproduct produced from thermal power stations, is a low density ferro-alumino silicate. Presence of various elements such as P, K, Ca, Mg, S and micronutrients in the fly ash make it a good source of plant nutrients (Deshmukh *et al.*, 2000). The increase yield of different crops due to application of fly ash was observed by Kuchanwar and Matte (1997). Oat needs not only macronutrients but secondary as well as micronutrients to produce higher yields. Use of manures, organic and inorganic wastes and bio-fertilizers is gaining wider acceptance to reduce input cost and to sustain soil fertility. Therefore, this research work was aimed to determine the response of oat to different doses of fly ash and nitrogen on growth and productivity.

## Materials and Methods

The present investigation "Effect of fly ash and nitrogen on the growth and productivity of oat (*Avena sativa* L.)" was conducted at experimental farm of University College of Agriculture, Guru Kashi University Talwandi Sabo, Bathinda during *rabi* season 2018-2019. Soil of experimental field was sandy loam in texture. The soil was alkaline (pH 7.4) and with normal electrical conductivity (0.34 $dSm^{-1}$). The soil was low in organic carbon content (0.34%). The available nitrogen (225.0 kg /ha) was low, whereas the available phosphorus (13.9 kg/ha) and available potash (245.6 kg/ha) were medium. The experiment was laid out in split plot design with three replications. The treatments comprised of Three levels of fly ash (0, 5, 10 t $ha^{-1}$) and four level of nitrogen (0, 37.5, 75 and 112.5 kg $ha^{-1}$). Source of fly ash was thermal power plant at village Banawala, Mansa Talwandi sabo road, District Mansa, Punjab, India.

The height of five randomly selected plants was measured at maturity. The number of grains per panicle counted from the ears of the tagged plants. Dry matter accumulation was recorded from each plot and then converted into q $ha^{-1}$. The plant biomass harvested from individual plots was first sun dried followed by oven drying at $65^{0}$C till constant weight was obtained. After complete drying, dry weight was recorded and converted into q/ha. Leaf area index (LAI) was recorded at spikelet formation first measure the leaf length, width of leaf and then count the leaf of each tiller and then count the number of tillers per plant.

$$\text{LAI} = \frac{\text{Leaf area}}{\text{Ground area}}.$$

The total biomass was recorded after complete drying of the harvested crop from each plot. The weight of total produce/plot was recorded after harvest of the crop with help of spring balance. Then the weight of grain per net plot was recorded after threshing of the harvested produce from each bundle and mean converted into the grain yield kg $ha^{-1}$. Number of effective tillers per meter row length were taken differently from every two sites from each plot. The weight of randomly 1000-grains was recorded from each plot and expressed in gram (gm). Harvest index (HI) was calculated by using following formula;

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

## Results and Discussion

### Growth parameters

The maximum plant height (170.6 cm) was recorded in application of 10 t fly ash $ha^{-1}$ which was at par with plant height (169.2 cm) recorded at the application of 5 t fly ash $ha^{-1}$ (Table 1). While minimum plant height (166.8 cm) was recorded at control. Similarly, the application of nitrogen increases the plant height and maximum plant height (176.1 cm) was observed at 112.5 kg N $ha^{-1}$ application which was at par with plant height (174.1cm) recorded at the application of 75 kg N $ha^{-1}$. While, lowest plant height (160.2 cm) was recorded under control. The interaction effect between fly ash and nitrogen was non significant.

Significantly highest leaf area index (3.17) was observed with application of fly ash 10 t $ha^{-1}$ as compare to other fly ash treatment (Table 1). While, lowest leaf area index (2.83) was observed at control. Increased nitrogen levels resulted in increase leaf area index. The highest leaf area index (3.28) was recorded with application of 112.5 kg N $ha^{-1}$ which was at par with leaf area index (3.17) was recorded at the application of 75 kg N $ha^{-1}$, While, lowest leaf area index (2.68) was recorded at control. The interaction effect between fly ash and nitrogen was non significant.

Application of 10 t fly ash $ha^{-1}$ recorded maximum dry matter accumulation (139.4 q $ha^{-1}$) which was at par with 5 t fly ash $ha^{-1}$ treatment (Table 1). The minimum dry matter accumulation (133.2 q $ha^{-1}$) was recorded in control. Dry matter accumulation was increased with increase nitrogen levels. The highest dry matter accumulation (157.1 q $ha^{-1}$) was recorded with application of 112.5 kg N $ha^{-1}$ which was at par with (155.1 q $ha^{-1}$) dry matter accumulation recorded at 75 kg N $ha^{-1}$ application. And lowest dry matter accumulation (106.3 q $ha^{-1}$) was recorded under control. The interaction effect between fly ash and nitrogen was non significant.

The variation in the above mentioned growth parameters have also been reported by many research workers Deshmukh *et al.,* (2000), Brown *et al.*, (1961); Brinkman and Rho (1984), Akbari *et al.*, (1988), Summers *et al.*, (1998), Malik *et al.*, (2015).

## Yield attributes

The maximum number of effective tillers per meter row length of oat (108.8) was recorded at the application of 10 t fly ash $ha^{-1}$ was at par with (106.4) number of effective tillers recorded at the application of 5 t fly ash $ha^{-1}$ (Table 2). The minimum effective tillers (103.3) were recorded in control. Experimental data indicated that increase in levels of nitrogen increase of number of effective tillers The maximum number of effective tillers (112.6) recorded at the application of 112.5 kg N $ha^{-1}$ which was at par with (109.4) effective tillers recorded at the application of 75 kg N $ha^{-1}$, while minimum number of effective tillers (98.5) was recorded under control.

The maximum number of grains per spikelet (99.3) was recorded with the application of 10 t $ha^{-1}$ was at par with number of grains per spikelet (97.3) was recorded at the application of 5 t fly ash $ha^{-1}$ (Table 2).While minimum number of grains (92.3) per spikelet was recorded in control. Increase in nitrogen levels increased number of grains per spikelet. The maximum number of grains per spikelet (108.0) was recorded at the application of 112.5 kg N $ha^{-1}$ which was at par with number of grains per spikelet (104.9) was recorded with the application of 75 kg N $ha^{-1}$. While, minimum number of grains per spikelet (77.8) was recorded under control. The significant interaction effect of fly ash 10 t $ha^{-1}$ and 112.5 kg N $ha^{-1}$ resulted maximum number of grains (112.2) per spikelet.

The significantly maximum test weight (31.2 g) was recorded in application of 10 t fly ash $ha^{-1}$ as compare to other fly ash treatments and minimum test weight (27.6 g) was recorded at control (Table 2). Data indicated that increase in nitrogen levels increased test grain weight. Maximum test weight (31.0 g) was recorded at the application of 112.5 kg N $ha^{-1}$ which was at par with (30.5 g) test weight was recorded at the application of 75 kg N $ha^{-1}$. Minimum test weight (27.3 g) was recorded under control. The interaction effect between fly ash and nitrogen was non significant. The variation in the above mentioned growth parameters have also been reported by many research workers Khan *et al.*, (1997), Jat *et al.*, (2017) and Ghosh (1985).

## Productivity

Maximum grain yield (24.2 q $ha^{-1}$) was recorded at application of 10 t fly ash $ha^{-1}$ which was at par with grain yield (23.4 q $ha^{-1}$) recorded at the application of 5 t fly ash $ha^{-1}$ (Table 3). Minimum grain yield (20.5 q $ha^{-1}$) was obtained at control. The percent increase grains yield at 10 t fly ash $ha^{-1}$ was 3.41 and 18.0 over 5 t fly ash $ha^{-1}$ application and control, respectively.

Increase the level of nitrogen increase grain yield. The maximum grain yield (25.0 q $ha^{-1}$) was recorded at application of 112.5 kg N $ha^{-1}$ which was at par with grain yield (23.9 q $ha^{-1}$) was recorded at application of 75 kg N $ha^{-1}$, while minimum grain yield (19.4 q $ha^{-1}$) was recorded at control.

**Table.1** Effect of fly ash and nitrogen on growth parameters of oat

| Treatments | Plant height (cm) | Leaf area index | Dry matter accumulation (q $ha^{-1}$) |
|---|---|---|---|
| **Fly ash levels (t $ha^{-1}$)** | | | |
| **0** | 166.8 | 2.83 | 133.2 |
| **5** | 169.2 | 3.02 | 138.1 |
| **10** | 170.6 | 3.17 | 139.4 |
| **CD at 5%** | 1.6 | 0.10 | 2.5 |
| **Nitrogen levels (kg $ha^{-1}$)** | | | |
| **0** | 160.2 | 2.68 | 106.3 |
| **37.5** | 164.4 | 2.92 | 129.2 |
| **75** | 174.1 | 3.17 | 155.1 |
| **112.2** | 176.1 | 3.28 | 157.1 |
| **CD at 5%** | 2.1 | 0.12 | 2.4 |

**Table.2** Effect of fly ash and nitrogen levels on yield attributing characters of oat

| Treatment | Number of tillers / meter row length | No. of grains per spikelet | Test weight (g) |
|---|---|---|---|
| **Fly ash levels (t $ha^{-1}$)** | | | |
| **0** | 103.3 | 92.3 | 27.6 |
| **5** | 106.4 | 97.3 | 30.1 |
| **10** | 108.8 | 99.3 | 31.2 |
| **CD at 5%** | 2.5 | 2.1 | 0.8 |
| **Nitrogen levels (kg $ha^{-1}$)** | | | |
| **0** | 98.5 | 77.8 | 27.3 |
| **37.5** | 104.1 | 94.4 | 29.7 |
| **75** | 109.4 | 104.9 | 30.5 |
| **112.5** | 112.6 | 108.0 | 31.0 |
| **CD at 5%** | 3.3 | 3.3 | 0.6 |

**Table.3** Effect of different fly ash and nitrogen levels on productivity in oat

| Treatment | Grain yield (q/ha) | Straw yield (q/ha) | Biological yield (q/ha) | Harvest index (%) |
|---|---|---|---|---|
| **Fly ash levels t ha$^{-1}$** | | | | |
| **0** | 20.5 | 129.5 | 150.0 | 13.6 |
| **5** | 23.4 | 136.7 | 160.1 | 14.6 |
| **10** | 24.2 | 139.5 | 163.8 | 14.8 |
| **CD at 5%** | 1.0 | 3.8 | 3.9 | NS |
| **Nitrogen levels (kg ha$^{-1}$)** | | | | |
| **0** | 19.4 | 101.7 | 121.2 | 16.0 |
| **37.5** | 22.4 | 138.8 | 156.2 | 14.3 |
| **75** | 23.9 | 151.8 | 175.7 | 13.6 |
| **112.5** | 25.0 | 153.8 | 178.8 | 13.9 |
| **CD at 5%** | 1.2 | 3.9 | 4.1 | NS |

The percent increase in grain yield with 112.5 kg N ha$^{-1}$ was 4.60, 11.60 and 28.8 over 75 kg N ha$^{-1}$, 37.5 kg N ha$^{-1}$ and control, respectively. The interaction effect between different fly ash and nitrogen levels showed that significant grain yield of oat. The application of 10 t fly ash ha$^{-1}$ with 112.5 kg N ha$^{-1}$ produced maximum grain yield (26.9 q ha$^{-1}$). Minimum grain yield (16.8 q ha$^{-1}$) recorded in control.

The maximum straw yield (139.5 q ha$^{-1}$) was recorded at the application of 10 t fly ash ha$^{-1}$ which was at par with (136.7 q ha$^{-1}$) application of 5 t fly ash ha$^{-1}$ (Table 3). While the minimum straw yield (129.5 q ha$^{-1}$) was recorded at control. Increase in straw yield with each increment of nitrogen application. The highest straw yield (153.8 q ha$^{-1}$) was recorded at 112.5 kg N ha$^{-1}$ application which was at par with (151.8 q ha$^{-1}$) straw yield was recorded at the application of 75 kg N ha$^{-1}$. While lowest straw yield (101.7 q ha$^{-1}$) was recorded at control. The interaction effect between fly ash and nitrogen was non significant.

The highest biological yield (163.8 q ha$^{-1}$) was recorded at 10 t fly ash ha$^{-1}$ application which was at par with biological yield (160.1 q ha$^{-1}$) application of 5 t fly ash ha$^{-1}$ (Table 3). Whereas, the minimum biological yield (150.1q ha$^{-1}$) was recorded under control. Increase nitrogen level with each increment increase biological yield. Maximum biological yield (178.8 q ha$^{-1}$) was obtained with the application of 112.5 kg N ha$^{-1}$ application which was at par with (175.7 q ha$^{-1}$) biological yield was recorded at the application of 75 kg N ha$^{-1}$. While the minimum biological yield (121.2 q ha$^{-1}$) was recorded at control. The interaction effect between fly ash and nitrogen was non significant.

The data indicated that harvest index increased with increased doses of fly ash. The maximum harvest index (14.8%) was recorded at application of 10 t fly ash ha$^{-1}$ (Table 3). While minimum harvest index (13.6%) was recorded at control. The data also indicated that application of nitrogen showed, increase in harvest index measured up to control. The maximum harvest index (16.0%) was recorded at control. While minimum harvest index (13.6%) was reported at 75 kg N ha$^{-1}$. The interaction effect between fly ash and nitrogen was non significant. The variation in the above mentioned growth parameters have also been reported by many research workers Prasad *et al.*, (2000), Tiwana *et al.*, (2004) and Chalmers *et al.*, (1998).

So on the basis of above finding it can be concluded the application of fly ash @ 10 t $ha^{-1}$ in oat crop improved the growth and yield of oat. Application of 112.5 kg N $ha^{-1}$ increased growth and yield attributes resulted in maximum grain yield of oat as compared to other levels of nitrogen. Fly ash @ 10 t $ha^{-1}$ and 112.5 kg N $ha^{-1}$ on gave significantly maximum grain yield. Application of fly ash is not a proper substitute of nitrogen application on oat crop. Thus use of fly ash will help to increase the crop yield as well as reduce the burden to dispose-off the fly ash.

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