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TREND ANALYSIS OF RAINFALL IN FCV TOBACCO GROWING AREA OF *HUNSUR* UNDER KARNATAKA LIGHT SOILS

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Tobacco (*Nicotiana tobacum*) is grown in red sandy loams called as Karnataka Light Soils as a *Kharif* crop as rainfed and irrigated when required. The study area *Hunsur* is in southern transition zone of Karnataka with a mean annual rainfall of 748 mm is a part of *Mysore* district which contributes about 80 % FCV tobacco grown during *Kharif* as rainfed. Crop growth generally affected when there is a moisture stress during the critical stages, it is more applicable to FCV tobacco where the economic produce is leaf. It is become more pertinent when crop is grown in light textured soils. Hence, a trend analysis was done for detecting and estimating trend in time series of annual values of monthly rainfall of *Hunsur* area (2001-2015) under FCV tobacco. The used statistical techniques were the nonparametric *Mann-Kendall* test for testing the presence of the monotonic increasing or decreasing trend and the nonparametric *Sen's* method for estimating the slope of a linear trend. It was found that a decreasing trend in monthly rainfall during May-June-July months significantly during *June* with z test value: -0.79, -1.68 and -1.54 and Sen's estimator of slope (Q) i.e. magnitude of change was highest significantly (- 9.44 mm/year) in June followed by July (- 4.55 mm/year) and May (- 3.60 mm/year) which is a critical period of *Kharif* grown FCV tobacco. Such aberrations in rainfall during this period result in poor yield and quality which can be mitigated to avoid moisture stress. Practicing rainwater storage and recycling (farm pond technology) for providing life saving irrigation is essential to maintain required soil moisture in the root zone of the crop. Little adjustment in planting time, if required may help in better yields and quality in FCV tobacco in the study area.

INTRODUCTION

The study area falls under southern transition zone under Agro climatic zones of Karnataka with a mean annual rainfall of 748 mm. Around 60 % of the rain is received during April to August. Soils are red sandy loam in major areas and red loamy in the remaining areas. The principal crops grown are *Rice, Ragi, Pulses, Jowar and Tobacco.* FCV tobacco is grown during *kharif* as rainfed with an average yield ranging from 900 to 1200 kg ha $^{-1}$and crop growth generally affected when there is moisture stress during the critical stages. It is more applicable to FCV tobacco where the economic produce is leaf and is become more pertinent when crop is grown in light textured soils. The frequent aberrations necessitate studying the rainfall trend during crop growth period and its distribution for meaningful crop planning. Sinha Ray and Srivastava (2000), Sadhukhan *et al.* (2000), Kothawale *et al.* (2010) studied trends of annual and seasonal rainfall at many locations and at different scales over India. Sequences of dry and wet spells are important factors for rain fed crops. Hence, necessary corrective measures can be taken for sustenance of the crop (Panigrahi and Panda, 2002). Keeping in view the importance of leaf productivity and quality of FCV tobacco a trend analysis was done for detecting and estimating trend in time series of annual values of monthly rainfall of *Hunsur* area (2001-2015) under FCV tobacco to know whether are there any changes are happening in the present climate change scenario which may assist in mitigating the moisture stress during the crop growth.

MATERIALS AND METHODS

The analysis was done for detecting and estimating trend in time series of annual values of monthly rainfall of *Hunsur* area under FCV tobacco. The used statistical techniques are the nonparametric Mann-Kendall test for testing the

Key words: Trend analysis, rainfall and Mann -Kendall

presence of the monotonic increasing or decreasing trend and the nonparametric Sen's method for estimating the slope of a linear trend.

Rainfall analysis and trend detection: Monthly rainfall data from 2001 to 2015 of *Hunsur station* of Mysore district of Karnataka was used as a representative case for trend detection analyses. Mann–Kendall nonparametric test, as described by Sneyers (1990), was applied in order to detect the presence of any trend. This test was used by several researchers to detect trends in hydrological time series data, especially groundwater level, stream flow pattern, rainfall, etc. (Serrano *et al.*, 1999; Brunetti *et al.*, 2000; Subash and Ram Mohan, 2010; Subash et al., 2010). Mann-Kendall test basically utilizes the ranks obtained by each data in the data series. The initial value of the Mann-Kendall statistic, S. The net result of all such increments and decrements yields the final value of S (Kundzewicz and Robson, 2000; Chiew and Sirivardena, 2005).

$$S = \sum_{i=1}^{n-1} \left[\sum_{j=i+1}^{n} \operatorname{sgn}(Rj - Ri) \right]$$

Where sgn(x) = 1 for x > 0; sgn(x) = 0 for x = 0; sgn(x) = -1 for x < 0.

The z-statistic (critical test statistic values for various significance levels can be obtained from normal probability tables) is therefore: $z = | S | / s^{0.5}$. A positive value of S indicates an increasing trend and vice versa. The test of significance (z) was compared with table value at 99 % (2.576), at 95 % (1.960) and at 90 % (1.645) confidence level, respectively. To estimate the true slope of an existing trend (as change per year) the Sen's nonparametric method was used (Shahid, 2010). This method follows the equation:

$f(t) = Qt + B$ (1)

Where, Q is the slope and B is a constant. To get the slope estimate Q in equation (1) we first calculate the slopes of all pairs of data: $Q = xj\text{-}xk / j\text{-}k$, *where j>k:* If there are *n* values, *xj* in the time series we get as many as $N = n(n-1)/2$ slope estimates *Qi*. The Sen's estimator of slope is the median of these *N* values of *Qi*. The *N* values of *Qi* are ranked from the smallest to the largest. The Sen's estimator is:

$Q = Q[(N+1)/2]$, *if N* is odd (or) $Q = ½ (Q[(N/2] + Q[(N+2)]$, *if N* is even

RESULTS AND DISCUSSION

Monthly rainfall data from 2001 to 2015 of *Hunsur* station of Mysore district of Karnataka showed that highest mean rainfall (138.9 mm) was in the month of *October* while lowest rainfall (1.50 mm) was in *Febrauary*. During Kharif season (June - August) when the FCV tobacco is grown the mean maximum rainfall was in the month of July (85.4 mm) (Table.1). Rainfall trend detection was done with the help of Mann-Kendal test and Sen's nonparametric method for change in rainfall trend.

Mann-Kendall trend analysis with z test showed that there was negative / decreasing trend in rainfall during May, June and July with z test value: -0.79, -1.68 and -1.54 and Sen's estimator of slope (Q) i.e. magnitude of change was highest (- 9.44 mm/year) and significant at 99 % of confidence of interval in June (Tab.1 & Fig.1a) followed by July (- 4.55 mm/year) and May (- 3.60 mm/year). Plotting of rainfall monthly and Sen's estimates of individual months clearly indicated that there is decreasing trend especially in the months of May, June and July over a time period of fifteen years (Fig.1a &b).

While an increasing trend was seen in *February* followed by *April* months and during *October* & November month where no tobacco is grown and are found non-significant statistically (Table.1 and Fig.1b). This negative trend may influence crop growth of FCV tobacco especially in rain fed light soil areas like *Hunsur.* This indicates that development of supplementary irrigation facility is essential to sustain productivity. Studies on the trends in seasonal rainfall in the *Shivalik* foothill region as part of crop planning efforts showed high variability in seasonal rainfall and indicate the need of supplemental irrigation for successful raising of crops (Agnihotri, 1999).

In order to mitigate the effect on crop due to changes in the rainfall during these three months and avoid moisture stress during crop growth

Table.1: Descriptive statistics, Mann-Kendall trend and Sen's slope estimates of monthly rainfall over a period (2001-2015) at *Hunsur*.

Time Series	Starting Year	Last Year	Mean (mm)	Standard Deviation(n-1)	*z*-test value for Mann-Kendall Trend (S)	Q (Sen slope estimate) (mm/year)	B (Constant)
Jan	2001	2015	2.2	7.0	-0.49	-1.515	91.78
Feb	2001	2015	1.5	4.4	0.99	4.527	85.78
Mar	2001	2015	13.6	21.4	0.20	0.333	67.33
Apr	2001	2015	86.9	61.6	0.89	2.000	70.40
May	2001	2015	103.3	53.6	-0.79	-3.600	121.60
Jun	2001	2015	84.3	26.6	* -1.68	*-9.440	158.24
Jul	2001	2015	85.3	53.1	-1.54	-4.550	170.20
Aug	2001	2015	84.2	38.1	0.10	1.267	40.67
Sep	2001	2015	109.4	68.5	-0.22	0.000	0.00
Oct	2001	2015	138.9	82.9	-0.93	0.000	0.00
Nov	2001	2015	60.2	49.2	-1.18	0.000	0.00
Dec	2001	2015	11.2	21.3	0.00	0.000	5.2

Note: * Significance at 99 % of confidence interval

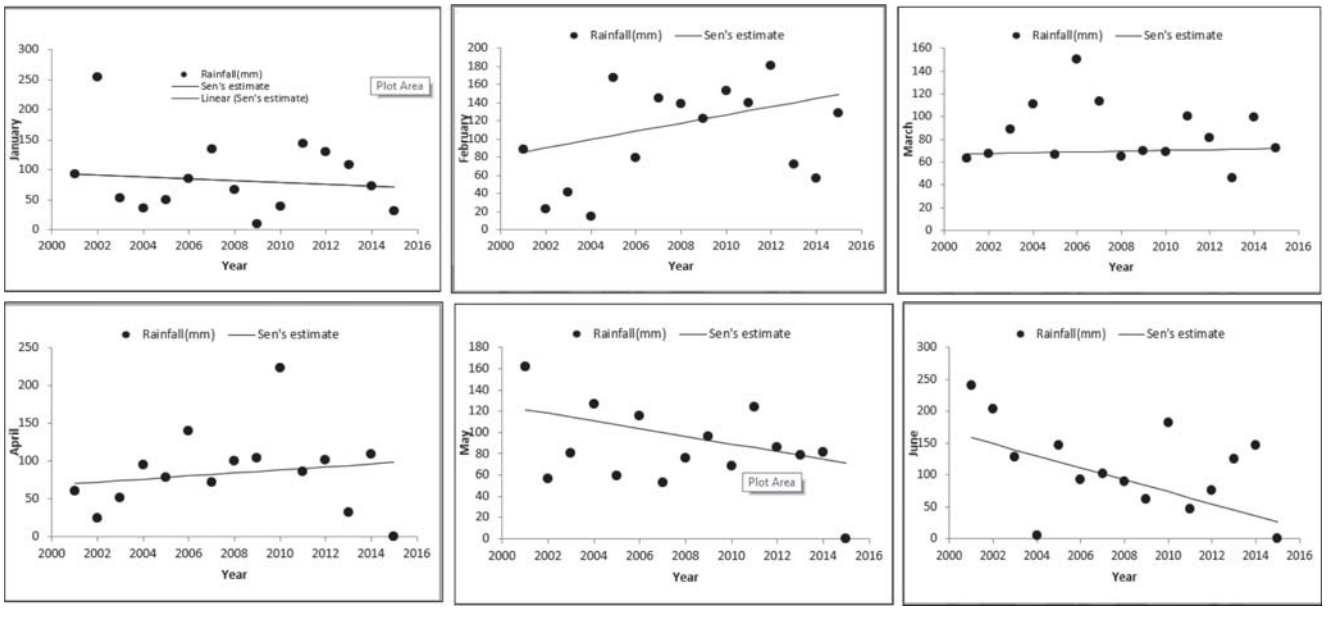

Fig.1a: Monthly trend of rainfall (mm) over 15 years in Hunsur of KLS region under FCV tobacco.

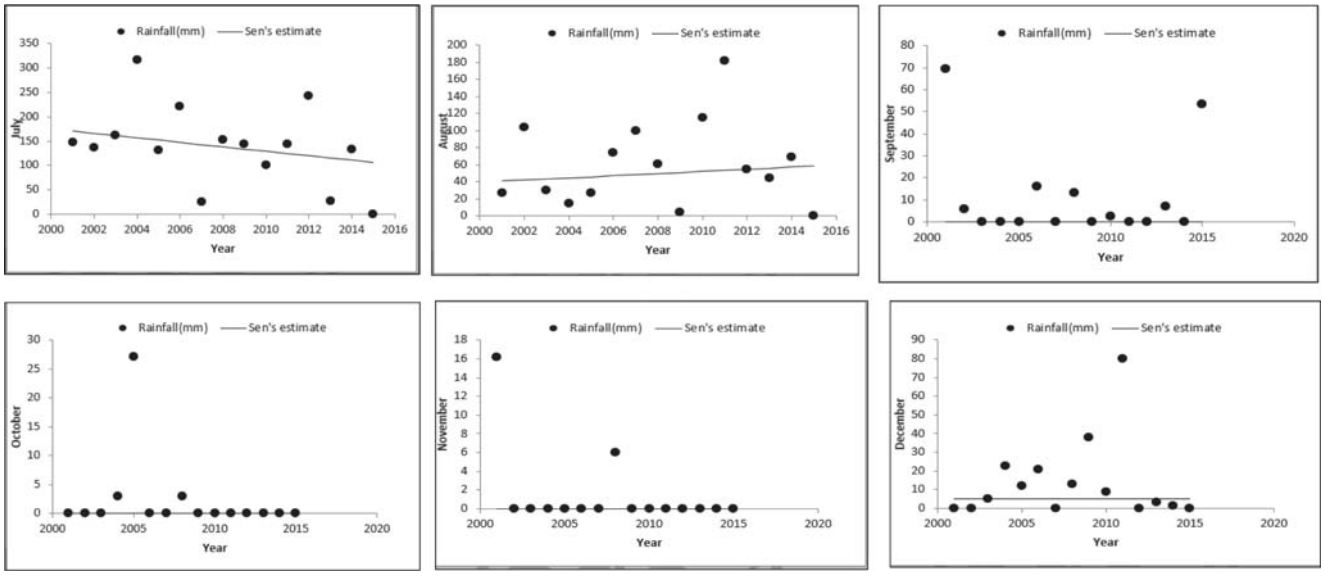

Fig.1b: Monthly trend of rainfall (mm) over 15 years in Hunsur of KLS region under FCV tobacco.

rainwater storage for supplementary irrigation and little adjustment in planting dates may help in better yields and quality in FCV tobacco in the study area. Similar studies of rainfall pattern during crop seasons in relation to yield were done in rice and wheat crops by Panigrahi and Panda, (2002); Subash and Ram Mohan, (2010); Prasad et al., (2013).

The study on trend in monthly rainfall of *Hunsur* clearly indicated that there is a negative /decreasing trend during May, June and July months and June being the highest. These three months are critical for establishment and growth of FCV tobacco crop in the study area, if aberrations in rainfall during this period result in poor yield and quality. Based on the above results it is suggested that mitigate effect of decreasing trend in rainfall during critical periods of crop establishment and active growth in those months and avoid moisture stress by adopting practices of rainwater storage and recycling for supplementary irrigation for maintaining proper soil moisture in the root zone and slight adjustment in planting time may help in better yields and quality in FCV tobacco in the study area.

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