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Frequency and Distribution Patterns of Maximum Consecutive Dry and Wet Spell in North Western Nigeria

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Abstract

This study analyses the frequency and distribution pattern of maximum consecutive dry and wet spells in Northwestern Nigeria during the growing season from June to September, using the Anderson-Darling Normality Test. Daily rainfall data were sourced from the archives of the Nigerian Meteorological Agency, Abuja, covering the period from 1980 to 2021. The frequency of the Maximum Consecutive Dry Days (MCDD) and Maximum Consecutive Wet Days (MCWD) was calculated using a frequency programme in Microsoft Excel. The results showed that maximum consecutive dry periods ranged from 4 to 7 days, while maximum consecutive wet days ranged from 1 to 5 days. Irregular distribution patterns of wet and dry spells were observed across all states, except in Katsina, where results indicated a uniform distribution pattern, with a P-value of -0.049 for dry spells in July. Information regarding the distribution pattern of maximum consecutive dry and wet spell lengths needs to be well understood at the grassroots levels to avoid the risk of drought and flooding and ensure food security.

Key word: Dry spell, Wet Spell, Frequency, Distribution, Drought, Flood

1. Introduction

Problems of precipitation probability and dry spell occurrence in tropical regions, particularly in West Africa, have been studied extensively due to their effects on rainfed agriculture (Kranjac-berisavljevic and Abdul-ghanyu, 2014). One form of drought is the interruption of the rainy season by a dry spell. In humid countries, the success or failure of the crops, particularly under rainy conditions, is highly related to the distribution of dry and wet spells (Mathugama and Peiris, 2011). Investigation of the frequency and distribution pattern of dry and wet spells in the Sudano-Sahelian region of Nigeria is of paramount importance. The impacts of natural climate variability and climate change on the hydrologic cycle and water resources have been studied (Li et al., 2016). Maximum consecutive Wet/dry spells specify the variability of daily precipitation and are suitable indicators to demonstrate the weather pattern of a region (Huang et al., 2017). Dry spells are indicators of drought, while wet spells can cause too much rainfall, eventually leading to a flood disaster (Mirdashtvan & Malekian, 2020). Understanding the local dry and wet states is a crucial aspect of regional water resources and related disaster risk management (Qiao, 2022). A recent study in Europe observe dry and wet periods, respectively, occur more frequently and last longer during certain periods (Hänsel, 2020) and conclude that the occurrence of drought and flood disasters is closely related to abnormal precipitation.

For crop planning and understanding drought and flood conditions, it is important to know the sequence of dry and wet periods. The importance of determining dry spell characteristics lies in the fact that dry and wet spells during the crop phenological period can impose significant stress on some crops. Therefore, understanding these characteristics helps in deciding which crops to plant in environments with long or short dry spells. Prior knowledge of the start dates and durations of dry and wet spells is crucial in rain-fed agriculture, irrigation planning, and various climate-related decision-making processes (Mathugama & Peiris, 2011). Additionally, Sivakumar (1991) pointed out that in arid and semi-arid environments, where moisture availability is limited for shorter periods annually, it is essential to match crop phenology with dry spell length to meet water requirements during sensitive growth phases. Various statistical indicators can be used in analysing dry and wet spells. According to Mathugama and Peiris (2011), the most common indicators include the Length of Dry Spell (LDS), Length of Wet Spells (LWS), Frequency of Dry Spells (FDS), Frequency of Wet Spells (FWS), and Length of Critical Dry Spells (CDS). Information on the duration of dry and wet spells assists in selecting suitable crops and is vital for planning agricultural activities and managing water supply systems (Shiru et al, 2018). Important rainfall characteristics affecting rain-fed agriculture include the onset date of effective rainfall, the duration and timing of dry spells, the duration of wet spells, rainfall cessation, and the number of rainy days. It is well known that a crop's production is affected when dry spells occur during sensitive phenological stages (Dabral et al., 2014). However, dry periods during the crop's ripening stage can sometimes be beneficial, as they facilitate post-harvest drying. Previous researchers (Adane et al., 2020; Bora et al., 2021) focused on the frequency of wet and dry spells without conducting statistical analyses of their distribution patterns. Since rainfall is a relatively rare phenomenon varying across time and space, the significance of regular, irregular, and uniform distribution patterns of dry and wet spells has not been sufficiently emphasized. To address this gap, we employ the Anderson-Darling Normality test to analyse the distribution patterns of maximum consecutive dry and wet spells in north-western Nigeria.

2. Materials and Method

2.1 Study Area

This study was carried out in Northwestern Nigeria. The location of the study area showed that it is bounded by latitudes 10^0 00^1N and 13^0 58^1N and longitudes 4^0 8^1E and 6^0 54^1E of the Greenwich meridian. It shares a border with the Republic of Niger to the north and the Benin Republic to the west around Kebbi State (Figure 1). Northwestern Nigeria technically falls under Koppen's Aw classification, a hot but dry climate with no precipitation in the cold season and a mean annual temperature of 28°C, indicating it is in a hot climate. However, in December and January, night and early morning temperatures could be far below 20°C. The average Maximum temperature ranges between 32°C -35ºC across the study area and sometimes reaches 44^0 in places like Sokoto.

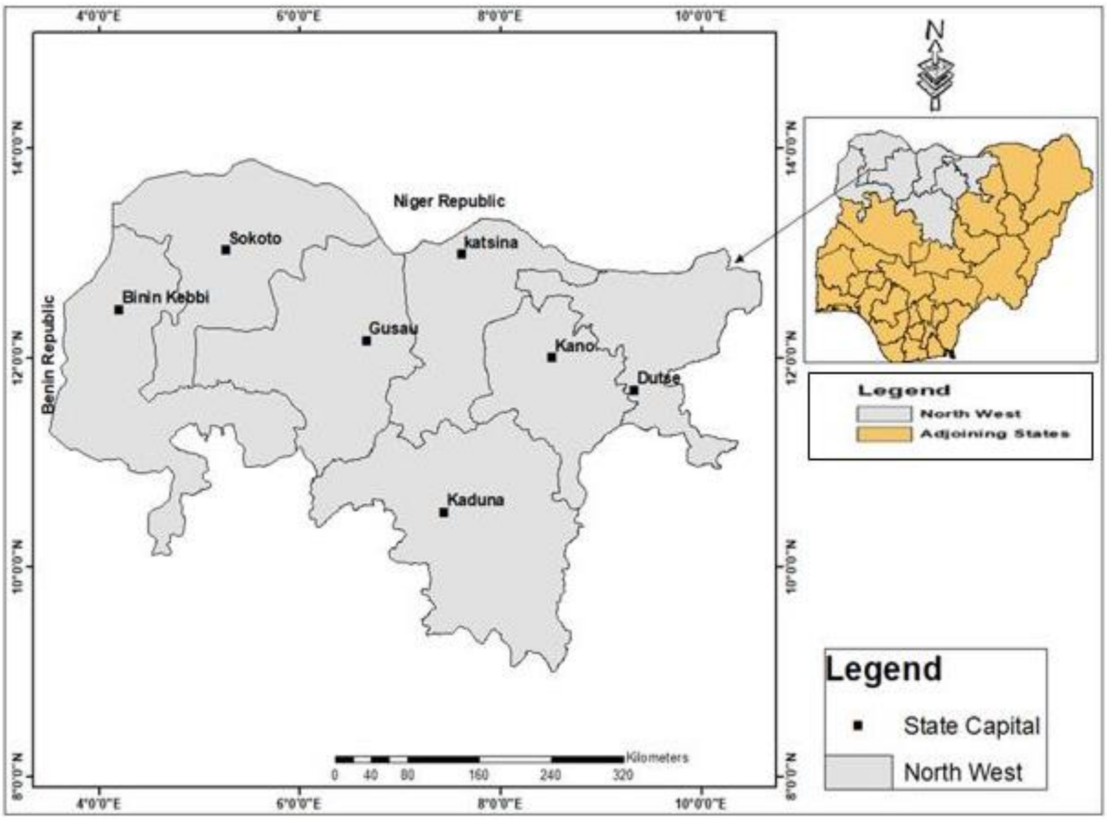

Figure 1: Study Area

2.2 Methodology

The analysis of the dry spell was carried out using daily rainfall data. For this study, dry and wet spells analysis was carried out using daily rainfall data from 1980-2021. The data were collected from the Nigerian Meteorological Agency (NIMET). The frequency of the Maximum Consecutive Dry Days (MCDD) and Maximum Consecutive Wet Days (MCWD) was examined during the growing season is from 1st June to 30th September. A number of studies (Atedhor, 2014; El-tantawi, 2013; Shiru et al., 2019; Shiru & Shahid, 2018) have acknowledged June-September as rowing season in Sudano Sahelian Area of Nigeria.

2.2.1 Maximum Consecutive Dry and Wet Spells

The program was written in Excel software. The analysis of dry and wet spells was carried out using daily rainfall data. The frequency of the Maximum Consecutive Dry Days (MCDD) and Maximum Consecutive Wet Days (MCWD) during the growing season months of June, July, August, and September were estimated. The program is presented below.

=MAX(FREQUENCY(IF(B2:AE2>0,COLUMN(B2:AE2)),IF(B2:AE2<=0,COLUMN(B2:AE2)))) For consecutive wet spell.

=MAX(FREQUENCY(IF(B2:AE2=0,COLUMN(B2:AE2)),IF(B2:AE2<>0,COLUMN(B2:AE2)))) For consecutive dry spell.

2.2.2 Distribution patterns of dry and wet spell

The frequency of dry and wet spells was subjected to Anderson Darling Normality Test. These statistics measure how well the data follow a particular distribution. If the p-value Anderson-Darling test is lower than the chosen significance level of 0.05 at 95% It indicates that the data do not follow the normal distribution, while if this is greater than0.05, the data follows normal distribution. Descriptive statistical technique such as minimum, maximum, mean (M), standard deviation (SD), coefficient of variation (CV), skewness and kurtosis were computed along with Anderson-Darling Normality test to know the variability and distribution pattern. The operation was carried in Minitab Software Version 17.

3 Result and Discussion

3.1 Frequency Pattern of Maximum Consecutive Dry and Wet Spells

The analyses of maximum consecutive dry and wet spells during the growing season are presented in Tables 1 – 6, respectively. The maximum consecutive dry spell increases during June across the states under study. This could be as a result of the onset of the rainy season in June, which is similar to the findings of a previous study, Umar and Mansur (2015), in the Sudano Sahelian region. On the other hand, wet spells with a length of 2 days were found to be higher in frequency in June. These scenarios are presented in Tables 1 to 6.

The number of maximum consecutive rainy and dry days for each year was calculated. The result visually revealed that dry spells also increased in September, while wet spells decreased in general. Given this analysis, it is possible to conclude that as the dry spell increases, the wet spell decreases.

The dry spells were divided into smaller sub-periods to ensure a more balanced distribution. Using the dry and wet spell sequences categorisation provided by (Anagnostopoulou et al., 2003; Gibson et al., 2022), the overall general distribution showed that many of stations are in the range of short sequences such as 1–5 days, followed by Medium sequences: 6–10 days, and exceptional cases of very long sequences of 21–30 days found in Kano and Kastina, Concerning longer dry spells greater than 30 days, less than 1 events occur in 1987 (Kebbi). However, in case of wet spells, larger distributions are within the short sequences of 1-10 days and 11-20 days. Overall analysis revealed that the study area was at risk of a dry spell during the beginning of the growing season and cessation period for the rainy season, which are detrimental to germination and final output. A related study (Ocen et al., 2021) in Uganda, it was also shown that at the beginning of the growing season, farmers were at risk of a dry spell.

The analysis of the frequency distribution of maximum consecutive dry and wet spells is extremely important, especially in areas where most people depend on rainfed agriculture. Mathugama and Peiris, (2011) observed that information about the duration of wet and dry spells can help determine which crops or varieties should be grown in a specific location and aid in breeding new crop varieties. The results for Critical Dry Spell (CDS) and Critical Wet Spell (CWS) are presented in Tables 1 to 6. The analysis also shows that Gusau experienced a CDS of 13 days in September and a CWS of 10 days in August; Kaduna had a CDS of 10 days in September and a CWS of 18 days in the same month; Kano's CDS was 21 days in September and its CWS was 14 days in June; Kastina had a CDS of 23 days in September and a CWS of

10 days in July; Sokoto experienced a CDS of 23 days in June and a CWS of 13 days, also in June; and finally, Kebbi had the longest CDS of 31 days in July (1987) and a CWS record of 10 days in July (1998) (Table 5).

The implications of CDS in June and September suggest that farmers should consider investing in early and late-season cropping during drought periods. Farmers often plant their seed 2-3 times before final germination, which can significantly reduce crop yields due to late-season drought. This finding is in consonance with Muluneh and Bayissa (2017), who noted that the long dry spells cause significantly high costs to affected societies. They concluded that in the tropics where the study was located, the success or failure of the crops is closely related to the occurrence of dry spells. Analysis of mean values of the maximum length of dry spell ranges between 2-9 days, approximately; with the highest mean of 9.333 days was found in June and September in Sokoto (Figures 10 and 11), while the lowest mean of 2.9048 days was observed in August at Kaduna (Figure 5). In general, dry spells occurring at the start of the growing season have a substantial negative impact on overall productivity due to reduced yields and lower production among the farming community (Ocen et al., 2021). One advantage of the wet and dry spell analysis is that it reflects the need to consider drought-sensitive crops such as maize and rice, as opposed to drought-hardy crops such as millet, which can withstand a long dry spell of even 15 days (Sivakumar, 1991). Another important issue is that certain crops during growth stages are more sensitive to drought and have higher water requirements. Other indices to be determined are the Critical Dry spells, which is the highest Maximum Consecutive Dry

Problems of precipitation probability and dry spell occurrence in tropical regions, particularly in West Africa, have been studied extensively due to their effects on rainfed agriculture (Kranjac-berisavljevic & Abdul-ghanyu, 2014). Previous studies (Dabral et al., 2014) have linked the decline of crop yield to dry-spell durations. In an arid and semi-arid environment where moisture is available for a relatively short period of the year, information on the pattern dry spell is crucial. Sivakumar, (1991) opined that it is essential to match crop phenology with dry spells to meet the crop water requirement at the sensitive stages of crop growth.

Table 1: Pattern of Maximum Consecutive Dry and Wet Spell in Gusau for the Growing Season

	June		July		August		September	
Years	Dry Spell	Wet Spell	Dry Spell	Wet Spell	Dry Spell	Wet Spell	Dry Spell	Wet Spell
1980	8	2	3	3	7	3	6	1
1981	9	3	5	3	6	4	9	3
1982	6	2	3	2	3	5	8	2
1983	7	3	5	2	3	3	13	2
1984	5	3	6	2	4	2	4	4
1985	8	4	5	4	4	5	5	3
1986	5	2	7	3	2	3	3	8
1987	7	4	5	2	2	3	9	3
1988	3	2	4	3	2	7	4	4
1989	6	2	4	4	4	6	7	2
1990	9	2	6	6	6	3	11	4
1991	5	3	5	3	4	6	8	4
1992	9	2	5	4	3	10	7	6
1993	10	4	3	3	3	5	3	3
1994	5	2	4	3	3	5	4	11
1995	5	2	8	2	3	5	4	3
1996	7	3	4	4	4	4	4	5
1997	4	4	4	2	6	2	9	2
1998	7	3	3	4	2	6	11	4
1999	7	2	9	4	2	6	4	6
2000	7	2	5	4	6	3	2	3
2001	5	2	4	2	2	4	4	3
2002	4	2	5	4	5	3	8	2
2003	6	3	6	9	4	5	4	3
2004	7	4	2	4	4	3	8	1
2005	6	2	3	4	4	5	7	2
2006	10	2	5	5	5	5	6	2
2007	10	1	8	2	3	4	6	4
2008	7	2	4	4	2	7	5	3
2009	6	2	4	3	4	3	11	5
2010	5	2	4	3	4	3	10	3
2011	5	2	12	1	3	4	5	4
2012	5	2	3	4	7	6	7	3
2013	7	2	4	3	3	6	3	3
2014	5	3	7	2	3	4	4	4
2015	2	5	3	4	3	4	5	5
2016	8	2	5	5	4	6	5	3
2017	6	3	5	3	4	4	9	3
2018	5	3	2	3	6	4	11	7
2019	6	2	9	2	3	5	11	3
2020	9	2	5	4	2	5	5	5
2021	6	1	11	4	3	6	6	2
CDS/CWS	10	5	12	9	7	10	13	11

Source: Author Computation (2024)

Table 2: Pattern of Maximum Consecutive Dry and Wet Spell in Kaduna for the Growing Season

	June		July		August		September	
Years	Dry Spell	Wet Spell	Dry Spell	Wet Spell	Dry Spell	Wet Spell	Dry Spell	Wet Spell
1980	7	4	3	4	2	6	5	4
1981	5	8	3	4	4	9	2	5
1982	6	2	3	2	3	5	8	2
1983	4	3	4	3	7	4	6	5
1984	6	3	3	5	2	8	4	6
1985	5	3	3	3	2	5	2	8
1986	7	4	2	4	2	8	5	5
1987	3	3	4	4	5	7	2	5
1988	3	5	4	4	3	9	4	7
1989	8	3	3	7	2	6	2	7
1990	4	4	3	8	2	9	3	4
1991	6	3	4	10	3	10	6	13
1992	5	4	2	12	3	5	6	8
1993	3	4	5	9	2	10	3	18
1994	4	4	3	7	3	6	2	7
1995	3	6	2	6	2	4	2	6
1996	3	5	6	4	2	8	4	6
1997	2	5	5	3	2	6	3	5
1998	6	4	3	6	4	6	3	8
1999	3	3	10	5	2	5	2	3
2000	3	3	10	5	2	5	2	3
2001	5	3	2	10	4	8	3	5
2002	3	4	4	7	2	6	5	8
2003	6	2	3	8	3	8	9	8
2004	4	4	5	13	2	7	2	6
2005	5	6	3	6	3	10	3	4
2006	7	7	3	10	3	4	2	6
2007	6	2	3	4	2	7	6	3
2008	8	3	7	6	3	14	5	5
2009	4	3	3	3	2	10	3	4
2010	4	3	4	5	4	5	4	5
2011	5	5	4	4	2	7	1	6
2012	4	2	2	5	2	6	3	6
2013	9	5	3	7	5	4	4	4
2014	4	7	4	4	3	13	2	6
2015	8	3	5	2	2	4	3	8
2016	4	4	4	4	3	5	4	6
2017	4	3	6	3	3	3	3	6
2018	4	4	2	7	3	12	6	5
2019	3	4	4	3	7	4	4	9
2020	3	3	2	7	3	6	2	5
2021	4	6	5	3	2	7	5	3
CDS/CWS	9	8	10	13	7	14	9	18

Source: Author Computation (2024)

Table 3. Pattern of Maximum Consecutive Dry and Wet Spell in Kano for the Growing Season

	June		July		August		September	
Years	Dry Spell	Wet Spell	Dry Spell	Wet Spell	Dry Spell	Wet Spell	Dry Spell	Wet Spell
1980	10	1	5	6	4	3	8	3
1981	19	1	5	2	4	2	10	2
1982	10	2	5	2	6	4	11	3
1983	6	3	8	3	6	1	10	2
1984	6	3	2	3	3	3	7	4
1985	4	2	3	5	4	2	7	5
1986	19	1	8	2	5	8	10	2
1987	8	2	4	5	3	10	9	3
1988	11	1	4	3	7	6	10	5
1989	15	2	4	4	4	3	9	3
1990	7	1	3	6	2	12	14	1
1991	7	2	4	5	5	7	12	4
1992	6	3	5	2	4	4	10	2
1993	6	3	5	2	4	4	10	2
1994	5	3	7	3	4	2	4	7
1995	8	2	5	3	5	3	7	2
1996	11	2	6	2	3	6	9	2
1997	6	2	6	3	2	5	5	5
1998	3	14	3	7	3	5	5	2
1999	2	8	9	4	3	3	10	4
2000	4	2	4	4	4	4	6	4
2001	6	3	7	3	3	2	6	3
2002	6	1	6	3	3	3	12	4
2003	7	2	3	3	3	3	9	2
2004	4	4	3	4	4	3	10	2
2005	5	2	6	5	3	3	5	4
2006	5	3	14	2	5	2	14	1
2007	1	7	3	4	5	6	5	3
2008	7	2	5	3	4	3	6	2
2009	4	2	4	3	4	4	4	2
2010	6	3	7	2	4	4	6	4
2011	4	2	4	4	4	5	21	3
2012	6	2	4	5	3	5	14	2
2013	7	2	8	1	3	3	12	1
2014	16	3	7	5	4	3	7	3
2015	6	3	7	5	5	3	15	3
2016	5	2	3	2	3	5	9	2
2017	5	3	3	3	3	5	5	3
2018	11	1	3	2	3	4	12	2
2019	10	1	4	3	3	4	5	2
2020	7	2	11	3	3	4	6	2
2021	7	2	11	3	3	4	6	2
CDS/CWS	19	14	14	7	7	12	21	7

Source: Author Computation (2024)

Table 4: Pattern of Maximum Consecutive Dry and Wet Spell in Katsina for the Growing Season

	June		July		August		September	
Years	Dry Spell	Wet Spell	Dry Spell	Wet Spell	Dry Spell	Wet Spell	Dry Spell	Wet Spell
1980	8	2	5	3	2	4	23	1
1981	9	4	4	2	5	4	4	2
1982	7	2	6	3	3	3	10	2
1983	13	2	6	2	5	4	11	2
1984	9	2	7	2	11	2	10	1
1985	15	2	6	2	6	3	7	2
1986	13	1	4	2	4	3	11	2
1987	11	3	5	2	5	2	8	3
1988	8	4	4	3	2	6	9	2
1989	7	3	5	2	5	2	9	2
1990	11	1	6	3	4	3	21	2
1991	4	4	8	2	3	4	14	1
1992	12	2	3	3	6	3	12	4
1993	12	1	6	2	7	3	8	2
1994	7	1	4	4	5	5	10	3
1995	7	2	8	1	2	2	4	2
1996	7	2	8	2	7	2	4	2
1997	6	1	8	3	5	3	4	4
1998	9	3	4	2	4	4	8	4
1999	17	1	4	6	8	5	5	3
2000	5	2	5	10	6	3	15	1
2001	7	2	4	4	4	4	12	2
2002	7	1	7	3	4	3	6	2
2003	7	3	9	3	3	5	10	2
2004	9	2	8	3	4	5	6	3
2005	8	1	8	2	5	4	6	2
2006	8	2	6	4	4	4	4	2
2007	6	3	5	3	5	5	6	3
2008	9	2	5	3	4	5	6	1
2009	8	2	7	3	6	3	11	2
2010	13	2	3	3	4	3	14	3
2011	12	1	10	2	4	3	10	2
2012	1	6	4	3	3	3	15	3
2013	10	3	6	3	5	4	9	3
2014	9	2	6	1	4	3	4	4
2015	17	1	10	5	3	3	6	1
2016	8	2	10	2	7	3	6	1
2017	7	3	10	3	8	4	12	3
2018	7	2	2	3	4	6	9	6
2019	7	2	3	2	3	5	15	1
2020	2	8	3	2	3	2	10	2
2021	1	6	7	1	5	5	3	6
CDS/CWS	17	8	10	10	11	6	23	6

Source: Author Computation (2024)

Table 5: Pattern of Maximum Consecutive Dry and Wet Spell in Sokoto for Growing Season

	June		July		August		September	
Years	Dry Spell	Wet Spell	Dry Spell	Wet Spell	Dry Spell	Wet Spell	Dry Spell	Wet Spell
1980	9	3	7	2	4	4	8	1
1981	15	2	5	4	5	3	7	2
1982	10	1	4	2	4	3	16	1
1983	14	1	8	1	6	2	15	2
1984	2	13	11	1	12	2	9	4
1985	16	1	8	3	5	3	10	2
1986	23	1	6	2	6	3	9	3
1987	5	1	7	2	15	2	10	3
1988	7	2	5	2	2	4	8	3
1989	9	3	4	2	4	4	10	2
1990	7	2	5	3	8	2	15	2
1991	10	2	5	3	3	4	8	2
1992	11	2	4	2	4	4	16	3
1993	11	1	10	3	6	3	7	3
1994	7	1	4	2	2	5	12	7
1995	6	1	6	5	4	4	6	4
1996	9	2	8	2	4	3	8	2
1997	5	1	7	3	4	2	8	2
1998	5	2	5	3	4	3	10	4
1999	10	2	3	4	3	4	6	4
2000	6	2	4	3	9	2	6	1
2001	9	3	3	3	6	2	14	2
2002	9	2	5	4	4	3	8	2
2003	8	2	7	3	5	2	9	3
2004	10	1	8	6	4	3	9	1
2005	9	1	5	4	5	5	11	3
2006	9	2	5	2	2	5	6	4
2007	10	1	5	2	4	3	10	4
2008	5	2	6	2	3	6	7	3
2009	10	2	6	4	6	2	6	2
2010	9	2	5	2	3	3	10	2
2011	8	1	11	2	8	7	7	3
2012	6	2	4	3	4	4	8	3
2013	8	2	4	3	3	5	18	6
2014	7	1	7	3	9	3	7	4
2015	20	2	5	2	4	5	9	4
2016	18	4	7	2	4	4	9	3
2017	14	2	4	1	9	4	11	2
2018	9	2	3	2	7	5	6	6
2019	5	2	3	2	5	4	12	3
2020	1	10	4	3	3	5	5	3
2021	11	2	5	3	3	6	6	4
CDS/CWS	23	13	11	6	15	7	18	7

Source: Author Computation (2024)

Table 6: Pattern of Maximum Consecutive Dry and Wet Spell in Kebbi for the Growing Season

	June		July		August		September	
Years	Dry Spell	Wet Spell	Dry Spell	Wet Spell	Dry Spell	Wet Spell	Dry Spell	Wet Spell
1980	8	2	4	3	4	3	5	4
1981	5	2	5	9	6	10	5	4
1982	3	1	4	4	4	2	6	2
1983	7	2	6	2	8	4	7	2
1984	7	2	6	2	24	2	4	3
1985	7	2	3	2	6	10	5	5
1986	7	3	7	5	3	8	5	7
1987	7	3	31	0	4	6	4	2
1988	3	4	4	4	5	4	8	4
1989	4	5	3	3	4	6	4	4
1990	12	2	4	4	5	5	6	5
1991	3	3	3	3	4	3	5	3
1992	10	3	4	4	5	4	5	9
1993	9	3	5	4	4	3	6	5
1994	5	3	3	3	4	3	5	4
1995	5	2	5	4	5	5	8	5
1996	5	2	5	4	8	5	5	3
1997	3	2	20	4	3	6	4	2
1998	7	1	3	10	4	8	3	6
1999	7	1	3	4	5	5	4	2
2000	7	2	2	3	3	4	5	2
2001	8	3	7	2	2	3	3	4
2002	5	2	5	3	3	3	4	3
2003	7	1	5	2	3	3	3	3
2004	4	3	3	6	4	6	3	8
2005	3	4	5	3	6	4	5	2
2006	7	6	12	2	4	4	4	5
2007	4	2	9	4	5	3	3	7
2008	8	3	5	3	4	5	3	8
2009	4	3	5	8	3	3	6	2
2010	7	2	7	4	3	4	3	2
2011	14	1	4	3	3	3	2	3
2012	2	6	4	5	5	3	5	8
2013	6	1	6	1	4	3	3	7
2014	4	4	4	2	4	2	4	4
2015	7	2	5	5	2	4	12	4
2016	4	2	9	3	4	2	4	4
2017	6	5	4	5	4	3	3	4
2018	4	2	3	3	4	2	5	4
2019	4	2	3	2	5	5	2	4
2020	9	3	4	2	4	4	5	5
2021	7	2	2	6	2	3	16	3
CDS/CWS	14	6	31	10	24	10	16	9

Source: Author Computation (2024)

3.2 Distribution Pattern of Maximum Length of Dry and Wet Spell

The dry and wet spell descriptive patterns were assessed using quantitative metrics such as the maximum, minimum, mean, median standard deviation, coefficient of variation, skewness, and Kurtosis and presented in Figures 2 to 13. The Anderson-Darling test shows that the patterns of dry and wet spell distribution were irregular and not significant at alpha = 0.05 across the states, as the majority of the p-values are <0.005. A scrutiny of Figures 5 and Figure 9 revealed two distinct p-values of 0.013 for a wet spell (August) and a P-value of -0.049 for a dry spell in July, respectively. A comparison of these two showed that Kastina (Figure 9) depicts a relatively normal distribution of dry spells as observed (P value 0.049). The skewness is a measure of symmetry or asymmetry of data distribution, and kurtosis measures whether data is heavy-tailed or light-tailed in a distribution. Data can be positive-skewed (data-pushed towards the right side) or negative-skewed (data-pushed towards the left side).

However, the analysis of the pattern of dry spell and wet spell in the study showed that the majority of the patterns of distribution highlighted a positive coefficient of skewness, while moderately skewness were also observed. Generally peaked distribution occurred in most cases, which showed positive value skewness, which is an indication that the mean consecutive dry and wet spells are greater than the median. A positive coefficient of kurtosis was also observed in all the months, which is an indication that the distribution of dry and wet spells peaked with a Leptokurtic distribution (a heavy-tailed distribution) in many cases. Further Analysis in Figure 4 and Figure 6 revealed a negative Kurtosis of -0.245770 and -0.046734 in the June dry spell (Kaduna) and July wet spell (Kano), respectively. Despite the negative Kurtosis in Kano during July, a near relative skewness was noticed. Furthermore, analysis of the mean maximum consecutive wet days showed that it ranges between 2 and 6 days across the study area, with the highest mean of 6.0228 records in September at Kaduna, while the lowest mean is 2,2381 records in June at Sokoto. These results are comparable with some earlier studies (Matazu et al., 2020; Otun and Adewumi, 2010). Regarding the standard deviation, the result indicated that the majority of the values fall within 1-5 days. and with the highest variation of 25days in July for Kebbi (Figure 12). The findings further confirmed the relative level distinction between the Sudano Sahelian and Sudan Savana regions. From this study, we can infer that the Anderson–Darling Normality test has the strength and capability to describe the distribution pattern of dry and wet spells during the growing season, about the rainfall distribution. Several authors have used different statistical distribution tests to model the behavior of a dry spell. The Anderson-Darling Normality test was used in the work of Pérez-Sánchez and Senent-Aparicio (2018).

Anderson–Darling test is one of the most powerful statistical tools for detecting most departures from normality. The test rejects the hypothesis of normality when the p-value is less than or equal to 0.05. Failing the normality test allows you to state with 95% confidence that the data does not fit the normal distribution. The descriptive analysis of maximum consecutive days of dry and wet spells is of great importance for researchers in decision-making, as it plays a dominant role in agricultural production (Anil, et al 2017).

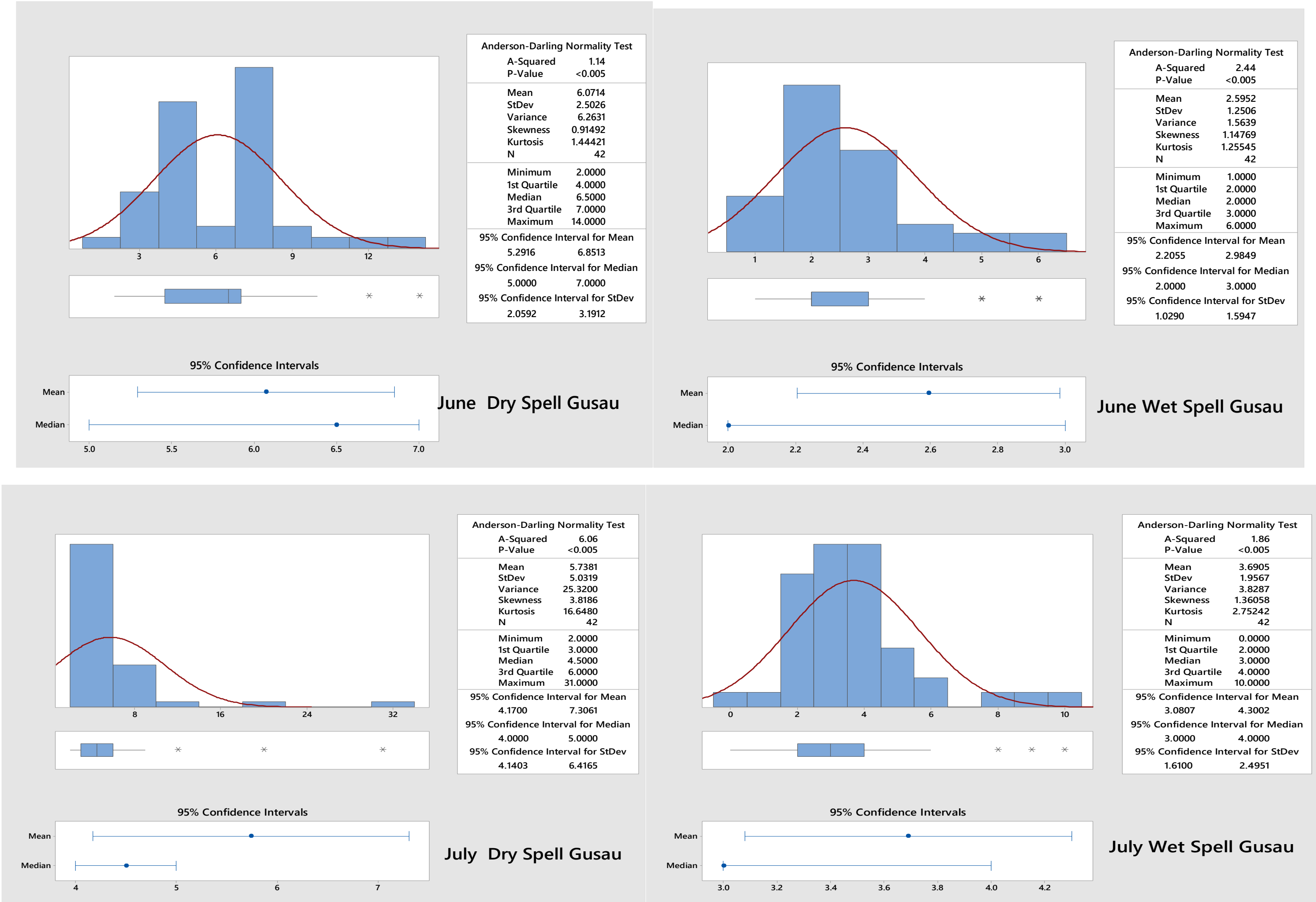

Figure 2: Dry and Wet Spell Distribution Pattern in Gusau June-July

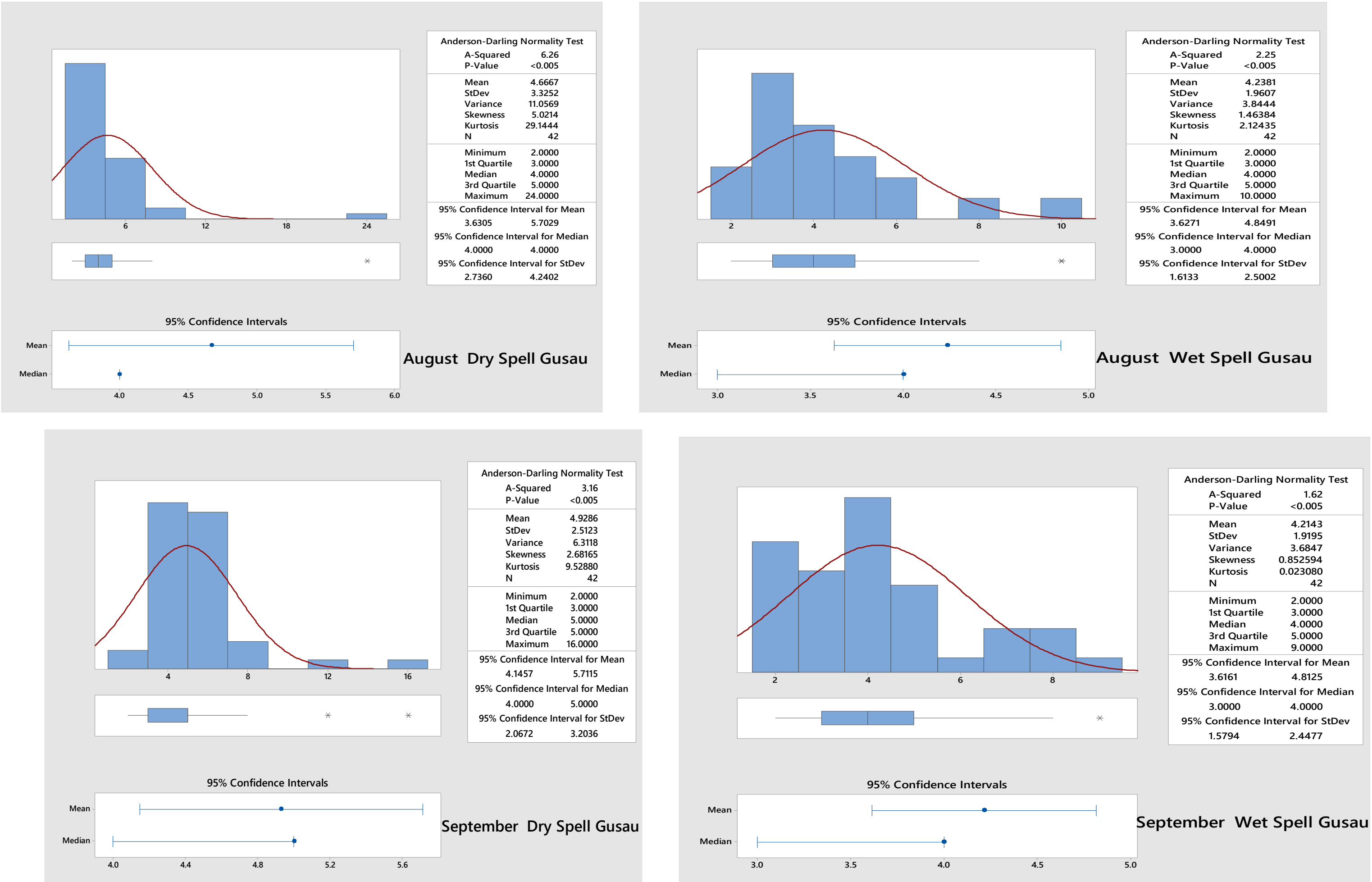

Figure 3: Dry and Wet Spell Distribution Pattern in Gusau August-September

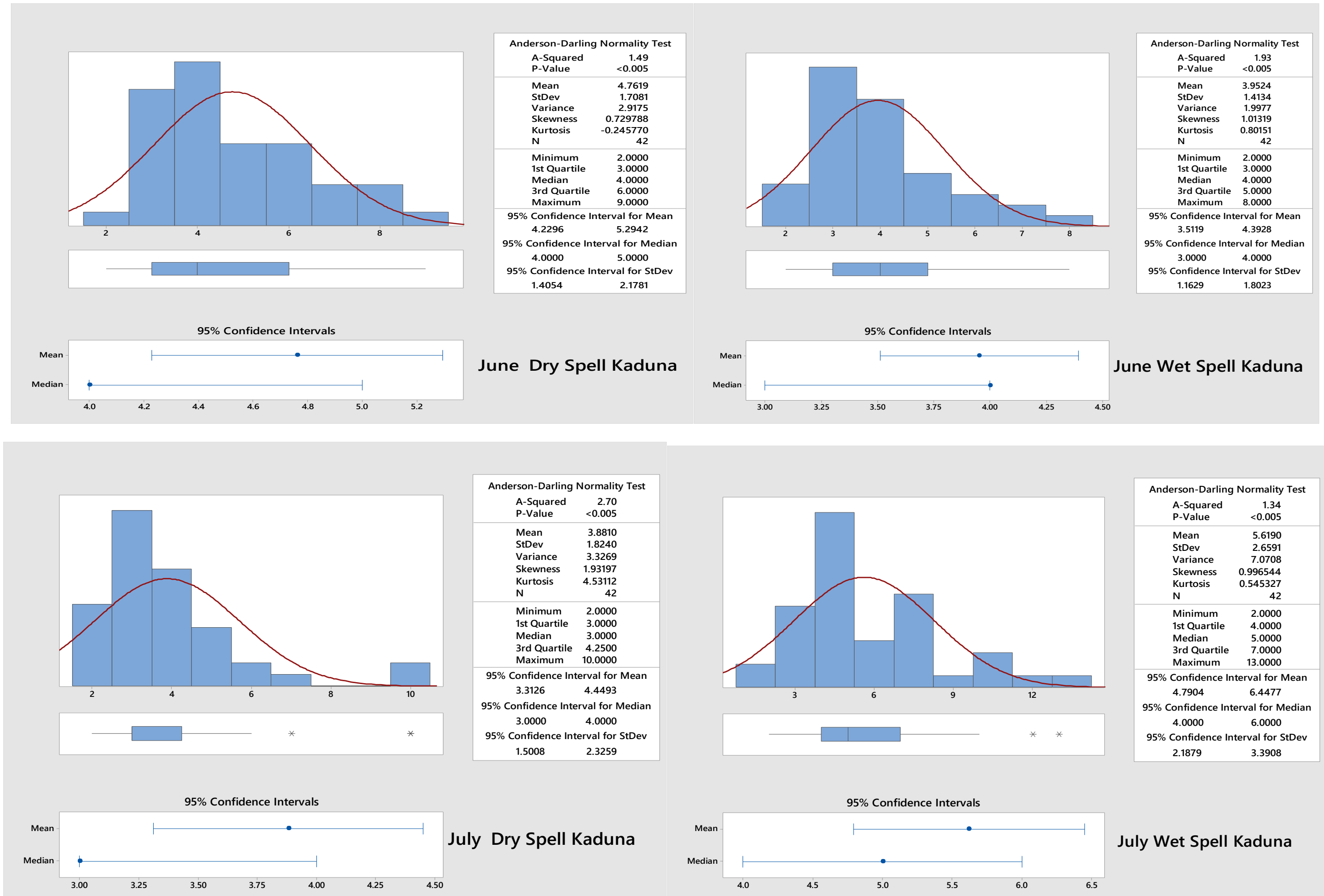

Figure 4: Dry and Wet Spell Distribution Pattern in Kaduna June-July

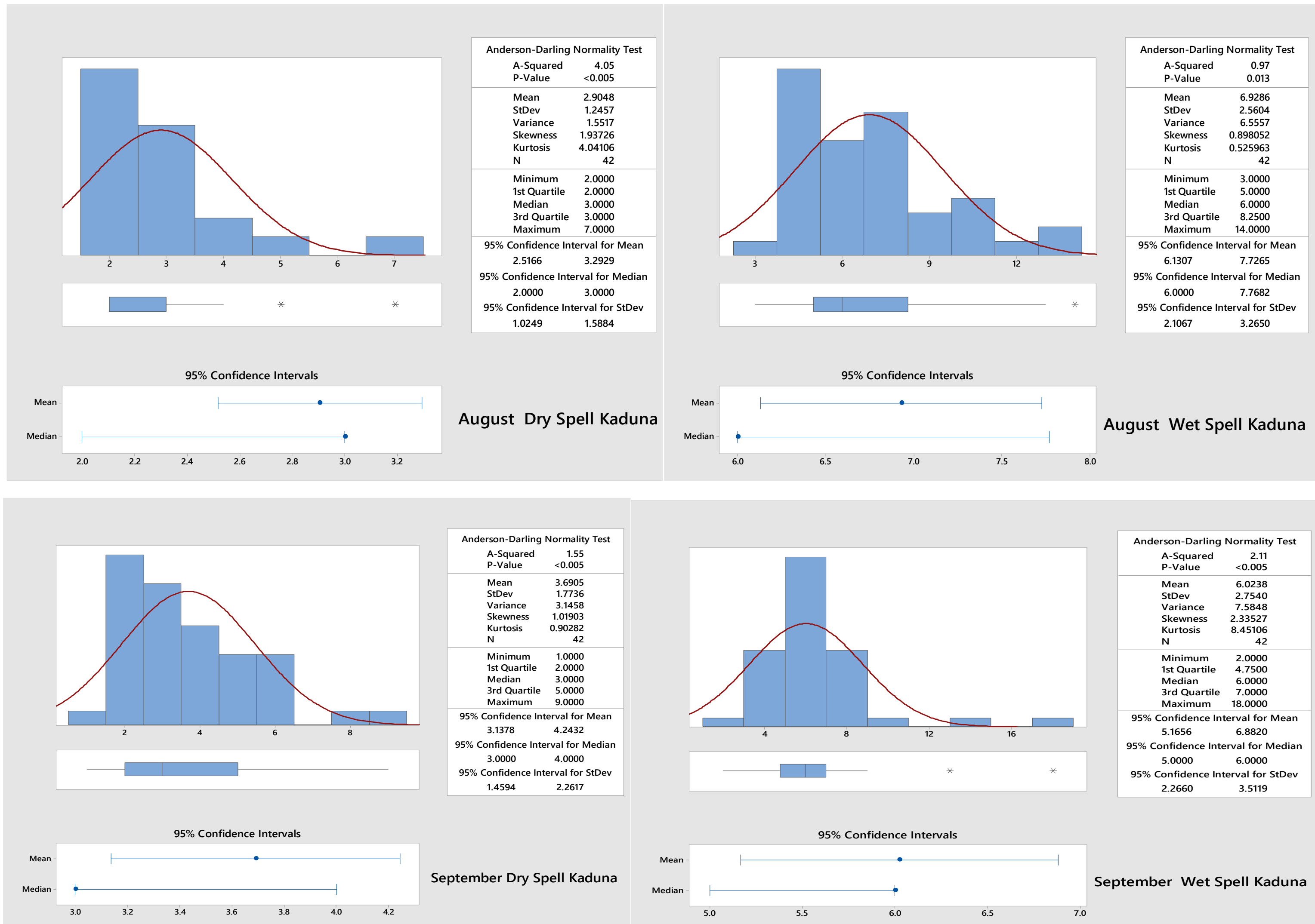

Figure 5: Dry and Wet Spell Distribution Pattern in Kaduna August- September

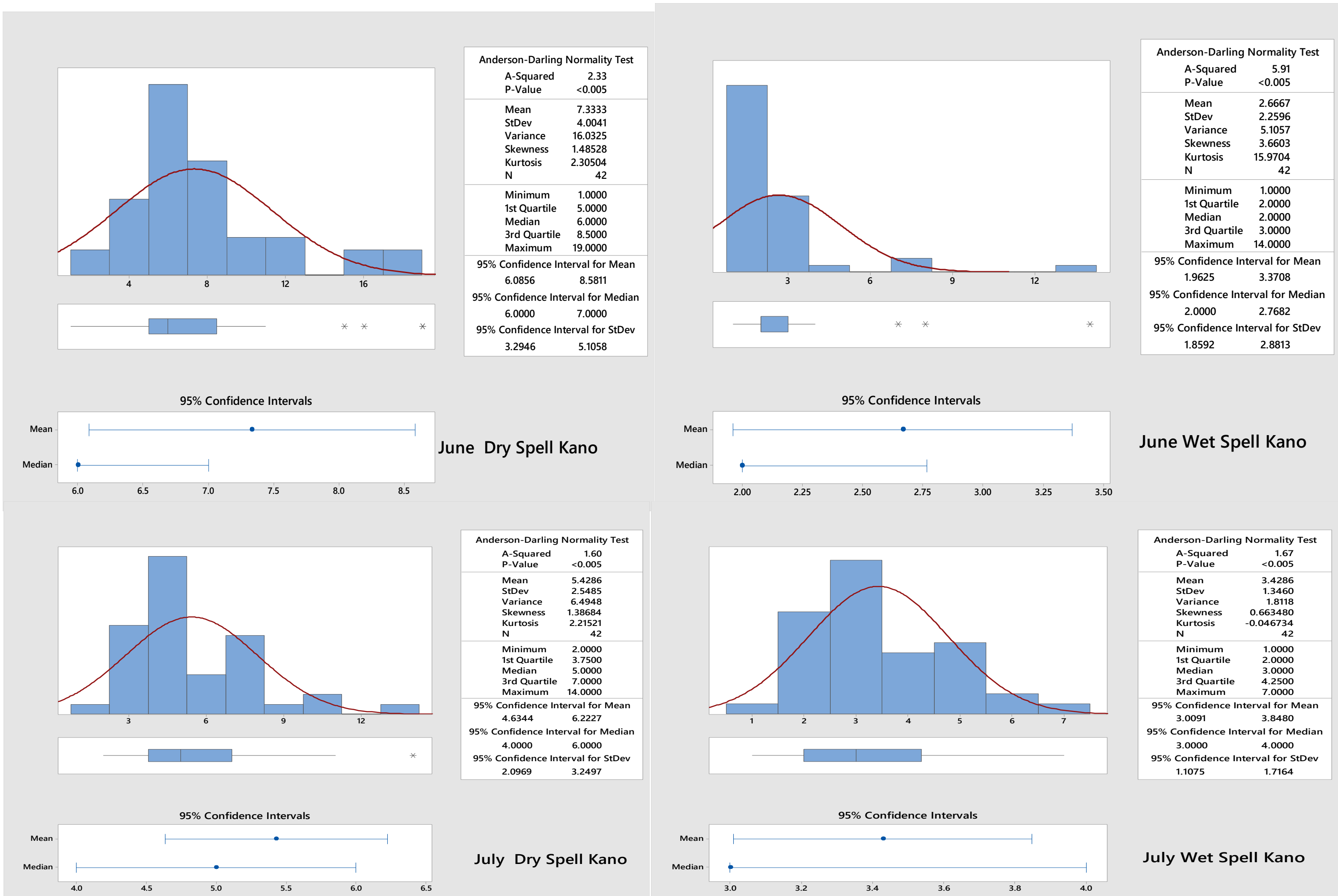

Figure 6: Dry and Wet Spell Distribution Pattern in Kano June-July

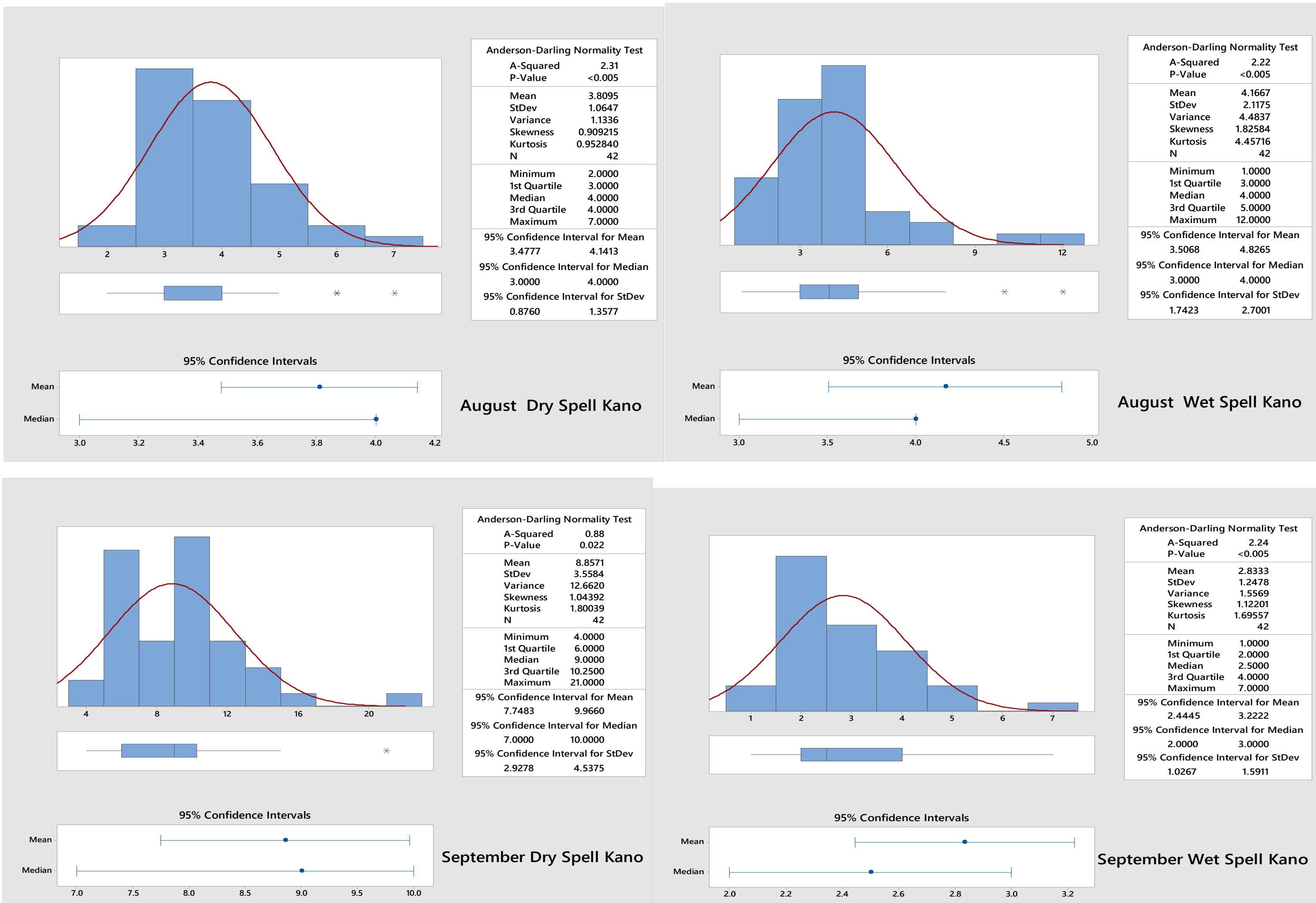

Figure 7: Dry and Wet Spell Distribution Pattern in Kano August-September

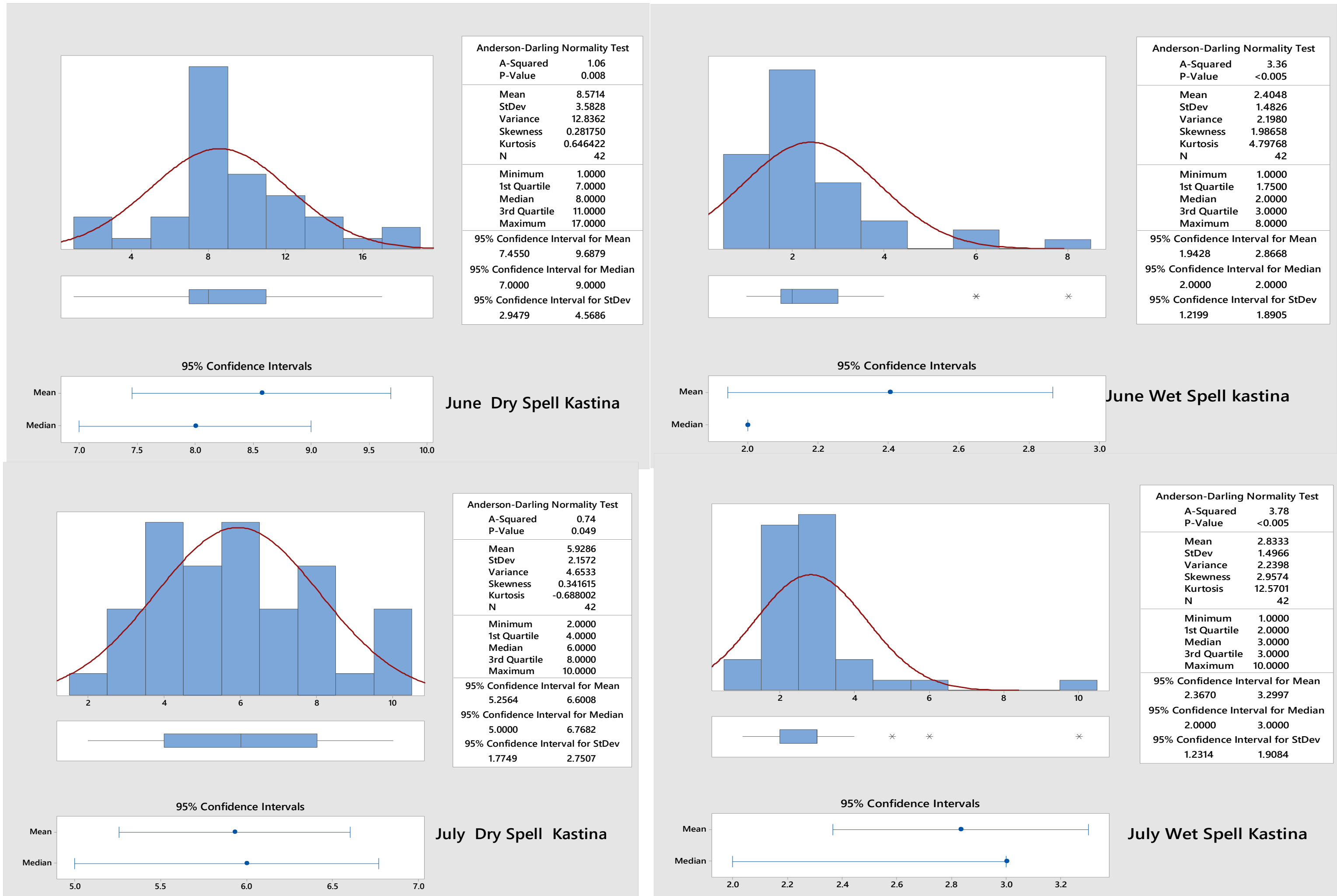

Figure 8: Dry and Wet Spell Distribution Pattern in Katsina June-July

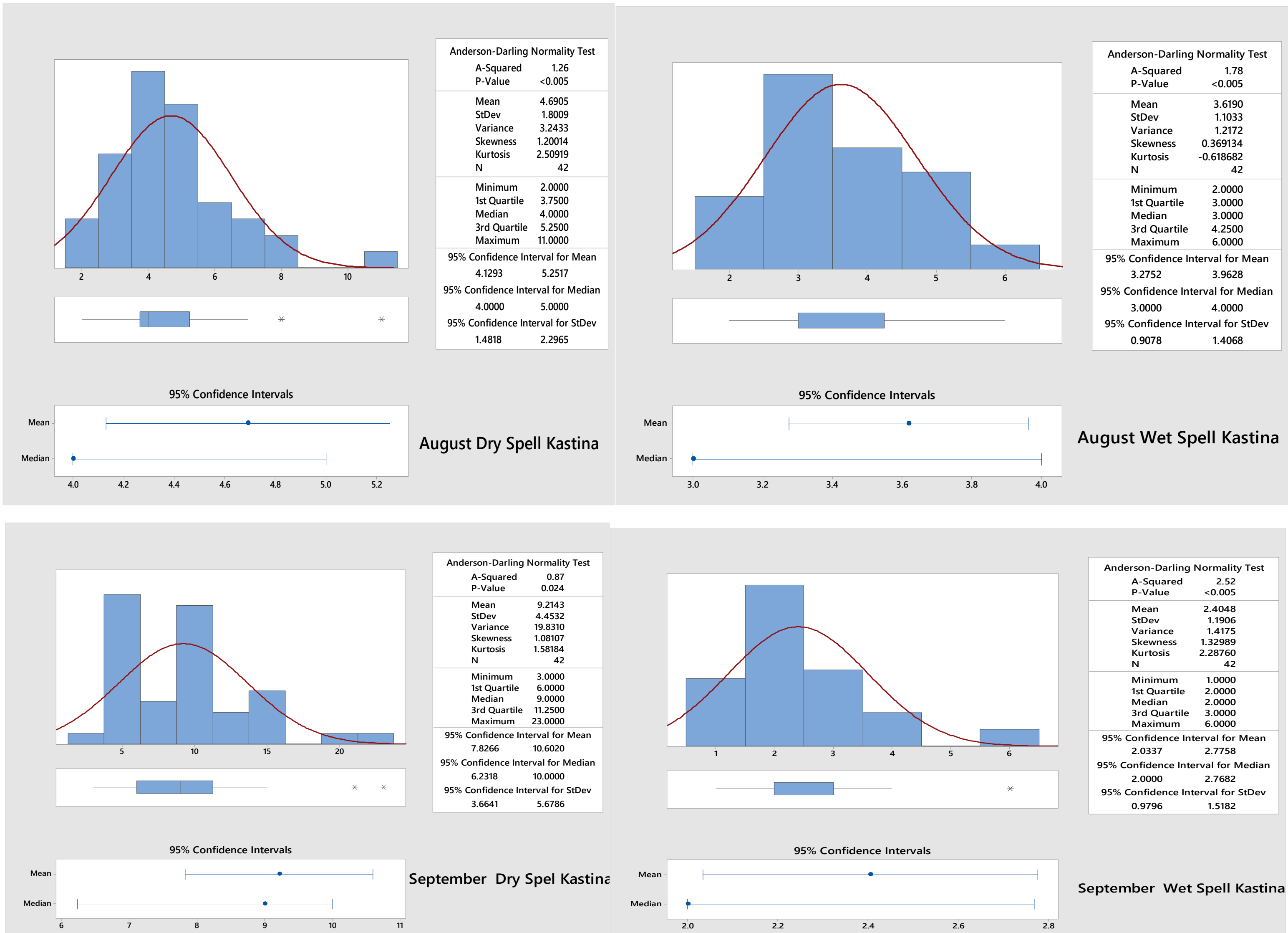

Figure 9: Dry and Wet Spell Distribution Pattern in Katsina August-September

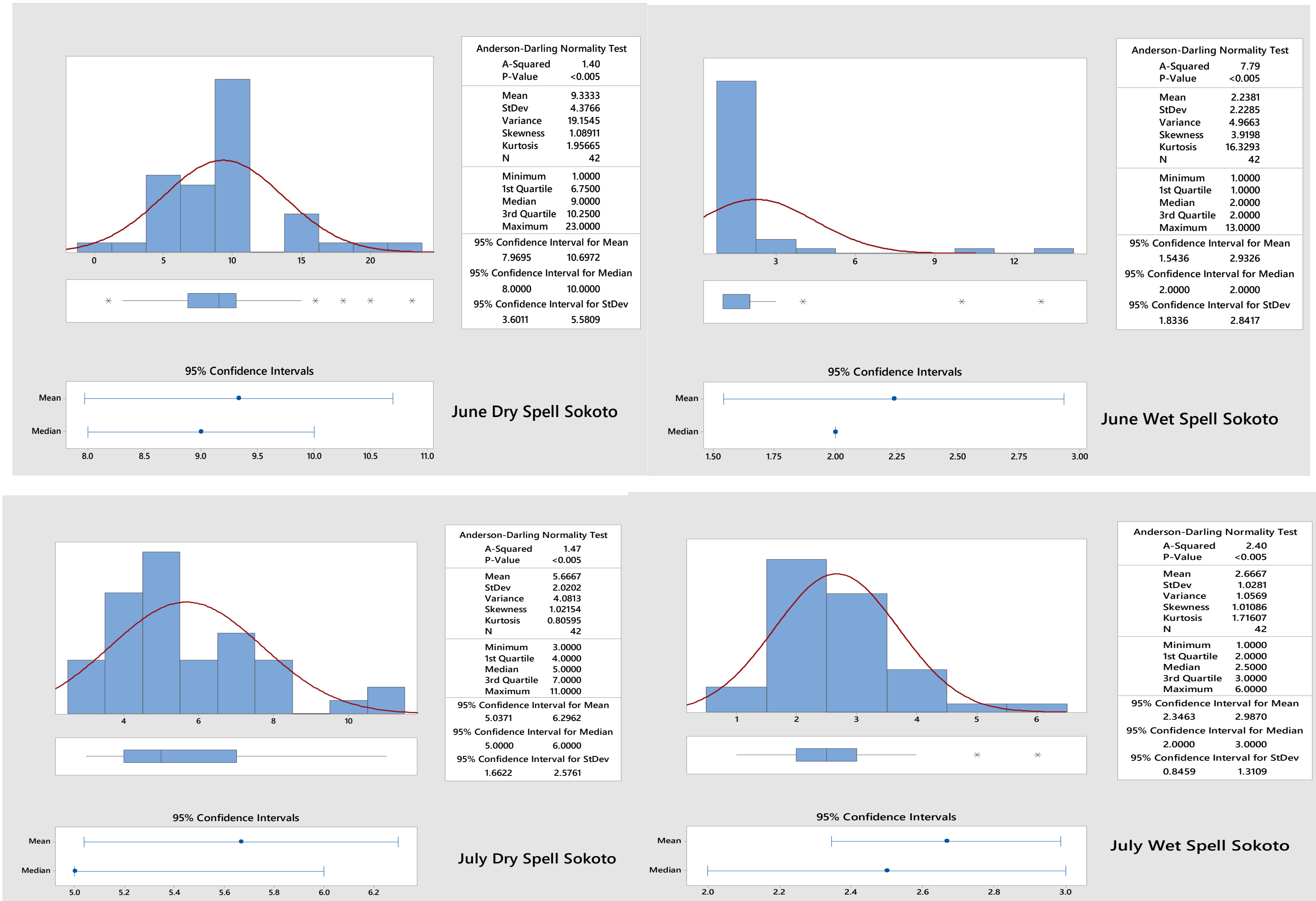

Figure 10: Dry and Wet Spell Distribution Pattern in Sokoto June-July

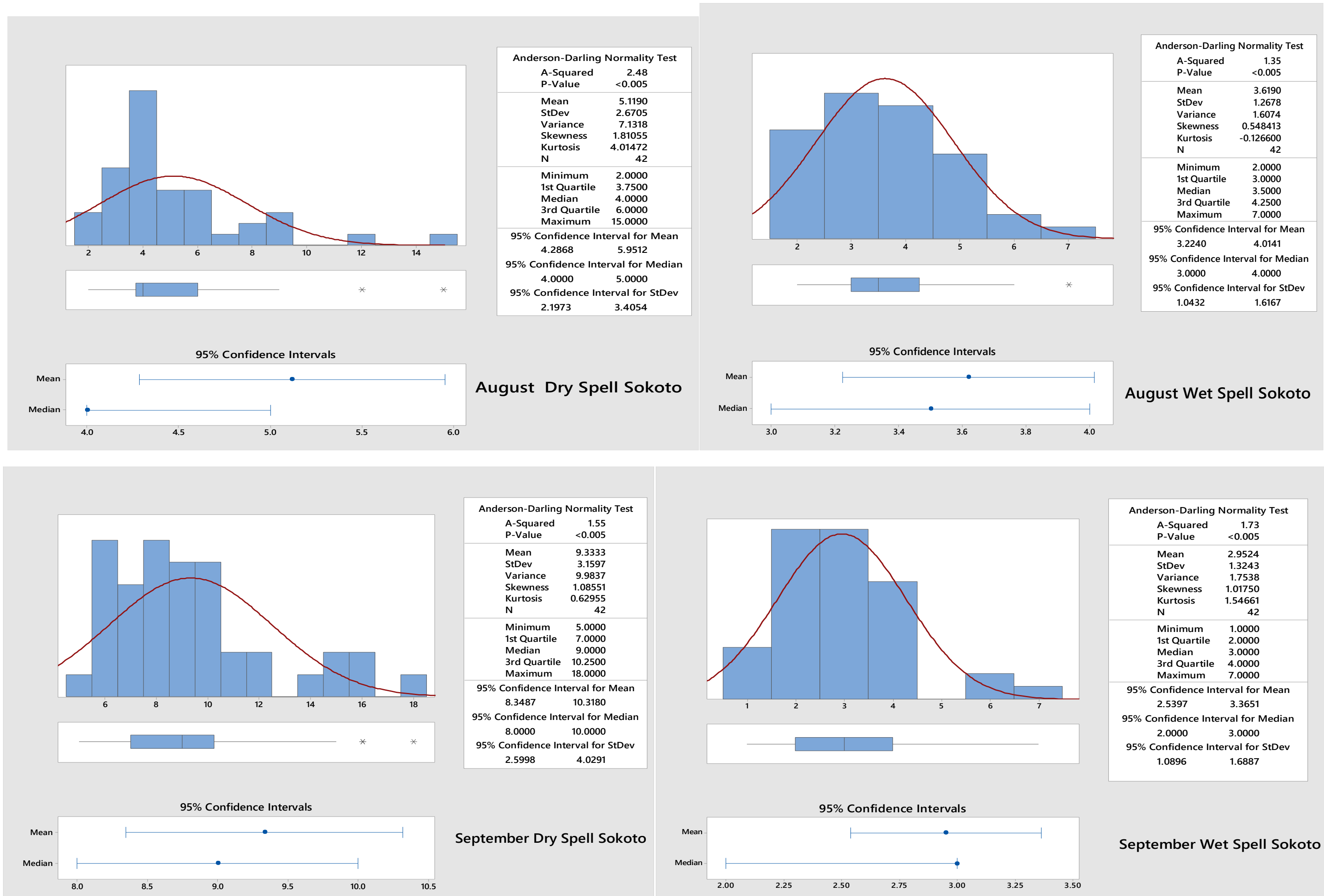

Figure 11: Dry and Wet Spell Distribution Pattern in Sokoto August-September

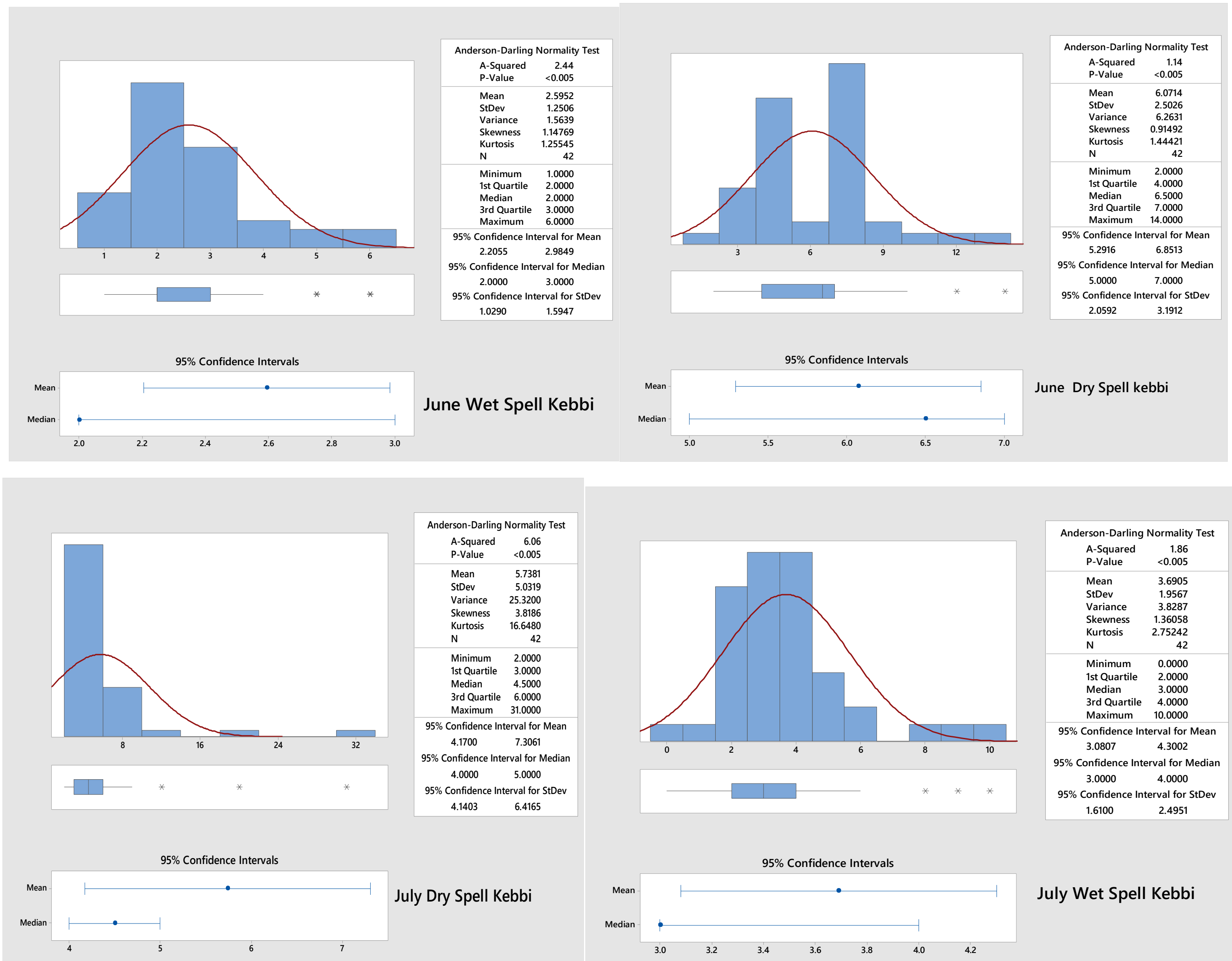

Figure 12: Dry and Wet Spell Distribution Pattern in Kebbi June-July

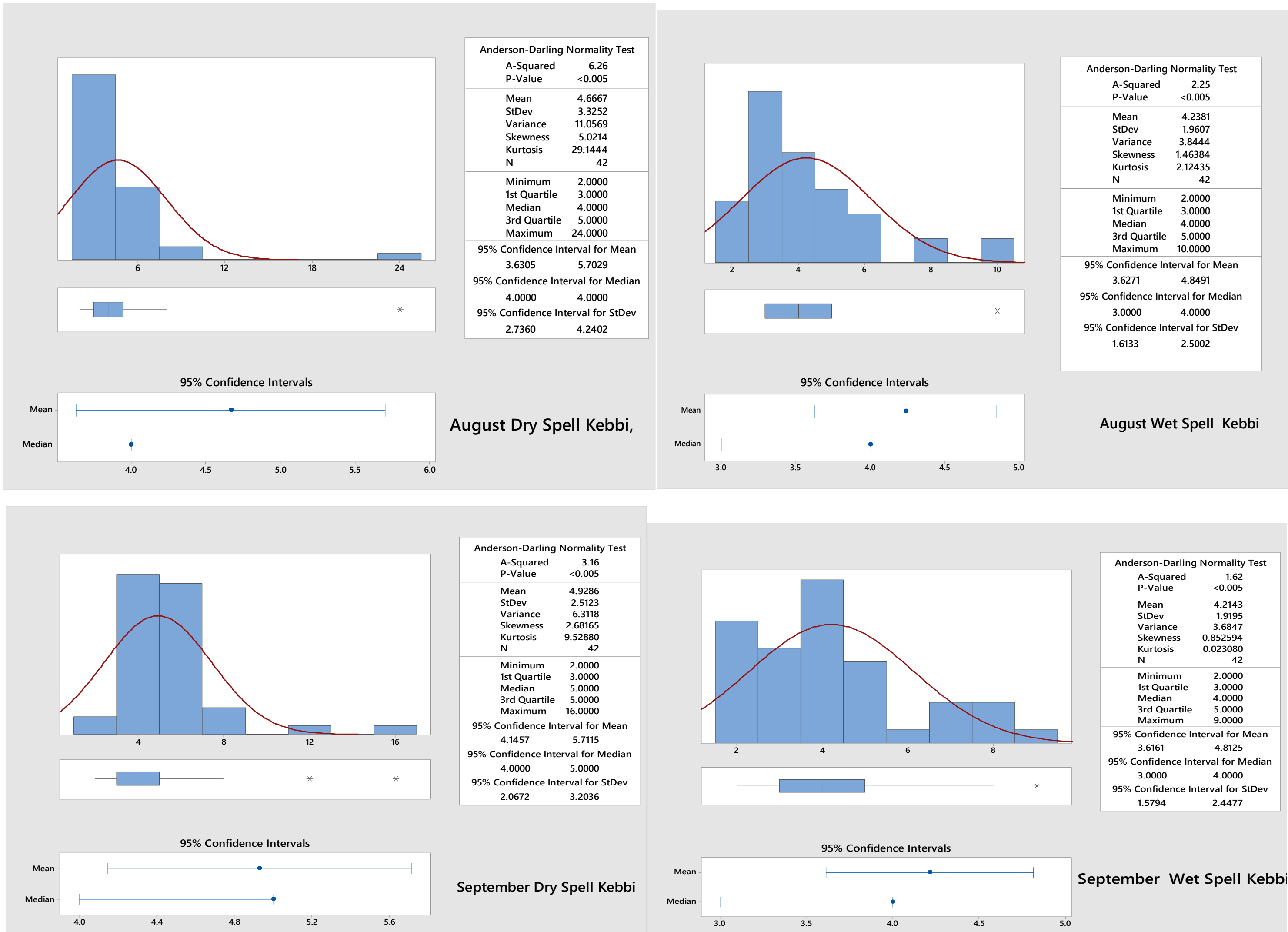

Figure 13: Dry and Wet Spell Distribution Pattern in Kebbi August -September

4. Conclusion and Recommendations

The study provides insights into dry spell occurrence during June, with the possibility of it being related to the false start of the rainy season, while the probability of prolonged wet spell duration increases during August and decreases throughout September. The results showed that the probability of dry spells occurring was higher during the onset of the growing season than towards the cessation of the growing season. These findings demonstrated the strength of the statistical parameters in mapping out the frequency of dry spells during the onset of the growing season and providing a framework for the detection of the occurrence of false starts in the first planting season. The maximum consecutive dry spell comes from 4-7 days, while the maximum consecutive wet days come from 1-5. Days. This could be concluded as an irregular distribution pattern of wet and dry spells. This increase in the irregular pattern of dry and wet spells strengthens the risk of natural catastrophes such as droughts and floods. This can have a substantial impact on agricultural production in Northwestern Nigeria, where the majority of subsistence farmers mainly depend on rainfed. The information generated by the rainfall analysis could find useful application in crop planning and management, and risk of agricultural drought.

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