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Devendra Singh
 Institute of Environment and
 development Studies,
 Bundelkhand University
 Jhansi, Uttar Pradesh, India

Dr. Smriti Tripathi
 Institute of Environment and
 development Studies,
 Bundelkhand University
 Jhansi, Uttar Pradesh, India

Priyanka Sinha
 Department of Botany,
 Bundelkhand University
 Jhansi, Uttar Pradesh, India

Corresponding Author:
Devendra Singh
 Institute of Environment and
 development Studies,
 Bundelkhand University
 Jhansi, Uttar Pradesh, India

Influence of fly ash deposition on chickpea (*Cicer arietinum* L.) growth around thermal power plants

Devendra Singh, Smriti Tripathi and Priyanka Sinha

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Abstract

A byproduct of burning coal in thermal power plants, fly ash affects agricultural systems in both positive and negative ways. The current study evaluated the growing performance of chickpeas (*Cicer arietinum* L.) in six agricultural fields near the Parichha Thermal Power Plant in Jhansi in 2021-2022 and 2022-2023. At each site, randomly chosen plants were measured for growth factors like height and number of branches. According to the results, Site 6 had the lowest values (56.28 cm and 10.40, respectively), whereas Site 4 continuously displayed the highest plant height (average 61.58 cm) and number of branches per plant (14.30). The statistical significance of the differences across the sites suggests that fly ash deposition has a beneficial effect on vegetative development. These results are consistent with past studies that demonstrated that while high concentrations of fly ash amendment may impair performance, moderate amounts enhance crop growth and yield. Although rigorous soil quality monitoring is required to prevent long-term concerns, the study's overall findings indicate that fly ash can be judiciously deposited as a positive soil amendment to enhance chickpea development in locations bordering thermal power plants.

Keywords: Fly ash utilization, Chickpea growth response, Crop yield improvement, Thermal power plant impact, Soil quality enhancement

Introduction

One of the most significant problems in the globe, especially in developing nations, is the environmental disposal of fly ash (FA), a waste product of coal-burned thermal power plants that is hazardous to the environment. The massive amount of fly ash generated by burning coals causes issues with safe disposal as well as the growing issues of water pollution from leaching effects and air pollution from the fine particle size. Over 100 million tons of fly ash are produced annually by Indian thermal power plants, with the potential to surpass 175 million tons in very few years. Fly ash, which is also correlated with coal quality, is produced in large quantities during the process of burning of coal in thermal power plants in order to create electricity. Due to the low calorific content of the coal utilized, Indian coal typically produces a comparatively higher amount of ash (10%-30%) than coal from other nations (Ram and Masto, 2014) ^[11]. The productivity of agricultural crops utilizing coal ash has already been extensively studied in India and overseas, however the existence of heavy toxic/trace metals in it has raised concerns (Ciravolo and Adriano, 1979) ^[3]. If coal ash is utilized in agriculture in the proper quantities, the problem of its disposal might be mitigated. The physicochemical characteristics of soil, such as water-holding capacity, pH, bulk density, electrical conductivity and texture (Pathan *et al.*, 2003; Ram and Masto, 2010) ^[10, 11], as well as the compaction of clay soils (Sharma and Kalra, 2006) ^[14], are all impacted by the use of fly ash as a soil amendment (Sharma *et al.*, 1989) ^[13]. Fly ash increases soil water retention and reduces porosity by reducing the bulk density of the soil (Pandey and Singh, 2010) ^[9]. Fly ash amendment raises the amounts of major and minor soluble inorganic elements in the soil and boosts electrical conductivity (Basu *et al.*, 2009; Pandey and Singh, 2010) ^[1, 9]. The chickpea (*Cicer arietinum* L.), the third most important legume crop in the world, belongs to the Fabaceae family. Grown all over the world, it is a crop of commercial importance and a good source of lipids, proteins, and carbs (Jukanti *et al.* 2012) ^[7]. It is extensively utilized in both animal feed and human nutrition.

In addition to having a higher protein content than other leguminous crops, chickpeas are a good source of micronutrients and β -carotene (Jukanti *et al.* 2012; Siddique *et al.* 2012) [7, 15]. Taking the aforementioned into consideration, the current study is to assess the chickpea's growth performance and yield response around the Parichha thermal power plant.

Material and Methods

For the present study, six crop fields were selected at different locations around the thermal power plant. Before the study, it was confirmed that all the farm owners use the same amount of fertilizer for chickpea cultivation. For study records, ten plants were randomly selected from each farm to estimate their growth. In this study, primary two parameters of crops plant height and number of branches were observed. After collecting the information, the data was recorded and statistically examined. Using SPSS software, a one-way Analysis of Variance (ANOVA) was conducted to determine the significance of site-specific differences. To compare mean values among treatments, Critical Difference (CD) values were computed at a 5% level of significance ($p < 0.05$).

Result and Discussion

The observation table 1.1 shows the data of chickpea height and number of branches for 2021-22 and 2022-23. The maximum height of chickpea plant was recorded at site 4 (61.05 cm) followed by site 3 (58.77 cm), site 2 (58.31 cm), site 1 (57.61 cm), site 5 (56.77 cm) and site 6 (55.66 cm) in

the year of 2021-2022. The minimum height of chickpea was observed at site 6 (55.66 cm). On moving to 2022-2023, the maximum height of the chickpea found at site 4 (62.10 cm) followed by site 3 (58.25 cm), site 2 (57.72 cm), site 1 (56.91 cm), site 5 (55.79 cm) and site 6 (54.76 cm). The smallest height of the chickpea was found at site 6 (54.76 cm) (Fig 1.1). Overall, the result indicates that the average highest height of the chickpea was found at site 4 (61.58 cm) and smallest height was recorded at site 6 (55.28 cm) during the both years. The value of CD was found to be significant during both the years. Kumar and Pandey, 2022 concluded in their study that small amounts of fly ash in the soil can increase plant height. It is possible to use fly ash, a byproduct of burning coal, to enhance soil quality, particularly in deteriorated soils. Fly ash's efficacy as a soil amendment can be increased by mixing it with biological waste, such as sewage sludge or animal manure. Especially in industrial locations where soil quality may be affected, this mixture can aid in agricultural regeneration and the establishment of commercially useful plants (Sahu *et al.*, 2017) [12]. According to the current study's findings, chickpea plants that were growing close to the thermal power plant showed improved plant height development, suggesting that fly ash deposition had a beneficial effect. Previous research has revealed similar results, showing that applying fly ash in the right amount to the soil greatly enhanced chickpea development, with the highest crop production occurring at 60% fly ash amendment (Chakraborty *et al.* 2014) [2].

Table 1: Growth parameter data of Chickpea

sites	Plant height (cm)			Branches per plant		
	2021-2022	2022-2023	mean	2021-2022	2022-2023	mean
S1	57.61	56.91	57.26	12	12.4	12.2
S2	58.31	57.72	58.01	11.4	11.6	11.5
S3	58.77	58.25	58.51	11.2	11.2	11.2
S4	61.05	62.1	61.58	14.4	14.2	14.3
S5	56.77	55.79	56.28	10.6	11.4	11
S6	55.66	54.76	55.21	10	10.8	10.4
SE(m)	0.66	0.57		0.91	0.76	
CD	1.96	1.69		2.69	NS	

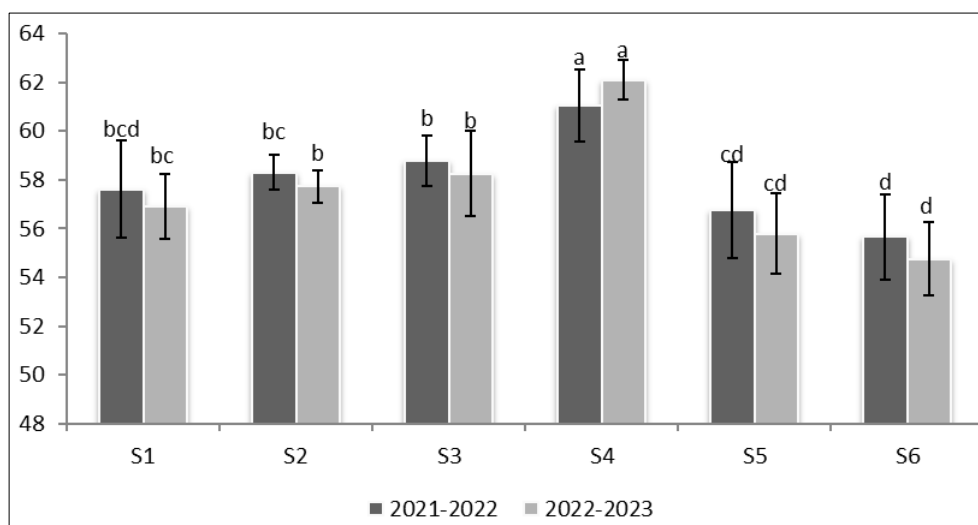


Fig 1: Impact on plant height of chickpea at different sites

Error bar represent the standard deviation. Means followed by the similar letters within the graph are not significantly

different by the LSD post-hoc test at the 5% probability level. In the year of 2021-2022, the highest number of

branches per plant of chickpea found at the site 4 (14.40) followed by site 1 (12), site 2 (11.40), site 3 (11.20), site 5 (10.60) and site 6 (10) respectively. The minimum number of branches per plant of chickpea was found at the site 6 (10). The maximum number of branches per plant of chickpea was recorded at site 4 (14.20) followed by site 1 (12.40), site 2 (11.60), site 5 (11.40), site 3 (11.20) and site 6 (10.80) respectively during the year of 2022-2023. Overall the result shows that maximum number of branches per plant of chickpea was observed at site 4 (14.30) and minimum value of branches per plant of chickpea was recorded at site 6 (10.40) in both the year (fig 1.2).

According to the current study, fields nearer the thermal power plant had more branches per plant, indicating that fly ash deposition had a beneficial effect on vegetative growth. Similar findings were reported by Jambhulkar and Juwarkar (2017) [6], who found that excessive fly ash had inhibitory effects and that chickpea plants grown in soil treated with fly ash had more branches per plant at moderate amendment levels. The use of fly ash in agriculture also improved chickpea development metrics, such as branching, at optimal levels, whereas greater concentrations had negative effects, according to Dhadse *et al.* (2024) [4].

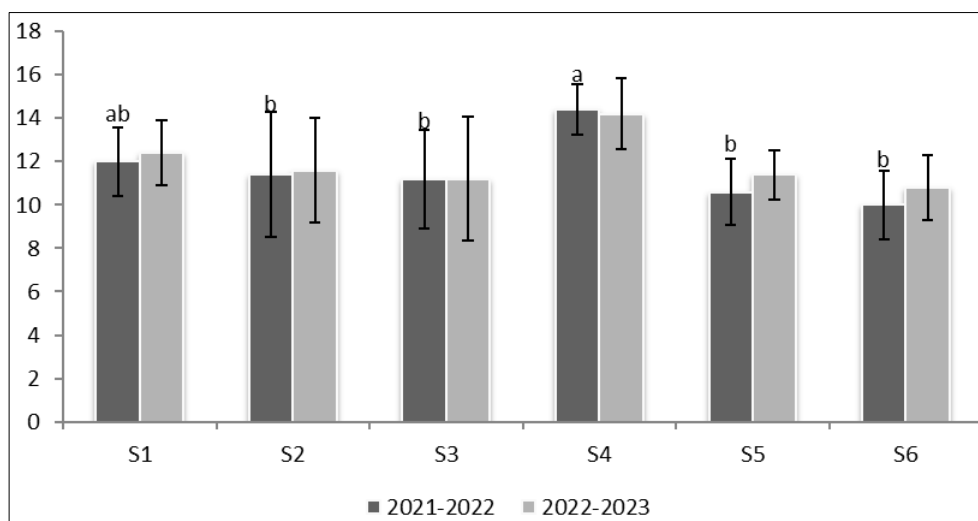


Fig 2: Impact on branches per plant of chickpea at different sites

Error bar represent the standard deviation. Means followed by the similar letters within the graph are not significantly different by the LSD post-hoc test at the 5% probability level.

Conclusion

The results of this study showed that fly ash deposition had a beneficial effect on crop growth since chickpea plants grown in areas close to the Parichha Thermal Power Plant had greater plant height and branching than plants grown at other locations. Out of the six locations, Site 4 consistently had the tallest plants and the most branches per plant, whereas Site 6 had the least values for both.

These results are consistent with past research showing that modest application of fly ash enhances plant development and yield characteristics (Kumar & Pandey, 2022; Chakraborty *et al.*, 2014) [2, 8]. In a comparable manner, Dhadse *et al.* (2024) [4] and Jambhulkar and Juwarkar (2017) [6] verified that while high dosages of fly ash inhibited branching, appropriate amounts promoted it.

Overall, the study indicates that fly ash can be a helpful soil amendment that improves chickpea growth and yield characteristics when it is moderately deposited. Its advantageous function as a nutrient supply must be balanced with the possible hazards of heavy metal buildup, though, in order to be used sustainably. This highlights the necessity of more thorough evaluations of crop and soil quality.

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