



ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(3): 528-534
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www.thepharmajournal.com
Received: 23-01-2022
Accepted: 25-02-2022

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Influence of climate change on silk cocoon production

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Abstract

Sericulture is one of the important allied agricultural activities which provides subsidiary income to the farmers and plays an important role in poverty alleviation. Climate is one of the main determinants of silk cocoon production. Even slight variation in climatic factors will adversely affects silk worm growth and in term affects cocoon production. In the present study the monthly data of silk cocoon production and climatic parameters for five years from 2012-13 to 2016-17 were obtained from the six selected locations of Karnataka, in order to study the impact of climatic changes on silk cocoon production. To study the variation in climate change linear trend analysis was done and results indicated that temperature showed a declining trend where as rainfall and relative humidity had Increasing trends which were statistically significant in all six locations under study.

Keywords: Climatic change, multivoltine and bivoltine silk, linear trend analysis, silk cocoon production

Introduction

Silkworm is one of the most important domesticated insect, which produces luxuriant silk thread in the form of cocoon by consuming mulberry leaves during larval period. The growth and development of silkworm is greatly influenced by environmental conditions. The seasonal differences in the environmental components considerably affect the genotypic expression in the form of phenotypic output such as cocoon weight, shell weight, and cocoon shell ratio. The silkworm body temperature is higher than the atmospheric temperature by about 1°C. The ideal temperature for healthy growth of silkworm varies according to its developmental stages and the breed. Increase in the temperature up to 27-28 °C increases the growth of silkworm. However, more than 30 °C imbalances the metabolic activity and the silkworms thus become unhealthy. High temperature also affects the quality of leaf in the rearing bed. Atmospheric humidity influences the silkworm growth through mulberry leaf in addition to its direct effect on the silkworm. In the case of low humidity, the rate of multiplication of pathogens is slow and though hygienic condition better, the leaf withers fast, rendering it unfit for the silkworm to eat. As a result, growth of the larvae slow down causing inanition (weakness) and irregular molting. On the other hand, high humidity keeps the quality of leaf better, the larvae growth fast become fat but weak in resistance to pathogens (muscardine). Hence, an optimum humidity during rearing has to be maintained for healthy growth of the larvae. So an attempt has been made to study the influence of climate change on silk cocoon production.

Material and Methods

The study area consists of Kolar, Chikkaballapura, Ramanagara, Chamarajanagara, Mandya, and Mysuru districts of Karnataka. The Karnataka is largest producer of silk in the country and accounts for nearly 30 per cent of the country's export. Sericulture is primarily concentrated in the southern region. Hence, the districts viz., Kolar, Chikkaballapura, Ramanagara, Chamarajanagara, Mandya, and Mysuru were selected for the present study. The monthly data on silk cocoon production of bivoltine and multivoltine races ('00 MT) pertaining to above respective districts of Karnataka were collected from Department of Sericulture, Government of Karnataka. The climatic parameters viz., Rainfall (mm), Temperature (°C) and Relative humidity (%) for the period from 2012-13 to 2016-17 was collected from AICRP on Agro-Meteorology, GKVK, Bengaluru.

The descriptive statistics such as the Mean, Standard Deviation (SD) and Coefficient of Variation (CV) were computed to study the variability of the climatic parameters at selected locations. Standard formulae were used to compare the above measures. These measures were calculated for monthly, yearly and pooled over years for 2012-13 to 2016-17 separately for each location. Lineartrend analysis was done by fitting the simple regression equation separately for each parameter over months for the period 2012-13 to 2016-17. Further the trend line presented using graphs of free hand curve fitting to know the trend of climatic parameters over a time.

Results and Discussion

Variations in climatic characteristics are one of the main causes for variations in cocoon production. The study is taken to analyze the cocoon production in multi locations hence it will of interest to analyze the variability in the climatic factor prevailing in these locations.

Descriptive statistics

The summary statistics such as Mean, Standard deviation and Coefficient of variation for study period (2012-13 to 2016-17) were used to measure variability in the important climatic factors such as rainfall, temperature and relative humidity. The monthly, yearly and pooled over year along with F test value statistics of climatic parameters such as rainfall, temperature and relative humidity were computed and presented in following heading.

Descriptive statistics of climatic parameters for Kolar location

From the Table 1 it was clear that the highest annual rainfall of 1180.00mm with a standard deviation of 69.26 mm was observed during 2014-15. The lowest recorded was 459.00 mm with a standard deviation of 42.16 mm during 2016-17. The average temperature was around 31 °C and the average annual relative humidity was found to vary from 57 to 64%. However, the CV varies from 5.87 to 11.57 per cent in rainfall. It indicates that not much variation was noticed over the years. Similar trend was observed in case of temperature and relative humidity. The results presented in overall rainfall, temperature and relative humidity was noticed that there is no statistical significance difference between mean values of climatic parameters such as rainfall, temperature and relative humidity over years under study.

It was observed from the Table 2 in Kolar the quantum of monthly rainfall during the rainy season starting from April to August ranged from 279.40 mm (April) to 590.10 mm

(August). The variability in the rainfall was also high during these periods. The temperature remained almost same in different months and were in the range of 27.23 °C (December) to 35.40 °C (April). The similar trend was also seen in relative humidity over different months and rages from 51.11 (March) to 70.14 (August).

Descriptive statistics of climatic parameters for Chikkaballapur location

The results in the Table 3 indicate that the highest annual rainfall of 1180.00 mm with a standard deviation of 69.26 mm was observed during 2015-16. The lowest rainfall recorded was 561.40 mm with a standard deviation of 63.16 mm during 2013-14. There was a very slight change in average annual temperature during the study period and recorded average temperature was around 31 °C. The average annual relative humidity ranges from 55.80 to 64.59%. However, the CV varies from 5.87 to 11.25 per cent in rainfall. It indicates that not much variation was noticed over the years. The slight variation was observed in case of temperature and relative humidity. The results of F calculated for means was noticed that there is no statistical significance difference between mean values of climatic parameters such as rainfall, temperature and relative humidity over years under study.

The results in Table 4 indicated that the average monthly rainfall, temperature and relative humidity in Chikkaballapur. The quantum of maximum rainfall received from April to October ranged from 303.20 mm (April) to 646.45 mm (October). The variability in the rainfall were also high during these periods. Apart from these months less amount of rainfall were recorded in other months with a lower variability. The temperature remained almost same in different months and it were in the range of 21.19 °C (December) to 34.49 °C (April). The variability in temperature was not seen much during the study period. The similar trend was also seen in relative humidity over different months.

Table 1: Descriptive measure for annual Rainfall (mm), Temperature (°C) and Relative Humidity (%) in Kolar during 2012-13 to 2016-17

Years	Rainfall			Temperature			RH		
	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)
2012-13	842.40	64.27	7.63	30.73	2.57	8.36	61.28	10.59	17.28
2013-14	459.00	42.16	9.19	30.73	2.57	8.36	64.97	9.15	14.09
2014-15	606.50	57.37	9.46	31.08	3.43	11.03	64.22	7.92	12.33
2015-16	1180.00	69.26	5.87	30.78	2.79	9.05	63.54	8.07	12.69
2016-17	554.20	64.11	11.57	30.25	2.16	7.13	57.36	7.44	12.98
Overall	3642.10	62.04	1.70	30.94	2.82	9.13	62.28	8.85	14.22
Fcal. values	1.93 ^{NS}	-	-	0.50 ^{NS}	-	-	1.50 ^{NS}	-	-

Note: NS: non-significance

Table 2: Descriptive measure of monthly Rainfall (mm), Temperature (°C) and Relative Humidity (%) in Kolar during 2012-13 to 2016-17

Months	Rainfall			Temperature			RH		
	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)
January	13.40	5.34	39.83	28.65	0.62	2.18	62.41	2.97	4.76
February	8.40	3.76	44.72	30.98	0.60	1.95	52.93	4.64	8.77
March	51.00	14.12	27.68	33.44	1.22	3.66	51.11	8.61	16.85
April	279.40	56.65	20.28	35.40	1.76	4.96	52.56	4.94	9.41
May	578.30	31.68	5.48	34.77	1.35	3.87	55.14	5.09	9.23
June	330.20	65.68	19.89	31.66	1.12	3.54	62.80	7.23	11.51
July	437.90	66.58	15.20	32.19	3.37	10.48	66.58	2.81	4.21
August	590.10	70.86	12.01	30.07	0.53	1.78	70.14	3.39	4.84
September	405.60	66.32	16.35	29.52	0.64	2.16	69.82	3.49	5.00
October	393.60	59.21	15.04	29.21	0.88	3.02	69.05	7.05	10.2
November	382.60	84.86	22.18	28.10	1.31	4.67	67.43	10.63	15.76
December	171.60	26.96	15.71	27.24	0.21	0.77	67.34	3.71	5.51

Table 3: Descriptive measure for annual Rainfall (mm), Temperature ($^{\circ}$ C) and Relative Humidity (%) in Chikkaballapur during 2012-13 to 2016-17

Year	Rainfall			Temperature			RH		
	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)
2012-13	665.53	63.40	9.53	30.70	2.64	8.58	62.16	11.26	18.11
2013-14	561.40	63.16	11.25	29.02	2.93	10.09	55.88	11.96	21.40
2014-15	893.10	90.72	10.16	30.18	2.70	8.96	64.59	11.25	17.42
2015-16	1180.00	69.26	5.87	30.03	1.90	6.34	63.59	8.01	12.60
2016-17	668.20	67.47	10.10	30.59	2.88	9.42	62.29	11.42	18.34
Overall	3968.23	71.53	1.80	30.10	2.62	8.69	61.70	10.94	17.73
Fcal. values	1.00 ^{NS}	-	-	0.77 ^{NS}	-	-	1.18 ^{NS}	-	-

Note: NS: non-significance

Table 4: Descriptive measure of monthly Rainfall (mm), Temperature ($^{\circ}$ C) and Relative Humidity (%) in Chikkaballapur during 2012-13 to 2016-17

Months	Rainfall			Temperature			RH		
	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)
January	1.00	0.45	44.72	28.42	0.68	2.40	57.85	6.87	11.88
February	12.80	5.61	43.85	30.73	0.79	2.58	49.84	3.46	6.94
March	40.80	14.64	35.87	33.43	1.09	3.26	44.90	5.76	12.84
April	303.20	71.89	23.71	34.49	2.10	6.09	50.47	3.26	6.47
May	555.20	41.91	7.55	33.53	0.26	0.77	57.46	6.26	10.89
June	512.40	74.36	14.51	30.34	1.38	4.53	66.26	8.13	12.27
July	499.00	58.02	11.63	28.94	1.72	5.96	71.16	6.45	9.07
August	468.50	55.55	11.86	29.02	1.02	3.51	71.99	4.71	6.55
September	546.83	80.55	14.73	28.53	1.14	3.98	72.22	1.53	2.12
October	646.45	106.30	16.44	28.74	1.50	5.23	68.38	7.18	10.51
November	278.40	80.64	28.97	27.89	1.54	5.54	66.25	9.17	13.84
December	103.50	27.04	26.13	27.20	0.66	2.42	63.65	11.50	18.06

Descriptive statistics of climatic parameters for Ramanagara location

The monthly, annual and overall period for Ramanagara location along with F test value, the descriptive statistics for climatic parameters were computed and presented in the Table 5 and Table 6. The results from the Table 5 revealed that the highest annual rainfall of 1205.00 mm with a standard deviation of 61.36 mm was observed during 2015-16. The lowest rainfall recorded was 515.17 mm with a standard deviation of 38.32 mm during 2012-13. The average annual temperature varies from 29.46 to 30.27 $^{\circ}$ C and average annual relative humidity varies from 63.17 to 68.98 per cent. However, there was a slight changes in CV for rainfall and temperature and indicates that no variation was noticed over the years. In case of relative humidity CV varies from 7.85 to 17.31 per cent. The results presented in overall rainfall, temperature and relative humidity was noticed that there is no statistical significance difference between mean values of climatic parameters such as rainfall, temperature and relative humidity over years under study.

The results from the Table 6 revealed that the relatively high rainfall received from May to October ranged from 414.10 mm (July) to 690.46 mm (September). The variability in the rainfall were also high during these periods. The temperature

remained almost same in different months and it is ranged from 27.13 $^{\circ}$ C (December) to 34.61 $^{\circ}$ C (April). The variability in temperature was not seen much during the study period. The similar trend was also seen in relative humidity over different months.

Descriptive statistics of climatic parameters for Chamarajanagara location

From the Table 7 it was clear that the highest annual rainfall of 849.90 mm with a standard deviation of 60.79 mm was observed during 2015-16. The lowest recorded was 215.00 mm with a standard deviation of 34.43 mm during 2016-17. There was not much change in average annual temperature during the study period and recorded average temperature were around 31 $^{\circ}$ C. The average annual relative humidity ranges from 39.91 to 63.52%. However, the CV varies from 7.15 to 16.02 per cent in rainfall. It indicates that not much variation was noticed over the years. Similar trend was observed in case of temperature and relative humidity. The results of F calculated for means was noticed that there is no statistical significance difference between mean values of climatic parameters such as rainfall, temperature and relative humidity over years under study.

Table 5: Descriptive measure for annual Rainfall (mm), Temperature ($^{\circ}$ C) and Relative Humidity (%) in Ramanagara during 2012-13 to 2016-17

Years	Rainfall			Temperature			RH		
	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)
2012-13	515.18	38.32	7.44	30.27	2.60	8.58	63.17	10.93	17.31
2013-14	908.70	82.94	9.13	29.46	2.73	9.25	68.98	5.42	7.85
2014-15	949.00	87.81	9.25	29.58	2.61	8.81	67.57	6.50	9.63
2015-16	1205.00	61.36	5.09	30.12	1.89	6.27	66.05	9.60	14.54
2016-17	552.90	54.07	9.78	29.99	2.90	9.68	67.39	5.55	8.23
Overall	4130.78	68.67	1.66	29.88	2.50	8.36	66.63	7.91	11.86
Fcal. values	1.54 ^{NS}	-	-	0.22 ^{NS}	-	-	0.92 ^{NS}	-	-

Note: NS: non-significance

Table 6: Descriptive measure of monthly Rainfall (mm), Temperature ($^{\circ}\text{C}$) and Relative Humidity (%) in Ramanagara during 2012-13 to 2016-17

Months	Rainfall			Temperature			RH		
	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)
January	1.00	0.45	44.72	28.31	0.73	2.57	63.99	5.08	7.95
February	0.00	0.000	0.00	30.67	0.55	1.79	56.79	7.73	13.61
March	131.00	36.64	27.97	33.34	0.97	2.91	55.01	8.10	14.73
April	303.06	65.88	21.74	34.61	1.06	3.06	57.18	3.62	6.33
May	567.58	35.78	6.30	32.95	0.47	1.42	64.50	1.89	2.93
June	459.30	50.48	10.99	29.69	1.22	4.12	69.95	3.32	4.74
July	414.10	33.39	8.06	28.54	1.19	4.18	73.39	1.80	2.46
August	569.85	41.00	7.19	28.49	0.65	2.29	73.69	1.41	1.91
September	690.46	117.22	16.98	28.29	0.66	2.32	73.54	1.7	2.31
October	593.49	79.50	13.39	28.81	0.96	3.35	71.15	3.71	5.21
November	323.34	64.22	19.86	27.78	1.08	3.88	71.79	5.85	8.15
December	77.60	16.72	21.55	27.14	0.54	1.98	68.59	3.81	5.55

Table 7: Descriptive measure for annual Rainfall (mm), Temperature ($^{\circ}\text{C}$) and Relative Humidity (%) in Chamarajanagara during 2012-13 to 2016-17

Years	Rainfall			Temperature			RH		
	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)
2012-13	321.60	28.77	8.95	31.61	2.02	6.4	60.64	7.74	12.76
2013-14	634.80	71.60	11.28	32.20	3.33	10.33	62.72	11.24	17.92
2014-15	554.40	51.80	9.34	31.01	2.62	8.44	63.52	10.83	17.05
2015-16	849.90	60.79	7.15	31.41	1.78	5.67	39.92	4.02	10.06
2016-17	215.00	34.43	16.02	32.42	2.58	7.96	57.94	10.09	17.41
Overall	2575.70	53.68	2.08	31.73	2.49	7.85	56.95	12.49	21.94
Fcal. values	1.97 ^{NS}	-	-	0.63 ^{NS}	-	-	1.57 ^{NS}	-	-

Note: NS: non-significance

Table 8: Descriptive measure of monthly Rainfall (mm), Temperature ($^{\circ}\text{C}$) and Relative Humidity (%) in Chamarajanagara during 2012-13 to 2016-17

Months	Rainfall			Temperature			RH		
	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)
January	16.60	6.99	42.08	30.30	0.67	2.22	48.88	8.33	17.04
February	1.00	0.35	34.64	32.69	0.39	1.19	45.60	7.18	15.75
March	47.90	19.26	40.22	34.81	0.81	2.31	43.94	6.32	14.39
April	217.50	44.30	20.37	35.79	1.42	3.97	50.26	6.98	13.89
May	501.20	30.59	6.10	33.89	1.16	3.41	58.91	9.25	15.71
June	124.20	16.57	13.34	31.00	0.72	2.33	62.60	12.38	19.78
July	153.20	27.39	17.88	30.03	0.91	3.02	65.00	14.92	22.95
August	308.80	44.75	14.49	32.41	3.72	11.47	63.68	13.83	21.72
September	531.50	91.48	17.21	30.68	1.00	3.27	62.02	12.85	20.73
October	365.60	66.83	18.28	30.59	1.44	4.71	63.11	13.86	21.96
November	266.20	68.79	25.84	29.37	1.79	6.09	62.91	9.36	14.88
December	52.20	4.54	8.70	28.02	1.93	6.90	64.09	6.21	9.70

It was observed from the Table 8 in Chamarajanagara mean monthly maximum rainfall received 531.50 mm which was observed in the month of Septembers and the lowest rainfall received 1.00 mm in the month of February. The temperature has slight changes during study period in different months and were in the range of 28.02 $^{\circ}\text{C}$ (December) to 35.78 $^{\circ}\text{C}$ (April). The similar trend was also seen in relative humidity over different months.

Descriptive statistics of climatic parameters for Mandya location

From the Table 9 it was clear that the highest annual rainfall of 700.12 mm with a standard deviation of 13.47 mm was observed during 2015-16. The lowest recorded was 218.30 mm with a standard deviation of 26.67 mm during 2016-17. There was not much change in average annual temperature during the study period and recorded average temperature were around 31 $^{\circ}\text{C}$. The average annual relative humidity

showed little variation and it ranges from 42.51 to 64.60. However, the CV varies from 1.92 to 12.22 per cent in rainfall, temperature varies from 5.80 to 10.69 per cent and relative humidity varies from 7.74 to 15.75. It indicates that not much variation was noticed over the years. The results presented in overall rainfall, temperature and relative humidity was noticed that there is no statistical significance difference between mean values of climatic parameters such as rainfall, temperature and relative humidity over years under study.

It can be seen from the Table 10 in Mandya the mean monthly maximum rainfall of 523.50 mm was observed in the month of Septembers and the lowest rainfall of 30.02 mm in the month of February. The change in temperature was observed during study period in the range of 28.92 $^{\circ}\text{C}$ (December) to 35.37 $^{\circ}\text{C}$ (April). The similar trend was also seen in relative humidity over different months ranged from 48.32 (March) to 66.12 per cent (September). CV was found that not much

variation in case of rainfall and relative humidity but moderate variation was found in temperature and it ranges from 1.46 to 14.26 per cent.

Descriptive statistics of climatic parameters for Mysuru location

From the Table 11 it is clear that the highest annual rainfall of 678.40 mm with a standard deviation of 64.41 mm was observed during 2014-15. The lowest recorded was 244.30 mm with a standard deviation of 31.18 mm during 2016-17. The temperature varies from 29.82 to 31.65 °C and relative humidity ranges from 68.50 to 72.13 per cent. However, the CV varies from 1.92 to 12.86 per cent in rainfall, temperature varies from 6.72 to 10.44 per cent and relative humidity varies from 8.40 to 13.20 per cent. It indicates that not much variation was noticed over the years. The results presented in overall rainfall, temperature and relative humidity along with F values was noticed that there is no statistical significance difference between mean values of climatic parameters such as rainfall, temperature and relative humidity over years under study.

It can be observed from the Table 12 in Mysuru mean monthly maximum rainfall received was 527.29 mm in the month of October and the lowest rainfall received was 44.74 mm in the month of January. The temperature has varied during study period in the range of 28.48 °C (August) to 35.58 °C (April). The similar results was seen in relative humidity

over different months ranged from 59.30 (March) to 77.30% (September). CV varies in rainfall from 4.72 to 44.72 and in case of temperature 1.74 to 10.87. Variation in relative humidity not much seen.

Descriptive statistics is an important statistical tool to know the variations in climatic parameters at different selected locations during the study period (2012-13 to 2016-17). The highest rainfall recorded had 4130.78 mm was observed in Ramanagara with standard deviation of 68.67 mm. the lowest rainfall recorded was 2493.42 mm with standard deviation of 39.63 mm and it was observed in Mandya. There was not much change in average temperature during study period in all locations and recorded average temperature were around 30 °C. The relative humidity has slight changes during study period in different location and were in the range of 56.94 (Chamarajanagara) to 70.37% (Mysuru).

It was found that there is a slight variation in CV value over the years of climatic parameter viz., rainfall, temperature and relative humidity. Krishnakumar *et al.* (2008) [12] was found that rainfall ranges as well as its variability was less during excess rainfall years. The results also revealed that there is no statistical significance difference between mean values of climatic parameters such as rainfall, temperature and relative humidity over years under study. These results are on par with the results obtained by Vaidya *et al.* (2008) [19] in Gujarat state over districts and Halikatti *et al.* (2010) [7] found higher variability and asymmetrical distribution over time.

Table 9: Descriptive measure for annual Rainfall (mm), Temperature (°C) and Relative Humidity (%) in Mandya during 2012-13 to 2016-17

Years	Rainfall			Temperature			RH		
	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)
2012-13	387.70	31.78	8.20	31.45	2.00	6.35	64.21	6.71	10.45
2013-14	555.30	53.07	9.56	31.26	2.73	8.73	64.60	9.36	14.49
2014-15	632.00	50.47	7.99	30.81	2.35	7.62	64.40	7.87	12.23
2015-16	700.12	13.47	1.92	31.17	1.81	5.80	42.51	3.29	7.74
2016-17	218.30	26.67	12.22	33.51	3.58	10.69	62.59	9.86	15.75
Overall	2493.42	39.63	1.59	31.64	2.66	8.42	59.66	11.48	19.24
Fcal. values	2.19 ^{NS}	-	-	2.08 ^{NS}	-	-	1.98 ^{NS}	-	-

Note: NS: non-significance

Table 10: Descriptive measure of monthly Rainfall (mm), Temperature (°C) and Relative Humidity (%) in Mandya during 2012-13 to 2016-17

Month	Rainfall			Temperature			RH		
	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)
January	48.51	21.20	43.69	30.28	0.67	2.21	53.01	8.76	16.52
February	30.03	13.37	44.54	32.52	0.48	1.46	50.54	8.21	16.25
March	52.75	15.98	30.29	34.77	0.81	2.34	48.32	6.41	13.27
April	181.70	21.07	11.60	35.37	1.41	3.99	53.09	7.82	14.73
May	301.50	30.35	10.07	34.07	0.94	2.75	58.97	8.92	15.13
June	225.93	33.41	14.79	30.55	0.96	3.14	65.07	11.87	18.24
July	195.32	21.45	10.98	29.64	0.98	3.32	66.04	13.18	19.96
August	216.48	16.70	7.72	31.92	4.55	14.26	65.36	11.89	18.20
September	523.73	41.35	7.90	30.06	0.70	2.32	66.12	12.47	18.85
October	417.51	57.41	13.75	30.23	1.07	3.54	65.97	13.29	20.15
November	199.10	33.81	16.98	29.45	1.62	5.49	65.13	9.87	15.15
December	107.56	23.42	21.78	28.93	0.88	3.05	59.21	8.94	15.10

Table 11: Descriptive measure for annual Rainfall (mm), Temperature (°C) and Relative Humidity (%) in Mysuru during 2012-13 to 2016-17

Years	Rainfall			Temperature			RH		
	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)
2012-13	564.40	72.57	12.86	31.65	2.13	6.74	68.50	5.75	8.40
2013-14	364.26	28.40	7.80	31.28	3.18	10.17	70.50	7.57	10.74
2014-15	678.40	64.41	9.49	31.44	3.06	9.72	72.13	8.24	11.42
2015-16	648.47	12.43	1.92	29.82	2.03	6.80	71.75	6.98	9.72
2016-17	244.30	31.18	12.76	30.42	3.18	10.44	69.00	9.11	13.20
Overall	2499.83	48.13	1.93	30.92	2.76	8.92	70.38	7.49	10.65
F cal. values	1.30 ^{NS}	-	-	0.95 ^{NS}	-	-	0.54 ^{NS}	-	-

Note: NS: non-significance

Table 12: Descriptive measure of monthly Rainfall (mm), Temperature ($^{\circ}$ C) and Relative Humidity (%) in Mysuru during 2012-13 to 2016-17

Months	Rainfall			Temp			RH		
	Mean	SD	CV (%)	Mean	SD	CV (%)	Mean	SD	CV (%)
January	44.74	20.01	44.72	29.67	0.85	2.87	69.10	6.10	8.82
February	70.75	19.65	27.77	31.72	0.83	2.60	64.50	10.61	16.44
March	59.92	16.11	26.89	34.36	1.13	3.28	59.30	3.05	5.15
April	190.03	31.49	16.57	35.58	1.31	3.69	61.40	2.88	4.69
May	309.43	40.76	13.17	34.13	1.63	4.79	68.00	3.52	5.17
June	238.73	11.27	4.72	30.89	2.64	8.54	75.30	4.93	6.55
July	215.16	41.01	19.06	29.82	3.24	10.87	76.30	4.22	5.53
August	178.46	32.95	18.46	28.48	1.23	4.33	76.80	3.83	4.99
September	422.43	64.78	15.34	29.34	1.19	4.06	77.30	2.02	2.61
October	527.29	99.07	18.79	29.31	0.51	1.74	76.20	3.85	5.05
November	127.93	28.56	22.32	28.86	0.58	2.02	72.00	3.79	5.27
December	114.95	24.41	21.24	28.88	0.92	3.19	68.3	3.95	5.78

Trend analysis on climatic parameters

Trend analysis is carried out to observe any linear shift in the climatic parameters at selected locations for the period 2012-13 to 2016-17. The linear trends for each of the climatic parameters have been computed the results are presented in the Table 4. For all the locations on climatic parameters such as rainfall, temperature and relative humidity data were obtained. It was found that all climatic parameters such as rainfall, temperature and relative humidity have linear trend at all locations and found to be significant with the moderate R^2 values. Rainfall and relative humidity shows positive trend whereas temperature shows negative trend in all locations.

This indicates that there is an increase in the quantum of rainfall and in term increasing the humidity during the study period. However the temperature showed a declining trend indicating a slight decrement in temperature during the study period. Murthy *et al* 2008 ^[14] also found in his study there was a declining trend of maximum temperature at Ranichauri. However the rainfall and relative humidity shows the increasing trend in all locations. Guhathakurta and Rajeevan (2008) ^[6] also found the increasing trend of monthly rainfall in karnataka. Das Sunit and Samui (2008) ^[2] in their studies reveals that, spatial distribution of heavy rainfall is not homogeneous over their study area.

Table 13: Results of linear trend analysis for important climatic parameters in different RH locations

Locations	Variables	β_0	β_1	R^2
Kolar	Rainfall (mm)	23.06 (16.29)	5.79* (2.21)	0.11
	Temperature ($^{\circ}$ C)	33.53 (0.68)	-0.40* (0.09)	0.24
	Relative Humidity (%)	52.15 (1.94)	1.56* (0.26)	0.37
Chikkaballapur	Rainfall (mm)	26.58 (18.97)	6.09* (2.58)	0.09
	Temperature ($^{\circ}$ C)	32.75 (0.61)	-0.41* (0.08)	0.29
	Relative Humidity (%)	49.59 (2.44)	1.86* (0.33)	0.35
Ramanagara	Rainfall (mm)	28.44 (18.09)	6.22* (2.46)	0.10
	Temperature ($^{\circ}$ C)	32.54 (0.57)	-0.41* (0.08)	0.32
	Relative Humidity (%)	57.28 (1.70)	1.44* (0.23)	0.40
Chamarajanagara	Rainfall (mm)	16.06 (14.35)	4.13* (1.95)	0.07
	Temperature ($^{\circ}$ C)	34.06 (0.60)	-0.36* (0.08)	0.25
	Relative Humidity (%)	46.75 (3.12)	1.57* (0.42)	0.19
Mandya	Rainfall (mm)	13.94 (10.20)	4.25* (1.39)	0.14
	Temperature ($^{\circ}$ C)	33.63 (0.68)	-0.31* (0.09)	0.16
	Relative Humidity (%)	50.61 (2.89)	1.39* (0.39)	0.18
Mysuru	Rainfall (mm)	17.55 (12.87)	3.71* (1.75)	0.07
	Temperature ($^{\circ}$ C)	33.63 (0.65)	-0.42* (0.09)	0.28
	Relative Humidity (%)	63.92 (1.85)	0.99* (0.25)	0.21

Note: Values in the parenthesis indicates S.E. * - At 5% level of significance

Conclusion

Climatic parameters plays a crucial role in cocoon production. As sericulture is very sensitive to a small change in climatic factors hence a modest attempt has been made to undertaken to study on climatic factors in selected locations. The present study indicated that the climatic parameters such as rainfall did not vary much from location to location. However, there was a slight difference in average temperature and relative humidity. The trend analysis of climatic factors indicated that temperature had declining trend in all selected locations, however the rainfall and relative humidity indicating the increasing trend in all study locations. Further, it was observed that rainfall, temperature and relative humidity trends were found to be significant in all locations.

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