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Dimension of Humidity in Various Rice Cropping Season at Rangpur District in Bangladesh

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Abstract: This research was intended to analyze the variation and trend of humidity pattern in the major cropping seasons like Aus, Aman and Boro season in Rangpur region of Bangladesh. Humidity data collected from the Bangladesh Meteorological Department (BMD) between 1990 and 2020 was utilized in this investigation. Analysis of linear trends was used to investigate the seasonal change in humidity. The investigation's findings demonstrated that there were numerous abnormalities in the daily, monthly, and seasonal variations of humidity where annual humidity rising in the Aman and Aus season and falling in the Boro season that main reasons are unusual monsoon pattern and abnormalities of temperature. According to the research's findings, there have been notable fluctuations in humidity during the Aus, Aman, and Boro seasons. Bangladesh's rice-based agriculture may suffer because of these adjustments. Bangladesh's climate-driven agricultural sector can benefit from the application of thresholding, regional and countrywide humidity analysis, and other environmental methodologies in combination with adaptation planning for sustainable agriculture.

Keywords: Humidity; Rice; Season; Variability; Production.

INTRODUCTION

Agriculture can be continuously impacted by unfavorable weather and climatic conditions. Climate and weather continue to be significant factors in determining agricultural production even with advances in technology such as improved crop types and irrigation systems (Basak *et al*., 2010). The production of agriculture is greatly impacted by climatic parameters such as precipitation, temperature, solar radiation, and humidity (Islam and Islam, 2022). Bangladesh is a developing nation whose economy is mostly focused on agriculture. Owing to the dense population, the agricultural sector acts a crucial role in both the overall economic progress and food security of the nation. Bangladesh's agricultural industry has traditionally been very important (Noorunnahar *et al*., 2023). Bangladesh is currently having a great deal of trouble producing enough rice to feed its growing population because of dwindling agricultural area and the consequences of climate change (Islam and Islam, 2022). Ahmed (1999) stated that variations in rainfall, temperature and relative humidity are becoming apparent both nationally and internationally. Rice (Oryza sativa L.), the main grain of Bangladesh, accounts for a sizable portion of their regular, well-balanced diet (Barua *et al*., 2014). In Bangladesh, Aus, Aman, or Boro rice is farmed all year round. Rice is significantly impacted by climate change and associated frantic weather events such as floods and droughts (Ali, 1996; Taslim *et al*., 2021; Yu *et al*., 2010). Owing to shifting climatic situations, decline the rice yield has been predicted to remain a major worry in the future (Masutomi *et al*., 2009).

Humidity has significantly influenced on plant growth. In the past, we discovered that, during the light period relative humidity is crucial to the photosynthesis of rice seedlings and growth. Specifically, high humidity during this time increased the number of roots, total length of roots, leaf blade length, leaf area, plant height, rate of leaf emergence, and photosynthesis (Hirai *et al*., 1998). The overall growth and photosynthesis of rice plant affected by high humidity which has been documented by other researchers (Horie, 1979; Sato and Otomo, 1976; Ishihara and Kuroda, 1986) as well as researchers studying other plant species (Schussler, 1992; Mortensen *et al*., 1998; Shimizu *et al*., 1997;), despite the fact that few studies have examined the variation and effect of humidity on growth. Changes in humidity patterns are being sparked by climate change, and these changes may have a big impact on when crops are sown and harvested (Mirza *et al*., 2004; Abrol *et al*., 2003; Noorunnahar *et al*., 2023). Pre-monsoon, post-monsoon, and dry seasons which together account for more than 75% of the annual humidity, when the principal rice types including Aus, Aman, and Boro are sown and harvested. The farming system depends largely on the well-timed arrival of monsoon rain and its allocation, even if the sowing and harvesting times of the crops alter geographically depending upon the agro-climatic parameters of the region (Mirza *et al*., 2004; Ahasan *et al*., 2010). Rangpur district is one of the key districts for agricultural output in northern Bangladesh. Rice production, for example, is entirely dependent on important meteorological factors like rainfall, temperature, and humidity (Islam and Islam, 2022). Chowdhury *et al*. (2015), Noorunnahar *et al*. (2023), Amin *et al*. (2015), Ferdous *et al*. (2011) and Islam *et al*. (2021) are just a few of the numerous studies that have been done to look at the peculiarities of humidity patterns in Bangladesh. These investigates have mostly concentrated on the patterns and effect of humidity on rice production but not focused on the variability of humidity among the different rice cropping seasons. To our understanding, there have been no investigations conducted to assess the fluctuation of humidity among Aus, Aman and Boro seasons in Rangpur district as the region of Bangladesh that is most sensitive to climate change. Here, present study was designed to analyze the trends of humidity variability among different rice crop seasons in the environmental circumstance of this region. Thus, the objectives of the study were to examine the following facts in rice plants: i) to determine the diurnal and monthly variation of humidity of the study area, and ii) to investigate the changeability of humidity patterns in Aus, Aman and Boro rice seasons.

MATERIALS AND METHODS

Study area

Rangpur district covers an area of 2400.56 km², situated in between 25°18' N and 25°57' N latitude, and in between 88°56' E and 89°32' E longitude. It consists of eight upazila's which is bordered by the Nilphamari, Lalmonirhat, Kurigram, Gaibandha and Dinajpur district (Figure 1) (BBS, 2011; Islam *et al*., 2022).

Data Source and Quality Control

For this study, the valid and process humidity data was provided by regional weather station and Bangladesh meteorological department (BMD) in the interval of 1990 to 2020. After examination, the BMD data and regional data, no abnormalities and data missing were found in the study period of Rangpur District.

Data Analysis

Data organized in different rice growing season such as Boro rice season (December to May), Aus rice season (March to August) and Aman rice season (June to November) (Sarker *et al*., 2012; Islam and Islam 2022). To find out the clear graphical trends which compared with 26 years average (1990 to 2015) data to the recent five years data (2016 to 2020). Excel 2019 was applied for data processing, formatting, and other statistical analysis.

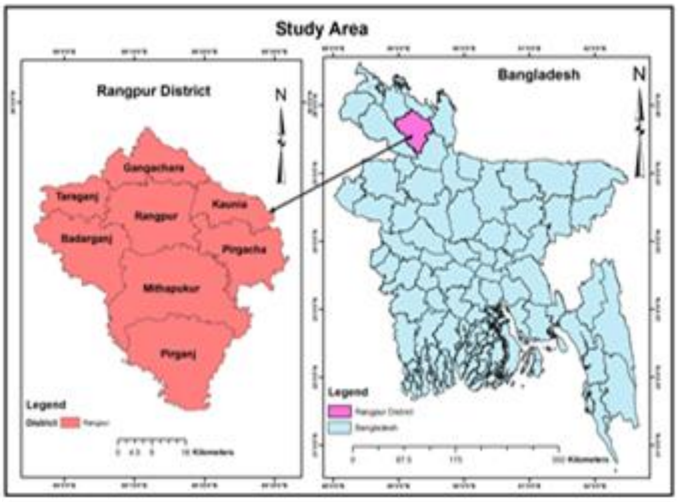

Figure 1. Location of the study area

RESULTS

Diurnal Variation of humidity in the study area

Figure 2 (a) showed that the highest amount of humidity in 2016 at DOY (Day of Year) 20 was 97% where the 26 years mean value was 79.4± 6.9 % (the mean ± SD) while the lowest amount of humidity in DOY 81 and 114 was 49% where the 26 years mean value was 64.2± 10.7% (the mean ± SD) and 69.7± 10.3% (the mean ± SD). From Fig. 2 (b), the highest value of humidity 2017 in DOY 10, 193, 205, 206 and 293 were observed 97%, while the value of 26 years mean value was 81± 4.5%, 87.2 ±4.9%, 84.3 ±4%, 85.9 ±3.8% and 82.9 ±5.7% (the mean ± SD) where the lowest value of humidity 2017 in DOY 101 was 50% and the 26 years mean value was 65± 11.4% (the mean ± SD). In 2018, the highest value of humidity in DOY 12 was observed 96%, at the same day 26 years mean value of humidity was 80 ± 6.1% (the mean ± SD) while the lowest value of humidity in DOY 65 was 56% where the 26 years mean value of humidity was 64.2 ± 8.1% (the mean ± SD) [Fig. 2 (c)]. In 2019 the highest value of humidity in DOY 273 was 95% where the 26 years mean value was 85.8 ± 2.2% (the mean ± SD) and the lowest value of humidity in DOY 76 was 55% where the 26 years mean value was 61.8 ±10.8% (the mean ± SD) [Fig. 2 (d)]. From Fig. 2 (e), in 2020 the highest value of humidity in DOY 261 was 97% where the 26 years mean value was 84.7 ± 4.9% (the mean ± SD) and the lowest value of humidity in DOY 90 was 54% where the 26 years mean value was 63.8 ± 6.6% (the mean ± SD). The highest 26 years mean value of humidity in DOY 224 was 88.9 ± 5.2% (the mean ± SD) and the

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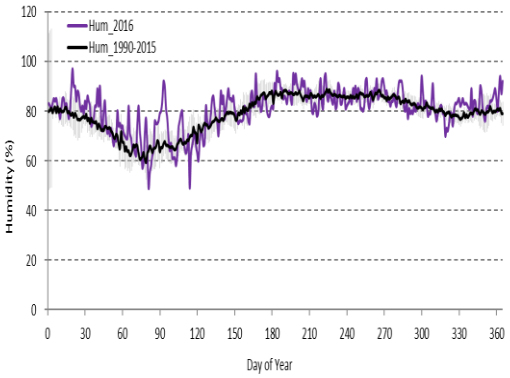
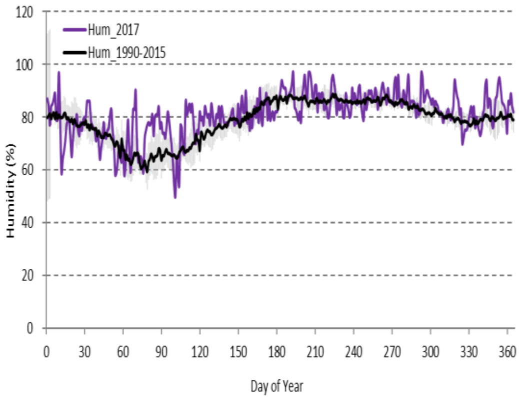
lowest 26 years mean value was 59.5 ± 7.5% (the mean ± SD) compared with the year of 2016 to 2020 [Figure 2 (a, b, c, d, e)].

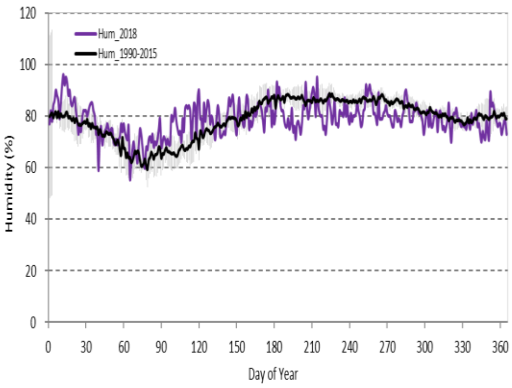
(a)



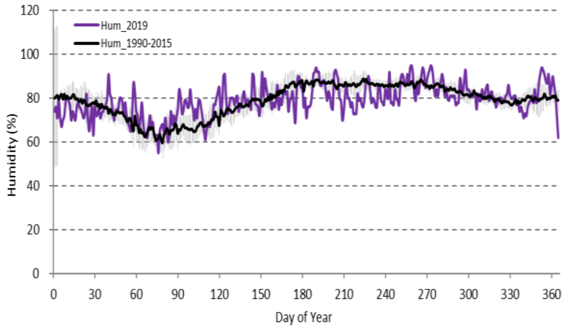
(b)



(c)



(d)



(e)

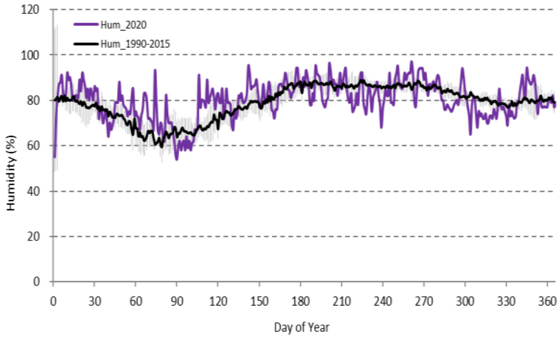


Figure 2. Diurnal variation humidity in (a) 2016, (b) 2017, (c) 2018, (d) 2019 and (e) 2020 with the average from 1990 to 2015. Bars represent standard deviation for the twenty-six years

Monthly variation of humidity in the study area

Monthly variation of humidity has shown in Figure 3. The year-to-year variations in monthly humidity were generally large in July, 2017 (88.8%) and the lowest value was observed in March, 2019 (67.4%), while the 26-years mean highest and lowest humidity were also observed in July 87±2 % (mean ±SD) and in March was 64±5 % (mean ±SD). The highest and lowest value of humidity in 2016 were 86.7% in September and 68.5% in March, in 2017 were 88.8% in July and 72.8% in April, in 2018 were 84.3% in January and 69.2% in March, in 2019 were 86.6% in September and 67.4% in March and in 2020 were 88.1% September and 71.1% in March, respectively.

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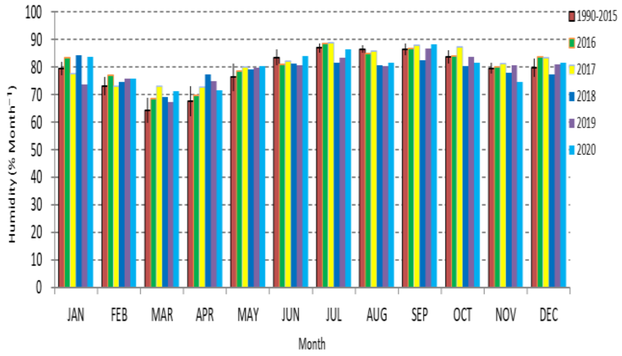

Figure 3. Monthly variation of humidity in 2016, 2017, 2018, 2019 and 2020 with the average from 1990 to 2015. Bars represent standard deviation for twenty-six years.

Seasonal trends of humidity variation

The total humidity in three growing seasons and fallow periods are presented in the Figure 4. Humidity in *Boro* season was less than 78% season^{-1}, and smaller than both in Aus and Aman season. The amount of humidity exceeded 78% season^{-1} in the year 2016, 2017, 2019, 2020 both Aus and Aman season while 26 years mean also exceeded 78% season^{-1} both Aus and Aman season. In the fallow period of rainy season, the maximum and minimum humidity were 85% in 2016 and 2017 and 81% in 2018 and 2019 respectively, where the 26 years mean value was 84%. The maximum and minimum observed value of humidity were 85% in 2017 and 75% in 2018 in the fallow period of dry season, where the 26 years mean value was 41%.

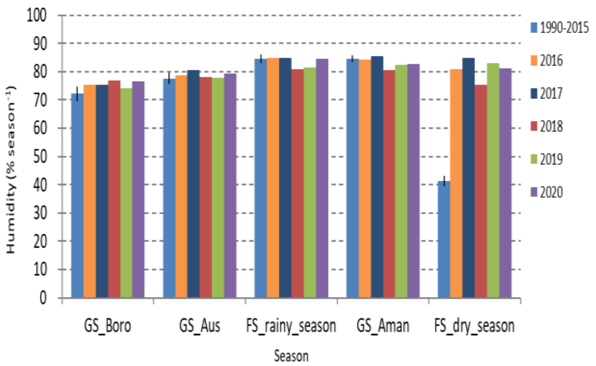

Figure 4. The humidity in growing and fallow periods of 2016, 2017, 2018, 2019 and 2020 with the average from 1990 to 2015. Bars represent standard deviation for the twenty-six years.

Annual trends of humidity variation

The annual humidity variation in Aus, Aman and Boro season of the study area from 1990 to 2020 has shown in Figure 5. The lowest annual humidity in Aus season was 72% in 1992, while the highest annual humidity was 81.4% in 1990. The co-efficient has a slightly growing trend throughout the Aus season and had a value of 0.0315. In Aman season, with a co-efficient value of -0.0265 with a slightly declining tendency in the Aman season, the highest and lowest humidity measurement was 86.4% in 1995 and 82% in 1994, respectively. The lowest humidity was 67.5% in 1992, while the greatest was 77% in 1990 where the co-efficient value is 0.0959 and it slightly increased during the Boro season.

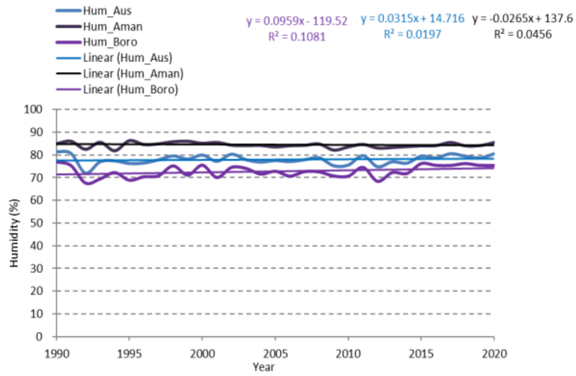

Figure 5. Annual trends of humidity variation in Aus, Aman and Boro season

DISCUSSION

According to the study, there were more anomalies found in the diurnal variation of the humidity pattern in the year of 2017, 2019, and 2020 compared to year of 2016 and 2018 (Figure 2), the monthly variation of humidity was also more anomalies (Figure 3), and the amount of seasonal humidity was higher in the season of Aman and Aus compared to the Boro season (Figure 4). In the seasonal variation, highest humidity was observed in Aman season and lowest humidity was in Boro season (Islam *et al.*, 2021). The yearly humidity variation from 1990 to 2020 was also observed slightly irregularities both Aus and Aman season but much irregularities in Boro season (Figure 5) where this indicated that slightly upward trend throughout the Aus and Aman season and a downward trend in the Boro season due to the unusual monsoon pattern in the study area. According to Ferdous and Baten, (2011) the overall average relative humidity has shown decreasing trends in Rangpur region. On the other hand, humidity has a positive effect on overall rice production in Bangladesh but not showed the variation of humidity in different rice cropping season separately (Noorunnahar *et al.*, 2023). Olabode (2015) observed that the yearly variation of highest humidity was 90% in 2012 and lowest humidity was 46% in 1997 which compared with the rice production. But the yearly humidity showed the increasing trends. Beside humidity, rainfall and temperature has unfavorable impact on rice yield in this region (Islam *et al.*, 2022). In recent years, the production of rice has been a key concernment due to change of climate because a less

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quantity of rice produce may be impeded for irregularities in humidity than the anomalies of rainfall and temperature (Siddik *et al*., 2013). On the other hand, humidity in monsoon season presented an upward trend, while slightly downward in the dry season that means humidity pattern gradually increased both *Aman* and *Aus* season and decreased in *Boro* season which has adverse influence on rice production in the study area.

CONCLUSION

This study presents the seasonal variation and trend of humidity in the major cropping seasons (Aus, Aman and Boro season) in Rangpur region of Bangladesh. The findings of the study revealed that seasonal, monthly, and diurnal variation of humidity were got much irregularities. In Aman and Aus season yearly variation of annual humidity showed a significant upward trend but a significant decreasing trend in the Boro season which could be adverse effect on rice yield in the research area. These findings will be very useful for academicians, researchers and policy makers to creates new knowledge, policy and different crop model for increase the rice yield and sustainable agricultural management in Bangladesh.

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Conflict of Interest

There are no conflicts of interest declared by the authors.

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