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Weather forecasting model for lace bug, *Cochlochila bullita* (Stål) (Hemiptera: Tingidae) on Tulsi crop

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Abstract

The present study, Lace bug, *Cochlochila bullita* (Stål) on *Occimum basilicum* L. was recorded continuously during the 38th to 1st meteorological weeks of the year 2015-16, 2016-17 and 2017-18. The peak population of Lace bug, *Cochlochila bullita* (Stål) was recorded on 47th (2015-16), 48th (2016-17) and 44th (2017-18) meteorological week that coincide moderate range of environmental factors of the growing season of crop *Occimum basilicum* and its population buildup. The influence of weather factor such as rainfall showed negative correlation as well as negative regression. Highly negative significant regression coefficient was found in the year of 2015-16 and 2016-17 in the comparison to 2017-18. The forecasting model was based on rainfall received that could be Y (population number) = intercept + [(-) significant regression coefficient (b) rainfall].

Keywords: Tulsi, *Occimum basilicum*, lace bug, *Cochlochila bullita*, forecasting model

1. Introduction

The *Ocimum tinged*, *Cochlochila bullita* (Stål) is a serious pest of *Ocimum* and related Lamiaceae and some other related culinary and medicinal herbs [15] [17] [18]. *Ocimum* tingid occurs throughout the old world and its records mostly found in India and Thailand [18]. In 2010, it was recorded as a new record for Malaysia at Subang, It infests nearly all host plants of the family Lamiaceae, some of the hosts include: *Ocimum kilmandscharicum* Linnaeus (camphor basil), *Ocimum basilcum* L. (sweet basil), *Ocimum tenuiflorum* (tulsi), *Mentha* spp. (Mint), *Lavandula* spp. (Lavender) *Orthosiphon stamineus* (Java tea) [14] *Orthosiphon stamineus* (Java tea, cat whiskers) [13], *Rosmarinus officinalis* L. (rosemary), *Slvia officinalis* L. (sage), and *Carthamus tinctorius* L. (safflower) [18] [16] and *Ocimum sanctum* Linnaeus in India [12]. It has also been recorded from *Ocimum basilicum* L., *O. sanctum*, *Coleus parviflorus* Bentham (Chinese potato) [10], *Mentha* sp. (Mint), *O. sanctum* (holy basil), and many other Laminaceae [9]. In Thailand, *C. bullita* is a serious pest of *O. basilicum* [18]. The plants of genus *Ocimum* (Family Lamiaceae) are called as 'basil' plants. Basil is a versatile group of aromatic and medicinal plants consisting of about 160 species [3]. Among all of the basil plants, the *Ocimum* species; *O. basilicum* and *O. sanctum* have the widest distribution, which covers the entire Indian subcontinent and its hybrid is now being cultivated in different parts of India [1].The major active constituents of are urosloic acid and eugenol [8]. Essential oil and flavonoids as active principles in leaves in abundant amount used as general medicines, tonic, wound healing and also *O. basilicum* (sweet basil) contains essential oil with ocimate, estragole, linalool, tannins and flavonoids used for the purpose of tonic, carminative, diuretic and anthelmintic [5]. Ayurvedic practice recommends Tulsi in several formulations to enhance immunity and metabolic functions [2].

Cochlochila bullita has a piercing and sucking mouthparts and it damage the host plants by removing nitrogen rich plants fluids. This results curling and drying of leaf tips, leaf dehiscence and lowering the inflorescence production [10] [12]. The adult lace bugs usually feed on tender shoots of the herb causing them to wilt and eventually die and in many instances, nymphs and adults feed gregariously on the leaves leaving tiny black spots of excrement on the upper surface of the leaves.

The adult male and female are morphologically similar but the female is significantly larger with respect to the body length (σ, 2.12 ±0.04mm & Φ 2.25±0.02mm). The female can be

Differentiated from the male by the presence of an ovipositor whereas the male has a distinct genital capsule with hidden structures. The adult of the *Ocimum* tinged are dark brown in colour, delicate minute bugs. It has lacy wings with brown swollen part at the discoidal area. The paranotum is strongly elevated and curved backwards to form a conspicuous, crescent-shaped structure that cover head. The nymphs are yellowish – black with red eyes and spiny and paranotum become more prominent after second instars. In India, *C. bullita* infests plants during the summer months from July to December and passes through five generations. During adverse climatic conditions adults hibernate in the plant debris [4]. This pest is also found during December and also at low population level during May [4].

Since the establishment of Tulsi crop as an important cash crop, the herb has been considered very important crop plant and it is seriously infested by tinged bug *Cochlochila bullita*. Deciding on the objective of a pest management system, each and every system seems to have some undesirable effect on environmental, economic or society. There is need of develop a dynamic model on the basis of change of population during the period of bug presence in the field. In general, the system dynamics are very important and the development of dynamic model needs some function relating population between periods. Dynamic model is useful that can predict the population change relating to the weather factors. The technique of regression equation can be used for estimating population levels of bug-pest in different years. So the objective of develop a "weather forecasting model based on population change in three different years".

2. Materials and Methods

The seasonal activity of lace bug *Cochlochila bullita* was studied continuously during 2015-16, 2016-17 and 2017-18 at Herbal Garden of Rajendra Prasad Central Agricultural University, Pusa, Bihar. The crop, sweet basil *Occimum basilicm* was raised in one acre area during main growing season *i.e*., June to December. Observation was recorded at weekly interval since 37th meteorological week *i.e*., at start of appearance of lace bug – pest in the field and continued till cession of the lace bug. For the data record 100 plants were selected for one observation and these plants were selected at 5 spots in the experimental field that were distributed as X-fashioned *i.e*., 4 spots at each corner at least one meter inside from the border to reduce the border effect and one at the centre. This sampling fashion was repeated for each observation with changing the length and widths accordingly change the central spot. Insect pest present on twigs and leaves of the plant was counted on all selected plants of 5 spots. Each spot included 20 plants numbers thereby 100 plants for an observation. Total number of *C. bullita* was made an average number which became data of one observation.

The weather factors that prevailed during the previous 7 days of start insect appearance were taken into account for the study as the developmental period of immature stages [20]. Each observation number was arranged on a weekly total number (Y) and average meteorological factors, i.e., maximum temperature(X_1) and minimum temperature (X_2), morning relative humidity (X_3), evening relative humidity (X_4) and total weekly rainfall (X_5). The interrelationship between population number of lace bug with respect to previous week's weather factors and the data was arranged to work out the correlation and regression equation.

3. Results and Discussion

Well-conceived findings after perusal of the data are presented in the Tables 1, 2, 3 and with correlation values and also regression equation of each year.

Seasonal fluctuation of population

Table 1, 2, and 3 revealed that Lace bug *Cochlochila bullita* appeared on the sweet Tulsi crop *O. basilicum* in the 38th meteorological week and disappeared during 2nd week of next year January. The peak number was found during 47th, 46th and 44th meteorological week during 2015-16, 2016-17 and 2017-18, respectively. The average peak number was 49.60, 55.67 and 18.01 during 2015-16, 2016-17 and 2017-18 per plant, respectively. There was only one peak and behavior of pest population dynamics like bell shaped during the period of 37th to 1st meteorological week of the next year. Infestation of *C. bullita* was found during the June to December as reported by [4] [7]. So the present study of population existence was observed in accordance with these workers. [7] reported the highest population of *C. bullita* per plant on *O. sanctum* was found 63.8 in 2011 and 71.2 in 2012 during the month of August and September, respectively. [6] also reported the peak infestation of *C. bullita* on *O. sanctum* during August to November with a maximum of 65 bugs per plant. Findings of peak population (44th (October – November); 46th and 47th (November) were observed in-accordance with the findings of above workers. Perusal of data also showed that the population had a definite trend of continuous increase since the appearance of insect-pest followed by higher level of maintenance phase and then continuous decreasing trend till the cessation of the pest insect on the crop during the period 37th to 1st meteorological week of the next year. This population fluctuation could be called as increasing trend, maintenance phase and decreasing phase.

Temperature

Maximum temperature

During the year2015-16 the maximum temperature varied in the range of 21.20 to 34.70 ºC having an average 28.78 ºC and population varied in the range of 4.66 to 49.60 per plant. In the year 2016-17 maximum temperature varied in the range of 22.40 to 34.50 ºC with an average 28.62 ºC and population varied in the range of 0.08 to 55.67 per plant and in the year 2017-18 temperature varied in the range of 13.88 – 34.30 ºC with an average 28.61 ºC had population fluctuation 1.60 to 18.01 per plant. The continuous increasing trend, maintenance phase and continuous decreasing trend in the years 2015-16 was found in the temperature range 28.50 to 34.70 ºC during 38th to 47th week, 25.80 - 30.50 ºC during 45th to 49th week and continuous decreasing trend in the temperature range 21.20 to 28.10 ºC during 48th to 1st meteorological week of the next year. The continuous increasing trend, maintenance phase and continuous decreasing trend in the years 2016-17 was found in the temperature range 26.80 to 34.50 ºC during 38th to 48th week, 26.80 – 31.90 ºC during 44th to 48th week and continuous decreasing trend in the temperature range 18.90 to 28.10 ºC during 47th to 1st meteorological week of the next year. The continuous increasing trend, maintenance phase and continuous trend in the years 2017-18 were found in the temperature range 29.80 to 34.30 ºC during 39th to 44th week, 27.80 – 32.80 ºC during 42th to 47th week and continuous decreasing trend in the temperature range 26.10 to 30.20 ºC during 45th to 50th meteorological week.

The data presented in Table 4, of the all three years revealed that there were poor correlation between population and average maximum temperature that had negative characteristic in the year 2015-16, positive in the year 2016-17 and 2017-18. It could be said that average maximum temperature had no definite relationship with the different population trend during the study period (37th to 1st meteorological week of the next year *i.e*., post monsoon). Regression coefficient was also found negative and positive characteristic with the maximum population change while it was non-significant.

Minimum temperature

During the year2015-16 the Minimum temperature varied in the range of 5.00 to 25.30 ºC having an average 15.97 ºC, 9.70 to 25.30 ºC with an average 18.04 ˚C and 6.92 – 27.00 ºC with an average 17.66 ºC during the years, 2015-16, 2016-17 and 2017-18, respectively. Peak population was observed at 12.80 ºC (47th meteorological week; 2015-16), 15.80 ºC (46th meteorological week; 2016-17) and 19.50 ºC (44th meteorological week; 2017-18). The continuous increasing trend, maintenance phase and continuous trend in the years 2015-16 was found in the temperature range 12.80 to 25.30 ºC during 38th to 47th week, 12.80 -15.70 ºC during 45th to 49th week, in the temperature range 5.00 to 14.00 ºC during 48th to 1st meteorological week of the next year. The continuous increasing trend, maintenance phase and continuous decreasing trend in the years 2016-17 was found in the temperature range 13.50 to 25.40 ºC during 38th to 47th week, 13.50 – 19.80 ºC during 44th to 47th week and 9.70 to 15.80 ºC during 47th to 1st meteorological week of the next year. The continuous increasing trend, maintenance phase and continuous trend in the years 2017-18 was found in the temperature range 19.50 to 25.80 ºC during 39th to 44th week, 12.40 – 23.00 ºC during 42th to 47th week and in the temperature range 10.50 to 17.30 ºC during 45th to 50th meteorological week.

The data presented in Table 4 of average minimum temperature reveal that poor negative correlation was found during all the three years of study period. It would be the fact that the pest, lace bug population preference can be comparatively higher level of temperature as this bug continued to increase until the start of winter as stated by [7]. Regression coefficient of average minimum temperature was found negative and positive during the years and also had non-significant influence on the bug population.

Relative humidity (%)

Maximum Relative Humidity (%)

During the year2015-16, 2016-17 and 2017-18 the maximum relative humidity varied in the ranges of 76 – 93 per cent having an average 89 per cent, 83- 93 per cent having an average 89 per cent and 85 to 91 per cent of average 90 per cent, respectively. Peak number was found in the year 2015-16, 2016-17 and 2017-18 at maximum relative humidity, 87, 83 and 86 per cent, respectively. The continuous increasing trend, maintenance phase and continuous decreasing trend in the years 2015-16 was found in the ranges 87 to 93 per cent relative humidity during 38th to 47th meteorological week; 87 to 93 per cent during 45th to 49th week and 76 to 93 per cent during 48th to 1st meteorological week of the next year, respectively. The continuous increasing trend, maintenance phase and continuous decreasing trend in the years 2016-17 was found in the ranges 86 – 93 per cent during the 38 to 47th meteorological week, 83 to 87 per cent during 44th to 48th meteorological week and 81 to 93 per cent 46th to 1st meteorological week of the next year, respectively. The continuous increasing trend, maintenance phase and continuous trend in the years 2017-18 were found in the range of 86- 90 per cent during 39th to 44th week, 86-90 per cent during 42nd to 47th week and 85-94 per cent during 45th to 50th meteorological week (Table 1, 2 & 3).

Minimum Relative humidity

Minimum relative humidity varied in the ranges of 45 to 83 per cent having average 56 per cent, 37- 83 per cent having average 60 per cent and 56 to 79 per cent of average 66 per cent 2015-16,2016-17 and 2017-18, respectively. The continuous increasing trend, maintenance phase and continuous trend in the years 2015-16 was found in the ranges 46 to 83 per cent, 46 to 60 per cent and 40 to 60 per cent. In the years 2016-17 all the three population activities found in the range of 37 to 83 per cent, 37 to 58 per cent and 37 to 75 per cent, respectively. The continuous increasing trend, maintenance phase and continuous decreasing trend in the years 2017-18 was found in the range of 60 to 70 per cent, 55 to 66 per cent and 56 to 79 per cent.

Negative correlation was found with the average maximum and minimum relative humidity that was non-significant (2015-16) and significant (2016-17 & 2017-18). Regression coefficients were found non-significant. It showed that relative humidity had no definite trend of influence on lace bug population trends during the studied period.

It was observed in the Table 4, that the temperature and relative humidity had no definite trend of relationship as shown by the negative and positive sign of correlation and regression coefficient respectively. These values were also significant and non-significant. It could be due to combined influence of various environmental factors act at a time and the rate of increase or decrease and consequently the resultant population of lace bug is the result of the combined effect of various factors. Temperature and relative humidity, these two physical factors are intimately interdependent. Other way of effect is that the same intensity may effect in insect in different ways according to the moisture content of the air. So it was observed that there was no definite direction of relationship with the temperature and relative humidity in the area of study. Rai *et al.*, 2002 [14] stated in their weather forecasting model that the maximum relative humidity is the determining factor for yellow stem borer *Scirpophaga incertulas* (Walk.) in rice crop

Rainfall

The data presented in Tables 1, 2, 3 and 4 showed that the growing season (post monsoon) rain range during the years 2015-16, 2016-17 and 2017-18 had 0.0 to 5 mm, 0.0 to 6.40 mm and 0.0 to 30.00 mm, respectively. Peak population of the insect-pest was found at 0.00mm (2015-16), 2.00 mm (2016-17) and 0.00 mm (2017-18) rainfall received. Variable pattern of rainfall was observed during the year of study. In the year 2015-16, small amount of rainfall received during 37th, 38th, 39th and 40th meteorological week and rest of the weeks of the study period there was no rainfall. In the year 2016-17 small amount of rainfall received through period of lace bug population occurrence (37th to 52nd meteorological weeks). Again in the year 2017-18 rainfall received was observed during 37th, 38th and 41st meteorological weeks and rest of foregoing weeks had no rainfall. During the period of study (post monsoon rainfall period *i.e.*, rain absence and presence) lace bug population showed increasing trend, maximum - established phase and continuous decreasing trend. Lace bug population was found throughout post monsoon on the crop *O. basilicum* and it was observed also according to the study of [14]. The perusal of Table 1, 2, and 3 showed that the post monsoon period population trends were not directly related with the rainfall received. Negative correlation (Table 4) was found with all three years but in the year 2015-16 and 2016-17 showed negative highly significant correlation (<0.01). The negative correlation could be due to rainfall dislodge the lace bug from the plants as stated by [11] [14] and [7]. It was also important to consider the rainfall amount received during the previous weeks *i.e*., before appearance of lace bug on the Tulsi plant in the field. In the year2017-18, there was heavy rainfall amounting 214.40 mm during the 33rd meteorological week which may cause to dislodge and drawing the initial population in the rain water in the field as well as on the other alternate hosts. Again during 38th meteorological week there was a heavy rain amounting 30.00 mm. These heavy rainfalls became detrimental to the lace bug population build up during the cropping season. Rainfall would be the major factor which actually negatively influenced population of lace bug.

Multiple regression equations of the different years were as follows: In the year 2015-16 (Table 4)

Y_1 (dependent) = -110.004 + (1.334) Avg. maximum temperature + (-1.087) Avg. minimum temperature + (1.248) Avg. maximum relative humidity + (0.084) Avg. minimum relative humidity + (-5.669**) weekly total rainfall.

R^2 (coefficient of determination) = 0.499

In the year 2016-17 (Table 4)

Y_2 (dependent) = 141.70 + (-0.895) Avg. maximum temperature + (1.136) Avg. minimum temperature + (-0.273) maximum relative humidity + (- 1.564) Avg. minimum relative humidity + (3.285**) weekly total rainfall.

R^2 (coefficient of determination) = 0.738

In the year 2017-18 (Table 4)

Y_3 (dependent) = 125.778 + (0.218) Avg. maximum temperature + (-0.398) Avg. minimum temperature + (-0.901) Avg. maximum relative humidity + (-0.537) Avg. minimum relative humidity + (-0.177) weekly total rainfall R^2 (coefficient of determination) = 0.691 Multiple regression equations revealed that the lace bug population could be significantly negatively influenced due to highly negatively significant change in the rainfall received in the year 2015-16 and 2016-17 by the unit of 5.669 and 3.285 unit. It would be desirable to develop a regression equation model based on the weather factor, rainfall for forecasting the lace bug population or incidence on the crop.

Following would be the forecasting model (regression equation) for lace bug on the basis of weekly total rainfall.

Y (lace bug number) = Intercept + [(-) significant regression coefficient (b) rainfall]

It could be said that the regression model for the forecasting of lace bug population significantly related with the rainfall amount received. During the year 2017-18, rainfall received before the 37th week had a remarkable influence on the population build up as it happened. Heavy rainfall negatively influenced the population build up of bug present on the leaves or the tender part of the plant. Different workers reported that the lace bug population dislodged from the plant due to heavy rainfall. So, regression equation model would be the best model based on rainfall received.

4. Conclusion

From the foregoing results it may be concluded that it is difficult to find out the direct cause and effect relationship between any single climatic factors and *Cochlochila bullita* population. The impact of weather on *C. bullita* pest is usually compound. In the present investigation, however the influence of the rainfall showed the reliability of consideration as the “t” value (table 4) of the regression were as negative 5.669** and 3.285** of the years 2015-16 and 2016-17. The coefficient of the determination (R^2) between *C. bulleta* with thw weather factors was 50%, 74% and 69% in the cropping year 2015-16, 2016-17 and 2017-18 respectively. It is much clear that the rainfall determine the population level of the *C. bulleta*. So weather forcasting model (regression equation) for *C. bulleta* based on rainfall is relevant

Studies on the above objective are expected to generate valuable information so that a comprehensive management programme for lace bug, *C. bullita* can be taken. Forecasting model is based on the rainfall amount received before the pest peak infestation.

Table 1: Weekly average population of Lace bug, Chlochila bullita and major weather factors during the year 2015-16

Meteorological week	Average population per plant	Average temperature (°C)		Average relative humidity (%)		Rainfall (mm)
		Maximum	Minimum	Maximum	Minimum	
37	0.00	31.90	25.30	92	80	5.00
38	4.66	31.70	24.80	93	73	3.50
39	6.66	29.60	24.20	91	83	2.00
40	7.20	34.70	22.2	90	51	4.20
41	14.80	33.80	21.4	90	52	0.00
42	19.50	32.60	21.60	90	54	0.00
43	22.70	32.70	17.40	89	41	0.00
44	26.10	30.50	17.10	90	48	0.00
45	35.40	30.50	15.70	90	50	0.00
46	41.90	29.10	15.50	93	60	0.00
47	49.60	28.50	12.80	87	46	0.00
48	42.1	28.10	14.00	88	55	0.00
49	35.10	25.80	13.20	93	60	0.00
50	30.90	21.20	9.70	90	60	0.00
51	17.20	22.30	5.30	88	45	0.00
52	11.10	22.50	5.00	76	45	0.00
1	9.67	23.80	6.40	89	53	0.00
Average	22.04	28.78	15.97	89.36	56.23	0.867
Correlation	Dependent factor	(-) 0.183	(-) 0.358	(-) 0.048	(-) 0.407	(-) 0.645*

Multiple regression equation

Y (dependent) = -110.004 + (1.334) Avg. Maximum temperature + (-1.087) Avg. Minimum temperature + (1.248) maximum relative humidity + (0.084) Avg. Minimum relative humidity + (-5.669**)

(R^2)= 0.499

Table 2: Weekly average population of Lace bug, *Chlochila bullita* and major weather factors during the year 2016-17

Meteorological week	Average population per plant	Average temperature (°C)		Average relative humidity (%)		Rainfall (mm)
		Maximum	Minimum	Maximum	Minimum	
37	0.00	31.90	25.30	92	80	4.40
38	10.00	31.70	24.80	93	73	5.50
39	12.60	29.60	24.20	91	83	6.40
40	22.08	34.50	25.40	90	67	2.90
41	23.92	32.00	23.40	92	70	3.60
42	29.33	30.90	23.00	87	51	2.0
43	43.77	31.30	21.30	86	49	1.70
44	54.33	31.90	19.80	84	43	1.50
45	55.33	30.60	18.20	87	39	1.80
46	55.67	29.50	15.80	83	37	2.00
47	43.33	27.10	13.50	86	50	1.20
48	46.00	26.80	13.80	91	58	1.10
49	25.20	22.80	12.10	87	62	3.00
50	18.72	18.90	9.70	91	66	3.40
51	10.00	23.50	10.50	91	58	2.10
52	0.80	22.40	12.00	93	75	2.60
1	1.40	28.10	14.00	88	55	0.00
Average	27.08	28.62	18.04	88.94	59.77	2.66
Correlation	Dependent factor	0.262	(-) 0.027	(-) 0.755*	(-) 0.808*	(-) 0.432

Multiple regression equation

Y (dependent) = 141.70 + (-0.895) Avg. Maximum temperature + (1.136) Avg. Minimum temperature + (-0.273) maximum relative humidity + (-1.564) Avg. Minimum relative humidity + (3.285**)

(R2)= 0.738

Table 3: Weekly average population of Lace bug, *Chlochila bullita* and major weather factors during the year 2017-18

Meteorological week	Average population per plant	Average temperature (°C)		Average relative humidity (%)		Rainfall (mm)
		Maximum	Minimum	Maximum	Minimum	
37	0.00	34.00	27.00	91	71	2.60
38	0.00	33.50	26.10	88	70	30.00
39	1.60	34.30	25.80	88	62	0.00
40	3.16	33.20	25.00	87	70	0.00
41	8.20	33.10	25.00	89	69	3.50
42	14.66	32.80	23.00	88	63	0.00
43	17.08	31.50	20.80	90	66	0.00
44	18.01	29.80	19.50	86	60	0.00
45	17.67	30.20	17.30	87	56	0.00
46	15.99	29.60	16.70	87	56	0.00
47	14.54	27.80	12.40	85	61	0.00
48	12.60	26.10	10.60	91	64	0.00
49	7.66	26.50	10.50	94	64	0.00
50	5.20	27.10	12.50	92	64	0.00
51	0.00	22.60	11.80	94	71	0.00
52	0.00	20.30	9.30	95	77	0.00
1	0.00	13.88	6.92	93	79	0.00
Average	8.027	28.61	17.66	89.71	66.06	2.13
Correlation	Dependent factor	0.268	(-) 0.002	(-) 0.564*	(-) 0.782*	(-) 0.314

Multiple regression equation

Y (dependent) = 125.778 + (0.218) Avg. Maximum temperature + (-0.398) Avg. Minimum temperature + (-0.901) maximum relative humidity + (- 0.537) Avg. Minimum relative humidity + (-0.177)

(R^2)= 0.691

Table 4: Correlation and regression value of measured weather factors of the year 2015-16, 2016-17 and 2017-18 of Lace bug population

S. No.	Year	Weather Factors	Correlation	Regression		
				Intercept	Regression Coefficient (b)	Coefficient of determination (R^2)
1.	2015-16	Av. Maximum temperature (^{0}C)	(-) 0.183	-110.004	1.334	50 per cent
		Av. Minimum temperature (^{0}C)	(-) 0.358		(-) 1.087	
		Av. Maximum relative humidity (%)	(-) 0.098		1.248	
		Av. Minimum relative humidity (%)	(-) 0.047		0.084	
		Weekly total rainfall (mm)	(-) 0.645 *		(-) 5.669**	
2.	2016-17	Av. Maximum temperature (^{0}C)	0.262	141.70	(-) 0.895	74 per cent
		Av. Minimum temperature (^{0}C)	(-) 0.027		1.136	
		Av. Maximum relative humidity (%)	(-) 0.755**		(-) 0.273	
		Av. Minimum relative humidity (%)	(-) 0.808**		(-) 1.564	
		Weekly total rainfall (mm)	(-) 0.432		3.285**	
3.	2017-18	Av. Maximum temperature (^{0}C)	0.268	125.778	0.218	69 per cent
		Av. Minimum temperature (^{0}C)	(-) 0.002		(-) 0.398	
		Av. Maximum relative humidity (%)	(-) 0.564		(-) 0.901	
		Av. Minimum relative humidity (%)	(-) 0.982		0.537	
		Weekly total rainfall (mm)	(-) 0.314		(-) 0.177	

*Significant ($p<0.05$)
** Highly significant ($p<0.01$)
Av. = Average

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