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**Dev Narayan**
Ph.D Scholar, Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

**Rama Mohan Savu**
Scientist, Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

**GP Pali**
Professor, Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

**Swati Kunjam**
Ph.D Scholar, Department of Agronomy, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

**Ravindra Kumar**
Ph.D Scholar, Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

**Rahul Raj**
Ph.D Scholar, Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

**Corresponding Author:**
**Dev Narayan**
Ph.D Scholar, Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India

# Effect of fly ash in combination of farm yard manure and Vermicompost on growth and yield of rice (*Oryza Sativa* L.)

**Dev Narayan, Rama Mohan Savu, GP Pali, Swati Kunjam, Ravindra Kumar and Rahul Raj**

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**Abstract**
The study entitled effect of fly ash in combination of farm yard manure and vermicompost on growth and yield of rice (*Oryza sativa* L.) was conducted at Krishi Vigyan Kendra, Jarve (cha) Janjgir Champa (Chhattisgarh) during *kharif*, 2022 and 2023. The experiment was conducted in Randomized Block Design consisting 16 treatments ($T_1$- Farmers practices (N:P: K - 75:45:30 kg $ha^{-1}$+ 1.5 t $ha^{-1}$ Farm Yard Manure), $T_2$- 50 % RDN (N:P: K - 50:30:20 kg $ha^{-1}$), $T_3$- Farm Yard Manure@ 5 $tha^{-1}$, $T_4$- Vermicompost @ 2.5 t $ha^{-1}$, $T_5$- 100 % RDN (N:P: K - 100:60:40 kg $ha^{-1}$), $T_6$- Fly ash @ 20 t $ha^{-1}$, $T_7$- Fly ash @ 30 t $ha^{-1}$, $T_8$- Fly ash @ 40 t $ha^{-1}$, $T_9$- Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$, $T_{10}$- Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$, $T_{11}$- Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$, $T_{12}$- Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$, $T_{13}$- Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$, $T_{14}$- Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$, $T_{15}$- 50 % RDN + Farm Yard Manure@ 5 t $ha^{-1}$, $T_{16}$- 50 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) and replicated thrice. The results revealed that higher values for plant height, number of leaves, number of tillers, dry matters accumulation and grain and straw yield of rice was obtained under $T_{13}$ (Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$).

**Keywords:** Vermicompost, fly ash, yield, plant height, farmers practice

## Introduction
Rice is the most important and extensively cultivated food crop which is a staple food for one-third world's population and occupies almost one fifth to the total land area covered under cereals. Fly ash is a by-product of the Thermal Power Station (TPS), where coal energy is converted into electrical energy. Fly ash is an amorphous mixture of ferro-alumino-silicate minerals generated from the combustion of coal at a temperature of 400 to 1500 $^oC$. There are 197 major Thermal Power Plants in India. The total fly ash production in India is expected to reach about 226.13 million tons in the year 2019-2020. Approximately 12.21 million tons of fly ash produced each year in India and 0.35 $m^2$ of area is needed for storing one ton of fly ash. As Chhattisgarh has a huge amount of coal reserves, it is a major fly-ash-generating state in India. There are 29 main Chhattisgarh Thermal Power Plants. A total of 34.822 million tons of ash are produced by the state in 2019-2020 and a 26.85 million tons (77.12 %) are used annually (Annonomous-1).

Fly ash is generally of silt loam texture with the diameter of the particle of less than 0.010 mm and fly ash has the pH value ranges from 6 to 11, electrical conductivity (EC) of 42 to 450 µ $Scm^{-1}$ and Most of the fly ash has the bulk density (BD) values less than 1 g $cm^{-3}$ and water holding capacity ranges from 43 to 66 per cent. Total major nutrients like nitrogen and phosphorus are low *i.e.*, 0.056 and 0.087 per cent, respectively, but it contains a sufficiently higher amount of total K (0.172 %), Cao (1.60 %), MgO (0.96 %) and total trace elements *i.e.*, manganese (3.98 ppm), copper (3.60 ppm), zinc (1.30 ppm) and iron (3.81 ppm) (Bhoyer, 1998) [4]. Fly ash amendment of soil has resulted in increased plant production when nutrient deficiencies were corrected by its addition. found that a single application of fly ash (80 g $kg^{-1}$) was effective in raising the pH (from 4.5 to 7.7) of acid soils and improving the plant nutrient

status and water-holding capacity of the soil. Use of fly ash as a soil amendment to field for cultivation of crops has been reported by several workers Adriano *et al*., 1980 [1]; Molliner and Street, 1982 [11]. Fly ash amended soils tend to have lower bulk density, higher water holding capacity, lower hydraulic conductivity, improved the content of organic carbon and enhanced soil strength (Kalra *et al.*, 1998) [7].

Application of chemical fertilizer, industrial wastes and agricultural animal wastes in an integrated manner may bring changes in the decomposition process of organic materials and hence are likely to alter the nutrient release pattern of the soil. Complementary use of plant nutrients from waste materials along with mineral fertilizers is of great importance in the maintenance of farm productivity and profitability. Use of manures, organic and inorganic wastes is gaining wider acceptance to reduce input cost and to sustain soil fertility. Lot of research is still needed to improve the agricultural use of fly ash soil conditioner, with respect to improvement of quality of fly ash and its optimum use with respect to type of soil and crop. Hence, an experiment was laid out to study the effect of integrated use of fly ash with and without farm yard manure and vermicompost on rice productivity and nutrient status of soil.

Organic inputs, such as fly ash, farm yard manure and vermicompost play a critical role in the productivity of rice by supplying nutrients and a substrate for the synthesis of soil organic matter through decomposition (SOM). Farmyard manure (FYM) is a decomposed mixture of dung, urine, litter, and leftover materials from roughages and fodder fed to animals. Farm yard manure is a good source of organic carbon, which activates the biotic life of the soil flora and fauna. Vermicompost is a microbiologically active organic nutrient-rich amendment that results from the encounters between microbial activities during organic matter breakdown. It is a stabilized, finely differentiated peat-like substance with a low C: N ratio, high porosity and high potential for water absorption, of which most nutrients are found in forms readily absorbed by plants (Dominguez, 2004) [6]. Vermicomposting and farm yard manuring is an environmentally-friendly, low-technology method used for handling agricultural waste. It has been shown that the resulting vermicompost and farm yard manure has many beneficial effects on plant growth and health. Combine application of 75% General Recommended Dose + fly ash @ 60 t $ha^{-1}$ + Farm Yard Manure @ 5 t $ha^{-1}$ recorded the highest soil available phosphorus, potassium and zinc (Lal *et al*., 2014) [9]. Compared with 100% general recommended dose and the control, the application of 75% general recommended dose + fly ash @ 60 t $ha^{-1}$ + farm yard manure @ 5 t $ha^{-1}$ significantly increased the organic carbon storage of degraded land. These above mentioned facts lead to conduct this study for the enhancement in crop yield and improving the soil quality.

## Materials and Methods

The study was conducted at Krishi Vigyan Kendra, Jarve (cha) Janjgir Champa (Chhattisgarh) which is located at about 154 km away from the district headquarter, Raipur during *kharif*, 2022 and 2023. The soil of the experimental field was *Inceptisol*, which was also locally called as Matasi (in Chhattisgarh plain) and Gader (in Northen hills). The experiment was conducted in Randomized Block Design consisting 16 treatments ($T_1$- Farmers practices (N:P: K - 75:45:30 kg $ha^{-1}$+ 1.5 t $ha^{-1}$ Farm Yard Manure), $T_2$- 50 % RDN(N:P: K - 50:30:20 kg $ha^{-1}$), $T_3$- Farm Yard Manure@ 5 $tha^{-1}$, $T_4$- Vermicompost @ 2.5 t $ha^{-1}$, $T_5$- 100 % RDN (N:P: K - 100:60:40 kg $ha^{-1}$), $T_6$- Fly ash @ 20 t $ha^{-1}$, $T_7$- Fly ash @ 30 t $ha^{-1}$, $T_8$- Fly ash @ 40 t $ha^{-1}$, $T_9$- Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$, $T_{10}$- Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$, $T_{11}$- Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$, $T_{12}$- Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$, $T_{13}$- Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$, $T_{14}$- Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$, $T_{15}$- 50 % RDN + Farm Yard Manure@ 5 t $ha^{-1}$, $T_{16}$- 50 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) and replicated thrice. Rice cultivar MTU-1156 was taken as a test crop. Organic manures in the form of vermicompost and farm yard manure were applied as per the treatments. For the result of the experiment some observations were taken at vegetative growth stages of crop *i.e*., plant height, number of leaves, number of tillers and dry matter accumulation and at harvest *i.e*., grain yield and biological yield.

**Growth parameters:** Five randomly tagged plants were considered for height, and it measured from ground surface to the tip of the top most leaf until the panicle emerged with the help of meter scale at 30, 60, 90 days after transplanting and at harvest. Number of leaves and number of tillers were counted with the same plants at same intervals. For dry matter accumulation, from individual plots three randomly selected plants were uprooted carefully then thoroughly washed and dried followed by oven drying at 65 °C for 24 hours until the constant weight was obtained. The sample weight was recorded and then averaged to get dry matter accumulation $plant^{-1}$.

**Yield:** The crop was harvested separately from individual net plot then weight of total biomass was recorded. By manual threshing grains were separated from straw. The grain weight was recorded and expressed in q $ha^{-1}$ and by subtracting grain weight from biological yield, straw yield was worked out and also expressed in q $ha^{-1}$. Harvest index was calculated by using formula:

$$\text{Harvest index} = \frac{\text{grain yield}}{\text{biological yield}} \times 100$$

## Results and discussion

### Growth parameters

**Plant height:** The effect of treatments on plant height was not noticed at 30 days after transplanting. The highest plant height was recorded under treatment $T_{13}$ (Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) at 60 days after transplanting (108.57 cm), 90 days after transplanting (111.23 cm) and at harvest (111.30 cm) on mean basis, which was statistically at par with treatment $T_9$ (Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{10}$ (Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{11}$(Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{12}$ (Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) and $T_{14}$(Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) at 60 days after transplanting on mean basis (Table 1) and statistically at par with all treatment except treatment $T_6$ (Fly ash @ 20 t $ha^{-1}$) at 90 days after transplanting and at harvest on mean basis. Increased plant height of crops with fly ash application had also been reported by Thanunathan *et al.* (2001) [21].

**Number of leaves:** The highest no. of leaves $hill^{-1}$ was recorded under treatment $T_{13}$ (Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) at 30 days after transplanting (37.54), 60 days after transplanting (62.00) and 90 days after

transplanting (20.31), which was statistically superior over than treatment $T_1$ (Farmers practices), $T_2$ (50 % RDN), $T_3$ (Farm Yard Manure @ 5 tonnes $ha^{-1}$), $T_4$ (Vermicompost @ 2.5 t $ha^{-1}$), $T_6$ (Fly ash @ 20 t $ha^{-1}$), $T_7$ (Fly ash @ 30 t $ha^{-1}$), $T_8$ (Fly ash @ 40 t $ha^{-1}$), $T_{15}$ (50 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$) and $T_{16}$ (50 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) at 30 days after transplanting and 60 & 90 days after transplanting statistically at par with $T_9$ (Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{10}$ (Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{11}$ (Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{12}$ (Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$), and $T_{14}$ (Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) on mean basis, respectively. Application of fly ash in combination of farm yard manure and vermicompost favourably influenced the cell division and enlargement which facilitated a greater number of leaves. This is in accordance with the findings of Reddy *et al.* (2010) [17].

**Number of tillers hill$^{-1}$:** Treatments $T_{13}$(Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$**)** produced significantly higher number of tillers than that of other treatments at 30 days after transplanting (15.67), 60 days after transplanting (12.17), 90 days after transplanting (10.50) and at harvest (8.84) on mean basis and at 30, 60, 90 days after transplanting and at harvest treatment $T_5$ (100 % RDN), $T_9$ (Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{10}$ (Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{11}$ (Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{12}$ (Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) and $T_{14}$ (Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) was statistically at par and higher yield than other treatments on mean basis, respectively. Higher growth due to increased photosynthetic rate under application of fly ash with combination of farm yard manure and vermicompost might be the reasons for increasing the number of tillers. Similar results were also reported by Kamakar *et al.* (2010) and Sims *et.al.* (1993) [20].

**Dry matter accumulation:** Data on Table 4 show that the highest dry matter accumulation was recorded under treatment $T_{13}$ (Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) at 30 days after transplanting (10.64 g $plant^{-1}$), 60 days after transplanting (25.28 g $plant^{-1}$), 90 days after transplanting (45.49 g $plant^{-1}$) and at harvest (69.26 g $plant^{-1}$) on mean basis followed by $T_{14}$ (Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$). At all the stages of observations, dry matter accumulation under treatments $T_9$ (Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{10}$ (Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{11}$ (Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{12}$ (Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) and $T_{14}$ (Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) were comparable to each other and found to be superior over rest of treatments on mean basis respectively except at harvest. At harvest treatments $T_{13}$ (Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) was statistically at par with treatments $T_5$ (100 % RDN), $T_9$ (Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{10}$ (Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{11}$ (Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{12}$(Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$)and $T_{14}$ (Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) on mean basis. More number of leaves and leaf area index reflected through increased in photosynthetic activities which ultimately increased the dry matter accumulation under the application of fly ash in combination of farm yard manure and vermicompost. These results are also corroborated by Saini *et al.* (2017) [18] and Pradhan and Sahu (2004) [13].

## Yield

**Grain yield:** In general, grain yield was enhanced under application of fly ash in combination of vermicompost by 20.25 per cent compared to farmer practices. The data presented in Table 5 showed that application of fly ash @ 30 t $ha^{-1}$+ 100 % RDN +Vermicompost @ 2.5 t $ha^{-1}$ recorded higher grain yield over other. The treatment $T_{13}$ (Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) recorded significantly higher grain yield (54.82 q $ha^{-1}$) over treatment $T_1$ (Farmers practices), $T_2$ (50 % RDN), $T_3$ (Farm Yard Manure @ 5 t $ha^{-1}$), $T_4$ (Vermicompost @ 2.5 t $ha^{-1}$), $T_5$ (100% RDN), $T_6$ (Fly ash @ 20 t $ha^{-1}$), $T_7$ (Fly ash @ 30 t $ha^{-1}$), $T_8$ (Fly ash @ 40 t $ha^{-1}$), $T_{15}$ (50 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$) and $T_{16}$ (50 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) which was at par with rest of the treatments. The conducive physical environment leading to better aeration, root activity and thereby increase in soil moisture holding capacity and nutrient absorption by the consequent complementary effect of fly ash, farm yard manure and vermicompost application would have produced higher crop growth and yield attributing characters and which resulted in increased grain yield of rice. Das *et al.* (2013) [5], Yeledhalli *et al.* (2008) [22] and Rautaray *et al.* (2003) [15] Matte and Kene (1995) [10] and Selvakumari *et al.* (2000) [19] were also concluded that the yields were highest when applied fly ash in combination with organic and inorganic fertilizer.

**Straw yield:** It is obvious from the data (Table 5) that, significant increase in straw yield was noted due to application of fly ash in combination of farm yard manure, vermicompost and fertilizers. Treatment $T_{13}$(Flyash @ 30 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) recorded significantly highest straw yield (65.76 q $ha^{-1}$) which was at par with $T_9$ (Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{10}$ (Fly ash @ 30 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{11}$ (Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$), $T_{12}$ (Fly ash @ 20 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) and $T_{14}$ (Fly ash @ 40 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$) on a mean basis, respectively. Similar findings were also reported by Patel *et al* (2016) [12], Ramteke (2016) [14] and Reddy *et al.* (2005) [16].

**Harvest index:** The harvest index was not found significant due to application of fly ash with combination of farm yard manure, vermicompost and inorganic fertilizers.

**Table 1:** Effect of fly ash in combination of farm yard manure and vermicompost on plant height (cm) of rice on mean basis

| Treatments | | Plant height (cm) | | | |
|---|---|---|---|---|---|
| | | 30 DAT | 60 DAT | 90 DAT | At Harvest |
| $T_1$ | Farmers practices (N:P: K - 75:45:30 kg $ha^{-1}$ + 1.5t $ha^{-1}$ Farm Yard Manure) | 71.40 | 100.87 | 109.13 | 109.25 |
| $T_2$ | 50 % RDN (N:P: K - 50:30:20 kg $ha^{-1}$) | 70.77 | 99.24 | 108.57 | 108.83 |
| $T_3$ | Farm Yard Manure @ 5 t $ha^{-1}$ | 70.47 | 97.93 | 107.10 | 107.10 |
| $T_4$ | Vermicompost @ 2.5 t $ha^{-1}$ | 70.22 | 98.67 | 108.46 | 108.55 |
| $T_5$ | 100 % RDN (N:P: K - 100:60:40 kg $ha^{-1}$) | 72.67 | 102.84 | 109.71 | 109.73 |
| $T_6$ | Flyash @ 20 t $ha^{-1}$ | 69.54 | 96.95 | 104.95 | 105.30 |
| $T_7$ | Flyash @ 30 t $ha^{-1}$ | 69.68 | 97.23 | 106.36 | 106.51 |
| $T_8$ | Flyash @ 40 t $ha^{-1}$ | 69.92 | 97.60 | 107.57 | 107.53 |
| $T_9$ | Flyash @ 20 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$ | 73.12 | 105.60 | 110.10 | 110.00 |
| $T_{10}$ | Flyash @ 30 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$ | 73.40 | 107.15 | 110.42 | 110.75 |
| $T_{11}$ | Flyash @ 40 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$ | 73.04 | 105.17 | 109.92 | 109.78 |
| $T_{12}$ | Flyash @ 20 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$ | 73.37 | 106.12 | 110.43 | 110.38 |
| $T_{13}$ | Flyash @ 30 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$ | 74.00 | 108.75 | 111.23 | 111.30 |
| $T_{14}$ | Flyash @ 40 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$ | 73.70 | 107.84 | 110.75 | 111.20 |
| $T_{15}$ | 50 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$ | 71.64 | 100.48 | 108.83 | 109.01 |
| $T_{16}$ | 50 % RDN + Vermicompost @ 2.5 t $ha^{-1}$ | 71.64 | 100.45 | 108.98 | 109.01 |
| | SEm± | 0.90 | 1.75 | 1.35 | 1.39 |
| | CD (P=0.05) | NS | 5.87 | 5.12 | 4.81 |

**Table 2:** Effect of fly ash in combination of farm yard manure and vermicompost on number of leaves $hill^{-1}$of rice on mean basis

| Treatments | | Number of leaves $hill^{-1}$ | | |
|---|---|---|---|---|
| | | 30 DAT | 60 DAT | 90 DAT |
| $T_1$ | Farmers practices (N:P: K - 75:45:30 kg $ha^{-1}$ + 1.5t $ha^{-1}$ Farm Yard Manure) | 33.09 | 45.48 | 14.57 |
| $T_2$ | 50 % RDN (N:P: K - 50:30:20 kg $ha^{-1}$) | 31.76 | 44.17 | 14.42 |
| $T_3$ | Farm Yard Manure @ 5 t $ha^{-1}$ | 31.15 | 41.35 | 13.66 |
| $T_4$ | Vermicompost @ 2.5 t $ha^{-1}$ | 30.35 | 42.83 | 14.27 |
| $T_5$ | 100 % RDN (N:P: K - 100:60:40 kg $ha^{-1}$) | 34.19 | 52.43 | 17.13 |
| $T_6$ | Flyash @ 20 t $ha^{-1}$ | 28.93 | 34.66 | 13.04 |
| $T_7$ | Flyash @ 30 t $ha^{-1}$ | 29.05 | 35.64 | 13.44 |
| $T_8$ | Flyash @ 40 t $ha^{-1}$ | 29.34 | 37.62 | 13.40 |
| $T_9$ | Flyash @ 20 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$ | 36.56 | 59.16 | 18.80 |
| $T_{10}$ | Flyash @ 30 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$ | 36.96 | 60.33 | 19.33 |
| $T_{11}$ | Flyash @ 40 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$ | 35.76 | 57.93 | 18.37 |
| $T_{12}$ | Flyash @ 20 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$ | 36.59 | 58.83 | 18.86 |
| $T_{13}$ | Flyash @ 30 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$ | 37.54 | 62.00 | 20.31 |
| $T_{14}$ | Flyash @ 40 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$ | 37.12 | 61.50 | 19.33 |
| $T_{15}$ | 50 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$ | 32.66 | 45.33 | 14.58 |
| $T_{16}$ | 50 % RDN + Vermicompost @ 2.5 t $ha^{-1}$ | 32.83 | 45.80 | 15.29 |
| | SEm± | 1.26 | 1.66 | 0.53 |
| | CD (P=0.05) | 3.74 | 4.90 | 2.26 |

**Table 3:** Effect of fly ash in combination of farm yard manure and vermicompost on number of tillers $hill^{-1}$ of rice on mean basis

| Treatments | | number of tillers $hill^{-1}$ | | | |
|---|---|---|---|---|---|
| | | 30 DAT | 60 DAT | 90 DAT | At harvest |
| $T_1$ | Farmers practices (N:P: K - 75:45:30 kg $ha^{-1}$ + 1.5t $ha^{-1}$ Farm Yard Manure) | 12.84 | 8.50 | 7.34 | 6.50 |
| $T_2$ | 50 % RDN (N:P: K - 50:30:20 kg $ha^{-1}$) | 12.50 | 8.50 | 7.50 | 6.33 |
| $T_3$ | Farm Yard Manure @ 5 t $ha^{-1}$ | 11.17 | 6.84 | 6.84 | 6.00 |
| $T_4$ | Vermicompost @ 2.5 t $ha^{-1}$ | 11.34 | 7.17 | 7.34 | 6.00 |
| $T_5$ | 100 % RDN (N:P: K - 100:60:40 kg $ha^{-1}$) | 13.84 | 10.33 | 8.84 | 6.84 |
| $T_6$ | Flyash @ 20 t $ha^{-1}$ | 10.00 | 6.67 | 6.67 | 5.50 |
| $T_7$ | Flyash @ 30 t $ha^{-1}$ | 10.50 | 6.84 | 6.84 | 5.50 |
| $T_8$ | Flyash @ 40 t $ha^{-1}$ | 10.67 | 6.84 | 6.84 | 5.67 |
| $T_9$ | Flyash @ 20 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$ | 14.34 | 11.17 | 9.84 | 7.67 |
| $T_{10}$ | Flyash @ 30 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$ | 14.67 | 11.50 | 10.17 | 8.17 |
| $T_{11}$ | Flyash @ 40 t $ha^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$ | 14.17 | 10.50 | 9.50 | 7.50 |
| $T_{12}$ | Flyash @ 20 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$ | 14.50 | 11.17 | 10.00 | 7.83 |
| $T_{13}$ | Flyash @ 30 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$ | 15.67 | 12.17 | 10.50 | 8.84 |
| $T_{14}$ | Flyash @ 40 t $ha^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t $ha^{-1}$ | 15.17 | 11.67 | 10.17 | 8.50 |
| $T_{15}$ | 50 % RDN + Farm Yard Manure @ 5 t $ha^{-1}$ | 12.67 | 9.17 | 8.17 | 6.17 |
| $T_{16}$ | 50 % RDN + Vermicompost @ 2.5 t $ha^{-1}$ | 12.84 | 9.17 | 8.17 | 6.17 |
| | SEm± | 0.84 | 0.66 | 0.64 | 0.81 |
| | CD (P=0.05) | 2.25 | 1.90 | 1.87 | 2.11 |

**Table 4:** Effect of fly ash in combination of farm yard manure and vermicompost on dry matter accumulation of rice on mean basis

| Treatments | | dry matter accumulation (g plant$^{-1}$) | | | |
|---|---|---|---|---|---|
| | | 30 DAT | 60 DAT | 90 DAT | At harvest |
| $T_1$ | Farmers practices (N:P: K - 75:45:30 kg ha$^{-1}$ + 1.5t ha$^{-1}$ Farm Yard Manure) | 5.76 | 19.09 | 37.57 | 56.78 |
| $T_2$ | 50 % RDN (N:P: K - 50:30:20 kg ha$^{-1}$) | 5.71 | 18.79 | 37.06 | 56.55 |
| $T_3$ | Farm Yard Manure @ 5 t ha$^{-1}$ | 5.18 | 17.83 | 33.50 | 45.41 |
| $T_4$ | Vermicompost @ 2.5 t ha$^{-1}$ | 5.25 | 18.33 | 35.36 | 52.47 |
| $T_5$ | 100 % RDN (N:P: K - 100:60:40 kg ha$^{-1}$) | 7.30 | 20.71 | 39.45 | 59.27 |
| $T_6$ | Flyash @ 20 t ha$^{-1}$ | 4.38 | 16.56 | 32.13 | 46.28 |
| $T_7$ | Flyash @ 30 t ha$^{-1}$ | 4.46 | 16.91 | 32.68 | 46.85 |
| $T_8$ | Flyash @ 40 t ha$^{-1}$ | 4.71 | 17.22 | 32.77 | 50.38 |
| $T_9$ | Flyash @ 20 t ha$^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t ha$^{-1}$ | 9.02 | 23.09 | 42.08 | 65.04 |
| $T_{10}$ | Flyash @ 30 t ha$^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t ha$^{-1}$ | 9.74 | 23.79 | 43.85 | 66.48 |
| $T_{11}$ | Flyash @ 40 t ha$^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t ha$^{-1}$ | 8.74 | 22.94 | 41.40 | 65.85 |
| $T_{12}$ | Flyash @ 20 t ha$^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t ha$^{-1}$ | 9.32 | 23.33 | 43.68 | 65.87 |
| $T_{13}$ | Flyash @ 30 t ha$^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t ha$^{-1}$ | 10.64 | 25.28 | 45.49 | 69.26 |
| $T_{14}$ | Flyash @ 40 t ha$^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t ha$^{-1}$ | 10.16 | 24.01 | 44.50 | 67.72 |
| $T_{15}$ | 50 % RDN + Farm Yard Manure @ 5 t ha$^{-1}$ | 6.09 | 19.34 | 37.39 | 56.72 |
| $T_{16}$ | 50 % RDN + Vermicompost @ 2.5 t ha$^{-1}$ | 6.30 | 19.67 | 37.92 | 57.38 |
| | SEm± | 0.61 | 1.33 | 1.98 | 3.38 |
| | CD (P=0.05) | 1.94 | 3.85 | 4.47 | 9.25 |

**Table 5:** Effect of fly ash in combination of farm yard manure and vermicompost on yield and harvest index of rice on mean basis

| Treatment | | Yield | | Harvest index (%) |
|---|---|---|---|---|
| | | Grain | Straw | |
| $T_1$ | Farmers practices (N:P: K - 75:45:30 kg ha$^{-1}$ + 1.5t ha$^{-1}$ Farm Yard Manure) | 45.33 | 55.26 | 45.06 |
| $T_2$ | 50 % RDN (N:P: K - 50:30:20 kg ha$^{-1}$) | 40.87 | 47.68 | 45.38 |
| $T_3$ | Farm Yard Manure @ 5 t ha$^{-1}$ | 36.83 | 43.64 | 45.37 |
| $T_4$ | Vermicompost @ 2.5 t ha$^{-1}$ | 36.93 | 43.72 | 45.40 |
| $T_5$ | 100 % RDN (N:P: K - 100:60:40 kg ha$^{-1}$) | 49.52 | 60.96 | 45.14 |
| $T_6$ | Flyash @ 20 t ha$^{-1}$ | 31.13 | 39.28 | 44.20 |
| $T_7$ | Flyash @ 30 t ha$^{-1}$ | 31.93 | 40.53 | 44.56 |
| $T_8$ | Flyash @ 40 t ha$^{-1}$ | 32.13 | 40.62 | 44.60 |
| $T_9$ | Flyash @ 20 t ha$^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t ha$^{-1}$ | 52.77 | 63.13 | 45.48 |
| $T_{10}$ | Flyash @ 30 t ha$^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t ha$^{-1}$ | 53.26 | 63.87 | 45.50 |
| $T_{11}$ | Flyash @ 40 t ha$^{-1}$+ 100 % RDN + Farm Yard Manure @ 5 t ha$^{-1}$ | 52.45 | 63.24 | 45.39 |
| $T_{12}$ | Flyash @ 20 t ha$^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t ha$^{-1}$ | 52.75 | 63.63 | 45.46 |
| $T_{13}$ | Flyash @ 30 t ha$^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t ha$^{-1}$ | 54.82 | 65.76 | 45.53 |
| $T_{14}$ | Flyash @ 40 t ha$^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t ha$^{-1}$ | 53.97 | 64.61 | 45.52 |
| $T_{15}$ | 50 % RDN + Farm Yard Manure @ 5 t ha$^{-1}$ | 45.29 | 53.95 | 45.43 |
| $T_{16}$ | 50 % RDN + Vermicompost @ 2.5 t ha$^{-1}$ | 45.88 | 54.53 | 45.43 |
| | SEm± | 1.33 | 1.17 | 0.69 |
| | CD (P=0.05) | 3.85 | 3.37 | NS |

**Conclusion:** During the study fly ash with the combination of organic manures enhances the growth and yield by facilitating the nutrient supply to the crop and improved the structure and quality of soil as well. On the basis of present study, it has been concluded that Fly ash @ 30 t ha$^{-1}$+ 100 % RDN + Vermicompost @ 2.5 t ha$^{-1}$ had significant effect on all growth parameters and yield of rice crop.

**Conflict of interest:** There was no conflict in this study.

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