

## **IMPACT OF FERTILIZER APPLICATION AND IRRIGATION MANAGEMENT ON ABOVEGROUND TEMPERATURES IN A PADDY FIELD**

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Different water management and fertilizer application could lead to an increase in aboveground soil temperature. This will lead to higher emission of greenhouse gasses. This study investigates the effect of fertilizer application and irrigation management on the dynamics of aboveground temperatures in a paddy field. Temperature measurements were recorded at four periods, before the application of fertilizer (A), a day after (B), two days after (C), and three days after the fertilizer application (D). Two water managements were also employed, Control (continuous flooding) and Alternate Wetting and Drying (AWD). The result showed that the fertilizer application prompted an immediate temperature increase of 1.58% from A to B, followed by a gradual decline of about 8.35 to 10.88% over the subsequent period of measurements (B to D). In the context of irrigation management, the Alternate Wetting and Drying (AWD) treatment had 0.58% higher temperature compared to the Control, with greater stability. These results underscore the complex interplay of factors influencing temperature responses in rice cultivation. Tailored agricultural practices are essential for optimizing temperature-regulated strategies. Therefore, long-term monitoring is recommended for a comprehensive understanding and refinement of temperature management in paddy fields.

Keyword: Fertilizer, Continuous flooding, Alternate wetting and drying, Irrigation, Rice

## Introduction

Rice (*Oryza sativa* L.) is a staple food for nearly half of the global population, making it a vital crop for food security worldwide (Smith et al., 2020). Achieving optimal yields in rice cultivation is a complex task influenced by various factors, among which environmental conditions play a crucial role (Niang et al., 2017; Brown et al., 2019). Temperature is a key determinant in the growth and development of rice plants, impacting various physiological processes (Ren, 2023).

Fertilizer application is a common agricultural practice employed to enhance soil fertility and promote plant growth (Zhou, et al., 2022). The timing and quantity of fertilizer application are critical factors that can influence the overall success of rice cultivation (Li et al., 2019). Irrigation management is a pivotal aspect of rice cultivation, with varying techniques employed globally. Alternate wetting and drying (AWD) is an innovative irrigation strategy that seeks to optimize water use efficiency while maintaining or improving crop yields (Ye et al., 2013).

By delving into the intricate relationship between fertilizer application, irrigation management, and aboveground temperatures, we aim to contribute valuable knowledge to the agricultural community. The outcomes of this research have the potential to inform sustainable practices, improve resource management, and enhance the resilience of rice crops to environmental challenges (FAO 2014). As we unveil the thermal dynamics of rice fields in response to these practices, our findings may pave the way for more precise and efficient cultivation strategies, ultimately supporting global efforts to ensure food security in an ever-changing climate. This study explores how fertilizer application and water management affects aboveground temperatures, providing insights into the potential benefits of irrigation methods. Therefore, this study is aimed at investigating the impact of fertilizer application at different stages on aboveground temperatures,

## Material and Methods

### Description of the Study Area

The experiment was performed at the Teaching and research farm of Federal University Dutse irrigation station (Latitude 11°46'39N and Longitude 009°20'30E) located in the Sudan Savannah ecological zone of Nigeria at an altitude of 437m above sea level. The Geology of Dutse has a rocky topography that is generally noticeable across the city. The climate of Dutse is semi-arid type defined by a long dry season of mostly eight months (Kura et al.,2023). The raining season falls between the months of June to September with an annual rainfall of 900 to 1000 mm (Barau, 2015) and 80% of this is received between July to September (Buba, 2000). The average annual temperature is 38 C. The soil at the study site is sandy loamy soil with a mean bulk density of 1.50 M gm<sup>-3</sup> and a porosity of 61%. The basic physicochemical properties of the soil were as follows: the mass ratio of organic matter was 0.61g kg<sup>-1</sup>, pH value was 4.77, total nitrogen mass ratio was 0.12g kg<sup>-1</sup>, total phosphorus mass ratio was 3.93 ppm, total potassium mass ratio was 0.69 cmol kg<sup>-1</sup>.

## Experimental Design and Data Collection

The study utilized a factorial design with the combination of fertilizer application periods; Before the application of fertilizer (A), a day after fertilizer application (B), Two days after fertilizer application (C) and three days after fertilizer application(D); and water management types: Control (continuous flooding), and AWD.

The temperature measurement was collected by means of closed cylindrical polystyrene chambers. A total of 6 chambers (3 per irrigation water treatment) were installed at the site of each treatment at 5 cm depth one week before sampling.

The chamber consists of a permanent base inserted into the soil and has a lid equipped with vent tube. The base was made of a poly vinyl chloride (PVC) frame and buried to a depth of 5 cm leaving about 33.8 cm above the soil level. To allow for relatively free water and root movement, holes were perforated at the base below the soil level. To avoid leakages and ensured airtightness of the chamber, all perforations above the water level plugged with rubber stoppers were checked properly before any measurement. Each plot contained one chamber installed at 30 cm from the plot boarder to provide easy access to the chambers and to avoid soil disturbance during sampling. Temperature measurements were conducted at every 1-day before and 1-day intervals for the next 3 days after each fertilization and during the periodic wetting and drying episodes of AWD (15 cm water level below soil surface or the appearance of hair-like crack in such plots). To maintain consistency and uniformity, temperature measurements were collected from 9:00–11:00 a.m during all samplings. All samples were collected at 45 min. after chamber closure using a hand-held thermometer.

## Statistical analysis

Experimental data obtained for different temperature measurement were analyzed statistically using the analysis of variance technique as applicable to randomized complete block design. Turkey's Studentized Range (HSD) Test was employed to assess differences between the treatment means at a probability level of 5%. All statistical analyses were performed using Minitab 19 (Pennsylvania, USA).

## Result and Discussion

Figure 1 present results of temperature measurements of aboveground temperatures before and after fertilizer application in a paddy field. Result from the study shows that application of fertilizer had a significant influence ( $p < 0.05$ ) on the dynamics of above ground temperature. Above ground temperature of  $36.52 \pm 0.84$  °C was recorded as the baseline temperature one day before the fertilizer was applied. One day after fertilizer application, the temperature rise to  $37.10 \pm 0.31$  °C (1.6% increase) compared to the day before which suggests a potential immediate effect of the fertilizer on the aboveground temperature. Two days after fertilizer application, the temperature decreased by 8.4% ( $34.00 \pm 0.71$  °C) compared to the day after fertilization indicating a fluctuation or a potential adjustment in response to the fertilizer application. Three days after fertilizer

application, a further decrease in temperature by 11.8% ( $30.32 \pm 0.31$  °C) was observed compared to the second day after the fertilizer application. This may suggest a more stabilized effect or a delayed response to the fertilizer application.

The fluctuations in temperatures suggest a dynamic response of the paddy field to the fertilizer application. The initial increase in temperature recorded one day after fertilizer application could be attributed to increase in microbial activity or metabolic processes triggered by the introduction of the fertilizer. The subsequent decrease in temperatures recorded in the second day might be a result of nutrient absorption, microbial population shifts, or other physiological changes in the rice plants and the surrounding environment while for the third day after fertilizer application the decrease could imply that the system is adapting to the added nutrients, and processes initiated by the fertilizer application are continuing or reaching a more stable state.

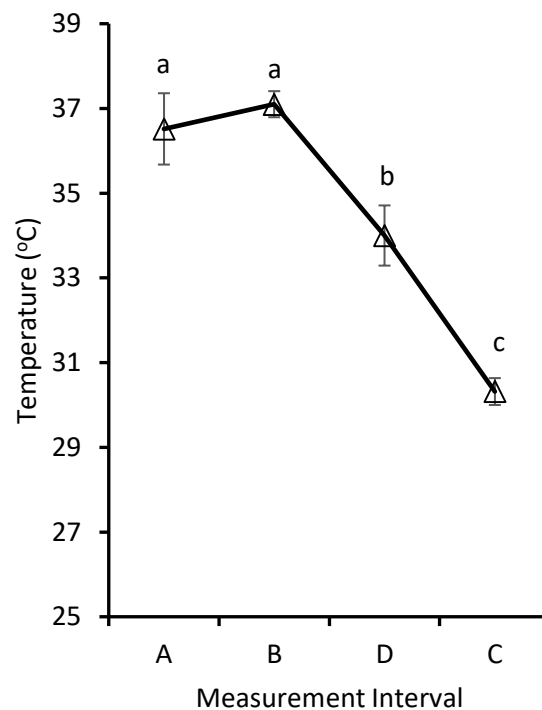


Figure 1. Means ( $\pm$  standard error) of temperatures at different measurement intervals in a paddy field. A is 1 day before fertilizer application, B is 1 day After fertilizer application, C is 2 days After fertilizer application, D is 3 days After fertilizer application.

Figure 2 presents the result of the effect of water management on aboveground temperatures of a paddy cultivated soil. The Result shows that there was no significant difference between the two water managements in terms of the above ground temperature. The control treatment being the conventional irrigation management in paddy fields had  $36.52 \pm 0.84$  °C which is 1.6% lower than

the AWD treatment that had  $37.10 \pm 0.31$  °C. This suggests that the AWD irrigation management may have an impact on aboveground temperatures in the cultivated soil (Figure 2).

The higher temperature in the AWD treatment could be attributed to factors associated with the specific water management practices. AWD involves cycles of wetting and drying, which may influence soil conditions, microbial activity, and plant responses, contributing to temperature variations.

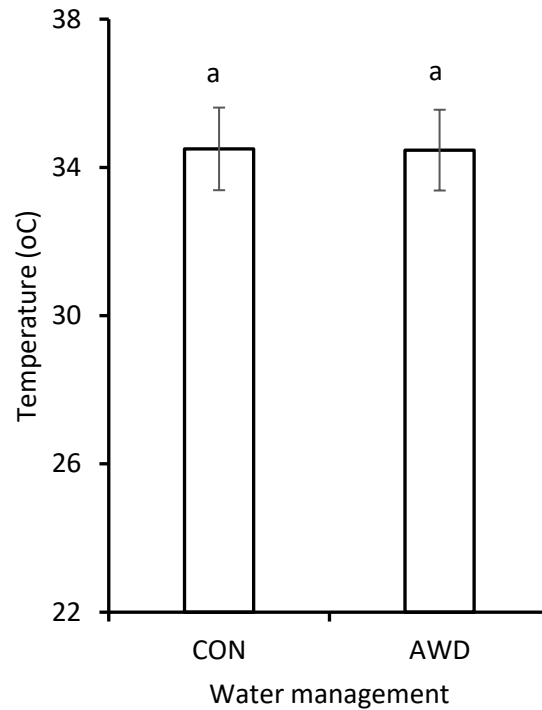


Figure 2. Means ( $\pm$  standard error) of the Effect of water management on aboveground temperatures of a paddy cultivated soil. CON is Control, AWD is Alternate wetting and drying.

## Conclusions

The study reveals that the combined effect of water management and fertilizer application had no influence on the above ground temperatures of a paddy field. However, the main effect of the fertilizer application affects the temperature which generally tends to decrease as the days of the fertilizer application passes. The findings underscore the dynamic nature of aboveground temperatures in rice fields. Fertilizer application induces short-term fluctuations, while AWD irrigation management influences temperature with a subtle increase. Further analyses and consideration of environmental factors are crucial for a comprehensive understanding and optimization of temperature-regulated agricultural practices.

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