

Meteorological aspects of the infestation of some pests on jowar crop

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सार — धारवार तथा कोयम्बतूर के खरीफ ज्वार के 7 से 13 वर्षों के आंकड़ों के सांख्यिकीय विश्लेषणों द्वारा मौसम के विभिन्न तत्वों तथा तनावक (Stem borer), इअरहेड बग (Earhead Bug) एवं वरुथी (mite) जैसे नाशक कीटकों के प्रकोप के सम्भावित सम्बन्धों को दर्शाया गया है। विश्लेषण के लिये साधारण तथा बहुसमाश्रयण विधियों का प्रयोग किया गया है।

अध्ययन से पाया गया कि नवम्बर-दिसम्बर में न्यूनतम तापमान 13 डिग्री सें. ग्रे. से अधिक, आपेक्षिक आर्द्रता 70 प्रतिशत से अधिक तथा ज्यादा उच्चतम तापमान तनावक-प्रकोप के लिये अनुकूल हैं। इअर हेड बग के लिये उच्चतम तापमान नवम्बर में 28 डिग्री सें. ग्रे. तथा अगस्त में 31 डिग्री सें. ग्रे. अनुकूल हैं। दिसम्बर में न्यूनतम तापमान 17 डिग्री सें. ग्रे. से अधिक हो जाने पर इनकी क्षमता कोयम्बतूर में घट जाती है परन्तु अक्टूबर में 18 डिग्री सें. ग्रे. से अधिक होने पर धारवार में बढ़ जाती है। कोयम्बतूर में उच्चतम तापमान जुलाई में 30 डिग्री सें. ग्रे., न्यूनतम तापमान नवम्बर में 20 डिग्री सें. ग्रे., जुलाई में घूप 7 घंटे से अधिक तथा सितम्बर के अन्तिम सप्ताह में कुल वर्षा 80-90 मि. मी. होने पर, वरुथी की कार्यशीलता बढ़ जाती है।

परिणामों का वास्तविक रूप से सत्यापन करने के बाद इन्हें कीटक-महामारियों के प्रकोप की पूर्व चेतावनी देने के लिए प्रयोग में लाया जा सकता है।

ABSTRACT. The possible linkage between different meteorological elements and a few pests of jowar, like stem-borer, earhead bug and mite, based on the statistical analysis of the past 7 to 13 years records is derived in this study. Data of kharif jowar crops at Dharwar and Coimbatore is utilized. The simple and multiple linear regression techniques are adopted.

It is found that higher maximum temperature, minimum temperature $>13^{\circ}\text{C}$ and relative humidity $>70\%$ during November-December are favourable for stem-borer attacks. The optimum maximum temperature of 28°C in November and 31°C in August are obtained for earhead bugs incidences. Their activities are suddenly decreased at minimum temperature $>17^{\circ}\text{C}$ in December at Coimbatore but increased when it is $>18^{\circ}\text{C}$ during October at, Dharwar. Jowar mites show enhancements in activity with increase in maximum temperature (30°C) during July higher minimum temperature (20°C) during November, sunshine hours of greater than 7 in July and a weekly rainfall of 80-90 mm during last week of September at Coimbatore.

After corroborating with the actual observations, these results may be useful in issuing forewarnings of the incidences of these pests on jowar.

1. Introduction

Jowar, a great millet or sorghum is mainly grown as a kharif crop with sowing time at the onset of monsoon. But it can be grown as a rabi crop also depending upon the soil moisture reserve or rains in the month of September-October. Both the crops are liable to be infested by various pests and diseases. Depending upon climatic condition and cultivation practices, the occurrence of pests on the crops varies. The knowledge of the effect of weather parameters and favourable climatic conditions for various pests may help in taking prophylactic measures at various places. Keeping this in view an attempt is made to study the correlation between various meteorological parameters and incidences of few pests, i.e., stem-borer, earhead bug and mites, on the kharif crop at Dharwar (Lat. $15^{\circ} 26' \text{N}$, Long. $75^{\circ} 06' \text{E}$) and coimbatore (Lat. $11^{\circ} 00' \text{N}$, Long. $77^{\circ} 00' \text{E}$).

2. Materials and method

Under "All India Co-ordinated Crop Weather Scheme" the entomological and meteorological observations were recorded at various agrometeorological stations in India. The details are given in Agricultural Meteorology Technical Circular Nos. 50 and 51 issued by Director of Agricultural Meteorology, Meteorological Office, Pune. The data of kharif jowar crop of the stations Dharwar and Coimbatore for 8 to 13 years between 1960 & 1980 are analysed. The qualitative observations of the pests in the categories 'light', 'moderate' and 'heavy' representing the ratio of jowar crops infested with pests to the total number of plants in the sampling unit, were taken. The categories light, moderate and heavy indicate infection of 25, 50 and 75 per cent respectively.

The average percentage infestation in a particular year is calculated from the monthly pest data of that

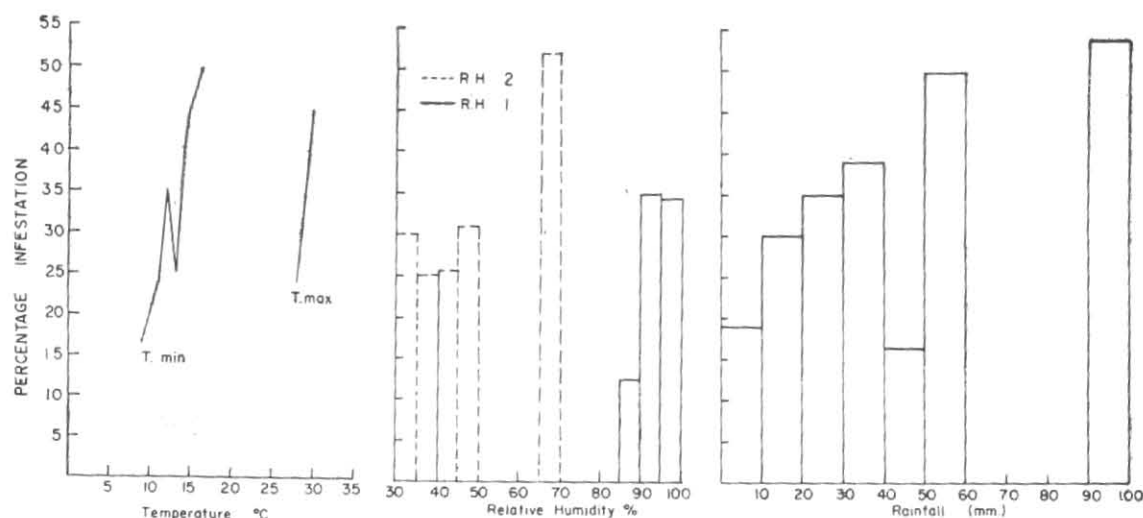


Fig. 1. Variation of the average percentage infestation of stemborer with T_{max} , T_{min} , RH and RFL at Dharwar

TABLE 1

Correlation coefficient between various meteorological parameters and infestations of jowar stemborer at Dharwar

Met. para meters	Corr. coeff. (CC)	Std. week No.	't' value	Level of significance
T_{max}	0.58342	48	2.03	10
T_{min}	0.63702	51	2.34	5
RH-1	0.54923	31	1.86	10
RH-2	0.66279	46	2.50	5
RFL	0.69141	26	2.71	5

year (Dubey *et al.* 1985). The weekly data of maximum temperature (T_{max}), minimum temperature (T_{min}), morning relative humidity (RH-1), evening relative humidity (RH-2), Sunshine hours (SSH) and rainfall (RFL) for the agrometeorological standard weeks between 26 and 52 were correlated separately with average yearly infestation. The correlation coefficients (CC) were calculated by using a simple linear regression technique and a student 't' test was applied to test its statistical significance. The data for the weeks of the highest CC value and significant at 1 to 5 per cent level were combined to calculate a multiple correlation coefficient using multiple linear regression technique. The regression equations are obtained.

The optimum values of different weather factors congenial for the infestation of stemborer, earhead bug and mite at Coimbatore and Dharwar were estimated on the basis of meteorological conditions persisting in the corresponding standard weeks of highest correlation coefficients during all the years of observations. For this purpose, the infestations reported at different values of a particular weather element were averaged out and depicted in the graphs.

3. Results and discussion

3.1. *Stemborer at Dharwar* — Stemborer is one of the major pests of jowar. It is generally observed in the early growth of the crop but the infestation on full grown crop even after the earhead formation

is not uncommon. The data available only for 10 years between 1963 and 1980 are used. The meteorological parameters having significant correlations with the percentage infestation of stemborer were found to be T_{max} , T_{min} , RH-1, RH-2 and RFL. The results of the statistical calculations are shown in Table 1. The highest correlation of 0.69141 during standard week 26 (25 June-1 July) is found for RFL.

The average percentage infestation for T_{max} in 48th week, T_{min} in 51st week, RH-1 in the 31st week, RH-2 in 46th week and RFL in 26th were calculated and depicted in Fig. 1. It shows that infestation increases with increase in T_{max} , but no optimum value could be obtained. The higher T_{min} the more is infestation but above 13°C the activity is suddenly increased. As seen from Table 1, the +ve CC values indicate the increase in infestation with the higher values of RH-1, RH-2 and RFL. Hence the congenial values are for RH-1 $\geq 90\%$, RH-2 $\geq 65-70\%$ and RFL > 50 mm.

The multiple linear regression equation was obtained as :

$$Y = -282.3018 + 3.407 X_1 + 3.100 X_2 + 1.851 X_3 + 0.057 X_4 + 0.115 X_5, \text{ where,}$$

Y = Estimated value of percentage incidence of stemborer of jowar.

X_1 = Weekly mean of T_{max} for 48th std week.

X_2 = Weekly mean of T_{min} for 51st std week.

X_3 = Weekly mean of morning relative humidity for 31st std week.

X_4 = Weekly mean of afternoon relative humidity for 46th std week.

X_5 = Weekly total of rainfall for 26th std week.

The multiple correlation is 0.892870 which accounts for 78.8 per cent of total variation in percentage infestation.

3.2. *Earhead bug at Dharwar and Coimbatore* — During severe infestation, hundreds of adults and nymphs of earhead bug may be observed on a single earhead

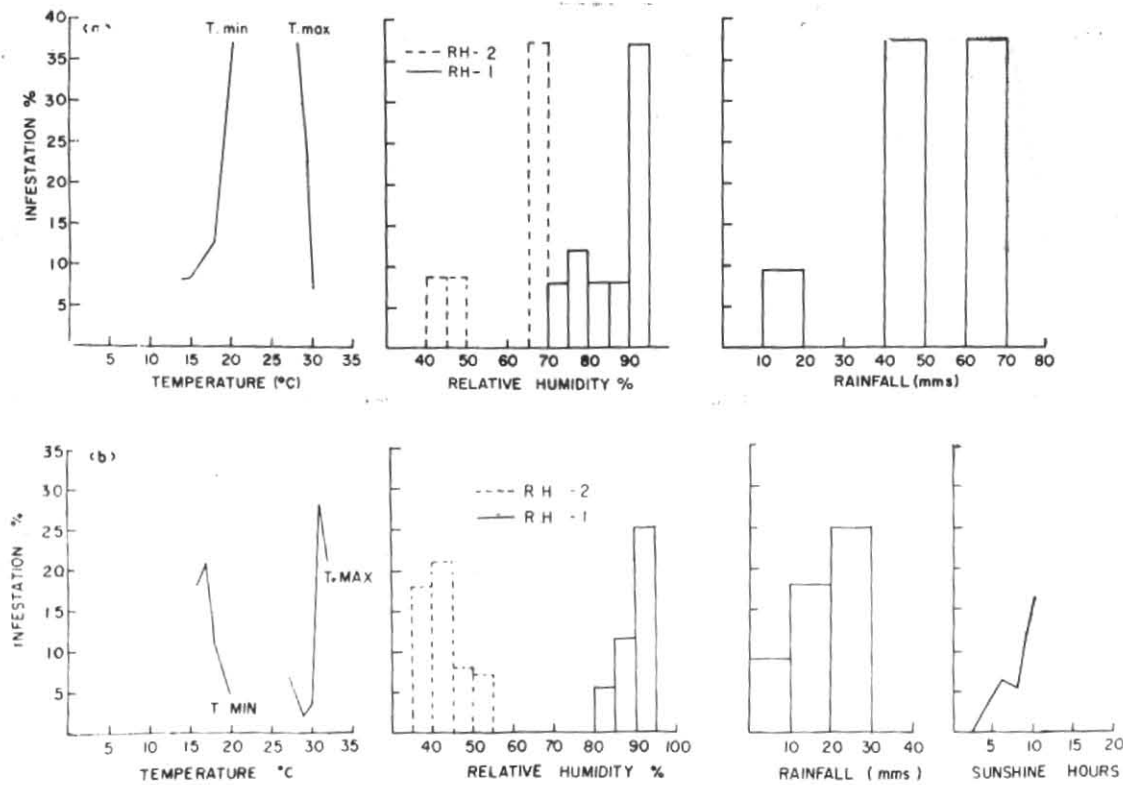


Fig. 2. Variation of average percentage infestation of earhead bug with different meteorological factors at (a) Dharwar and (b) Coimbatore

TABLE 2

Correlation coefficients between various meteorological parameters and infestation of earhead bugs

Met. parameters	Corr. coeff. (CC)	Std. week No.	't' value	Level of significance
(a) Dharwar				
T_{max}	-0.69663	47	2.17	10
T_{min}	0.93381	46	5.84	1
RH-1	0.86162	46	3.80	2
RH-2	0.92336	46	5.38	1
RFL	0.91839	40	5.19	1
(b) Coimbatore				
T_{max}	0.63124	32	2.70	5
T_{min}	-0.69434	50	3.20	1
RH-1	0.60571	47	2.52	5
RH-2	-0.65965	50	2.91	2
SSH	0.55118	50	2.19	10
RFL	0.72488	34	3.49	1

sucking sap from tender milky stage ripening grains, causing the formation of chaffy and shrivelled grains. There may not be grain formation if the infestation is immediately after emergence from the boot leaf. The bug population drops when the grains are well set.

The data of Dharwar for 7 years (1974-80) and Coimbatore for 13 years (1955-67) were analysed. The meteorological parameters and the calculated correlation coefficients are given in Table 2. The variation of average percentage of incidence with different weather parameters in the weeks of highest correlation coeffi-

cients are shown in Fig. 2. The multiple linear regression equation to estimate the infestation from the weather factors for both stations are obtained as :

$$Y = -914.4685 + 27.976 X_1 + 7.333 X_2 - 0.038 X_3 - 0.868 X_4 + 1.053 X_5 \text{ (for Dharwar)}$$

The multiple correlation is 0.898509 which accounts for 79.8 per cent of total variation in percentage infestation :

$$Y = -81.0650 - 1.947 X_1 - 1.270 X_2 + 0.57 X_3 - 0.016 X_4 + 0.539 X_5 + 0.173 X_6 \text{ (for Coimbatore)}$$

The multiple correlation is 0.930280 which accounts for 86.6 per cent of total variation in to percentage infestation,

where,

Y = estimated value of percentage incidence of earhead bugs of jowar.

X_1, X_2, X_3, X_4, X_6 are the weekly mean of $T_{max}, T_{min}, RH-1, RH-2, SSH$ and X_5 is the weekly total of RFL in the standard weeks of highest correlation coefficients are shown in Table 2 for Dharwar and Coimbatore respectively.

It is seen from Fig. 2 that the optimum values of T_{max} at Dharwar is 28°C in the 3rd week of November and at Coimbatore is 31°C during second week of August. The temperature difference is due to seasons but the pest activity is in the early stage at Coimbatore and in later stage at Dharwar. The correlation coefficient is negative at Dharwar but positive at Coimbatore which is clear from the curves also. The T_{min} and RH-2

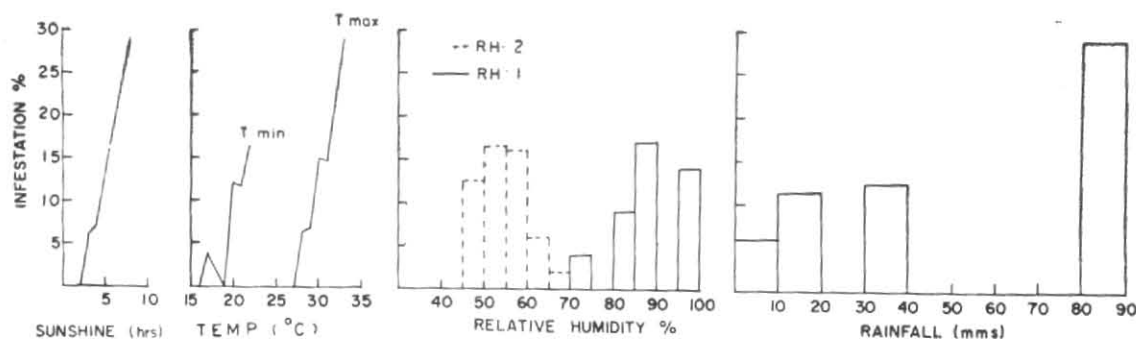


Fig. 3. Variation of average percentage infestation of mite with T_{max} , T_{min} , SSH, RH and RFL at Coimbatore

TABLE 3

Correlation coefficients between various meteorological parameters and infestation of jowar mites at Coimbatore

Met. parameters	Corr. coeff. (CC)	Std week No.	't' value	Level of significance
T_{max}	0.83593	27	5.05	1
T_{min}	0.52217	48	2.03	10
RH-1	0.53577	39	2.10	10
RH-2	-0.64521	30	2.80	5
SSH	0.74792	27	3.74	1
RFL	0.70761	39	3.32	1

show negative correlation at Coimbatore whereas positive at Dharwar. The infestation shows sudden decrease when T_{min} increases beyond 17°C at Coimbatore in the middle of December, whereas infestation has suddenly increased at T_{min} higher than 18°C at Dharwar in the middle of October. Higher relative humidities are found favourable at both the places. The weekly rainfall in August between 20 and 30 mm at Coimbatore and more than 40 mm at Dharwar are also found favourable. The bright sunshine for more than 8 hours in middle of December at Coimbatore is congenial. It may help to increase the activity to cause more damage to the crop.

3.3. *Mites at Coimbatore* — The mite is a polyphagous pest of jowar. It sucks the sap from the leaves which results in reddening the leaves. In severe infestation the leaves dry and wither. The available data of 13 years (1955-67) were analysed. The highest correlation coefficient obtained for various weather elements alongwith the corresponding standard weeks, 't' values and level of statistical significance are given in Table 3. The maximum CC values of 0.83593 was obtained for T_{max} . The evening relative humidity (RH-2) has shown a negative correlation coefficient of -0.64521, significant at 5% level. The multiple linear regression equation calculated combining T_{max} , T_{min} , RH-1, RH-2, SSH and RFL was obtained as:

$$Y = -61.3439 + 3.267 X_1 + 0.408 X_2 - 0.248 X_3 - 0.259 X_4 + 0.687 X_5 + 0.076 X_6$$

where,

Y = estimated value of percentage infestation of jowar mites.

X_1, X_2, X_3, X_4, X_5 are the weekly means of $T_{max}, T_{min}, RH-1, RH-2, SSH$ and X_6 is the weekly total of RFL.

These are shown in Table 3 for the weeks of highest correlation coefficients. The multiple correlation is 0.873076 which accounts for 76.3 per cent of total variation in percentage infestation.

This may help in estimating the percentage infestation of jowar mites. The average percentage infestations in weeks of highest CC values, were calculated for different values of meteorological parameters and depicted by curves for T_{max}, T_{min}, SSH and by histograms for RH-1, RH-2 and RFL in Fig. 3. The favourable values in the corresponding standard weeks of highest CC for different parameters shown in Table 3 were found as:

$$\begin{aligned} T_{max} &\geq 30^\circ\text{C}, & T_{min} &\geq 20^\circ\text{C}, & \text{RH-1} &: 85-90\%, \\ \text{RH-2} &: 50-60\% \\ \text{SSH} &\geq 7 \text{ hours and rainfall about } 80-90 \text{ mm.} \end{aligned}$$

These values may not hold good for other places situated in different climatic zone.

The study is purely based on the statistical analysis of a qualitative pest data. The results are still to be corroborated with the actual observations before using for the issue of forewarning about any incidence of these pests on jowar.

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