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The role of meteorological factors on the infestation of spotted bollworm of cotton

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सार — 1962–80 के दौरान गुजरात राज्य के सूरत जिले में कपास की फसल में चित्तीदार डोडा कृमियों के वार्षिक प्रतिशत प्रकोप के मौसम सूचक न्यूनतम तापमान, अधिकतम तापमान, सापेक्ष आर्द्रता, धूप के घण्टे, वर्षा जैसे मौसमी तत्वों के साप्ताहिक माध्य का सांख्यिकीय विश्लेषण किया गया है। इस विश्लेषण के लिये साधारण तथा बहु-सहसंबंध समाश्रयण तकनीकों का उपयोग किया गया है। वर्धन अवधि में धूप वाले घण्टें, फूल आने की अवधि में सापेक्ष आर्द्रता तथा वर्षा, और डोडा बनने की अवधि में न्यूनतम एवं अधिकत्तम तापमान कृमि-प्रकोप में महत्वपूर्ण भूमिका निभाते हैं। कपास की फसल में कलियां और फूल सबसे अधिक मर्मस्थल हैं। पश्चिमी उत्तर प्रदेश के कई भागों में, विदर्भ, गुजरात, उत्तरी आन्तरिक कर्नाटक तथा आंध्र प्रदेश में कृमि के प्रकोप की बहुत अधिक घटनाएं सितम्बर से नवम्बर तक होती हैं जो कि फसल की वृद्धि के लिए डोडा उगने की मुख्यतः अवधि है।

ABSTRACT. A statistical analysis of weekly mean meteorological factors like minimum temperature, maximum temperature, relative humidities, sunshine hours, rainfall and seasonal index of the yearly percentage infestation of spotted bollworm (*earias spp.*) in cotton crop grown at Surat in Gujarat State during 1962-80 is done by applying simple and multi-correlation regression techniques. Sunshine hours during squaring period, relative humidity and rainfall during flowering period, minimum and maximum temperatures at the time of boll formation play an important role in the infestation. Flower buds and bolls are most vulnerable parts of the crop. Heavy incidences occur in parts of west Uttar Pradesh, Vidarbha, Gujarat, north Interior Karnataka and Andhra Pradesh during months of September to November which is mostly boll-formation stage period for the crop growth.

1. Introduction

Spotted bollworm (*earias spp.*) is a most noxious pest of cotton which is an important fibre crop grown in India as kharif and partly as winter crop. There was a failure of cotton crop in 1905, 1906 and 1911 in Punjab and Sindh due to this pest (Dastur *et al.* 1960). It is very sensitive to environmental factors so it may be possible to predict their occurrences on the basis of meteorological factors in advance. This may help in making an effective and most economic use of farmer's armory like insecticides and pesticides used to fight against the menace. Timely preventive measures can be taken in advance. The outbreak in the form of plague can be checked with less use of pesticides/ insecticides and thus reducing the harmful side effects on the human beings.

An attempt has been made in this study to look into various meteorological aspects of the incidence of spotted bollworm in cotton crop at Surat in Gujarat State.

2. Material and methodology

2.1. *Meteorological factors congenial to infestation*

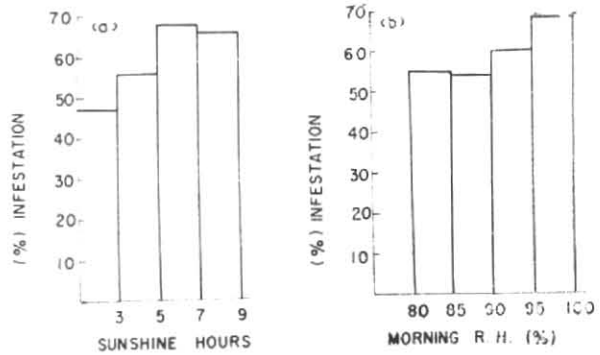
The pest data of cotton crop at Surat (21° 12′ N, 72° 52′ E) for the years 1962 to 1980 are utilised for this study. The percentage of the pest attack in different years of crop duration (*i.e.,* June to December) was taken as the mean of monthly incidences recorded in that crop season. These percentages corresponding to same meteorological elements in different years were combined together to get the average seasonal index of the pest attacks. These seasonal indices were correlated with weekly means of meteorological elements like minimum temperature (T_{min}), maximum temperature (T_{max}), morning relative humidity (RH-I), bright sunshine hours (SSH) and rainfall (R.F.) for the standard week numbers 26th to 52nd falling in the crop growing period. It covers the period from germination to 1st picking of cotton at Surat. The weeks having highest correlation coefficients and statistically significant at 5 and 10 per cent levels after

TABLE 1

Correlation coefficient of various meteorological parameters

S. No.	Met. parameter	Standard week	Corr. coeff.	*t* values	Degrees of freedom
1	T_{min}	43	0.44404	1.85	14
2	T_{max}	50	0.47045	1.99	14
3	RH-I	34	0.37905	1.53	14
4	SSH	30	0.67252	3.40	14
5	R.F.	35	0.41079	1.69	14

Multiple correlation coefficient is 0.853725 which accounts for 72.9 per cent of total variation in the infestation.



Figs. 1(a&b). Variation of percentage (%) infestation of spotted bollworm of cotton with :

(a) Duration of sunshine.

(b) Morning relative humidity

applying student's "*t*" tests were selected for individual parameters. Then a multiple correlation coefficient was calculated combining all the parameters for these selected weeks and a "*f*" test was applied for testing its statistical significance.

The highest correlation coefficient between the percentage infestation of seasonal indices and the weekly average values of meteorological parameters was found to be 43rd standard week (22-28 October) for minimum temperature, 50th standard week (10-16 December) for maximum temperature, 34th standard week (20-26 August) for morning relative humidity, 30th standard week (23-29 July) for bright sunshine hours and 35th standard week (27 August to 2 September) for rainfall. The values of the highest correlation coefficients for different parameters along with their "*t*" values, standard weeks and degrees of freedom are numerated in Table 1.

The average percentage infestation at 2 hours intervals of bright sunshine and 5 per cent intervals of relative humidity are shown by histograms in Figs. 1(a) and 1(b) respectively. The changes in percentage infestation with the weekly average values of maximum and minimum temperatures are shown in Figs. 2(a) and 2(b) respectively. The average percentage infestations are calculated taking yearwise values of seasonal indices for required class intervals of different parameters.

A multiple regression analysis enabling to estimate the joint effect of T_{max}, T_{min}, SSH, RH-I and R.F. upon the percentage infestation of the bollworm is done. The multiple regression equation which describes the average relationship between these variables is derived and expressed as below :

$$Y = 85.2868 + 0.189x_1 + 2.848x_2 + 0.420x_3 + + 2.380x_4 + 0.056x_5$$

where,

Y = Estimated value of percentage of incidence of spotted bollworm of cotton.

x_1 = Weekly mean of minimum temperature for 43rd std. week.

x_2 = Weekly mean of maximum temperature for 50th std. week.

x_3 = Weekly mean of morning relative humidity for 34th standard week.

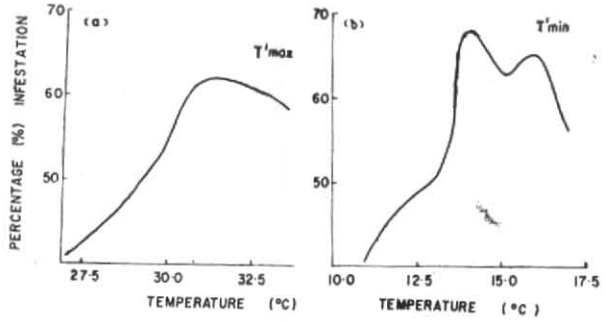
x_4 = Weekly mean of bright sunshine hours for 30th standard week.

x_5 = Weekly mean of rainfall for 35th standard week

The multiple correlation coefficient was obtained to be 0.853725 with a calculated "*f*" value 31.4849 significant at 1% level which accounts for 72.9 per cent of total variation in percentage of incidence.

2.2. *Seasonal infestation and zonal apportionment*

The source of data since 1954 to 1981, utilized and its procedure is same adopted by Dubey (1984). Qualitative data of pests from about 50 stations have been used in the present study. Out of these 8 stations reporting heavy attacks of frequency $\geqslant$ 10%, 6 stations reporting moderate attack of frequency $\geqslant$ 20% and 14 stations reporting light attack of frequency $\geqslant$ 25% were selected arbitrarily and marked on the



Figs. 2(a&b). Variation of percentage infestation of spotted bollworm of cotton with :

(a) Temperature maxima, (b) Temperature minima

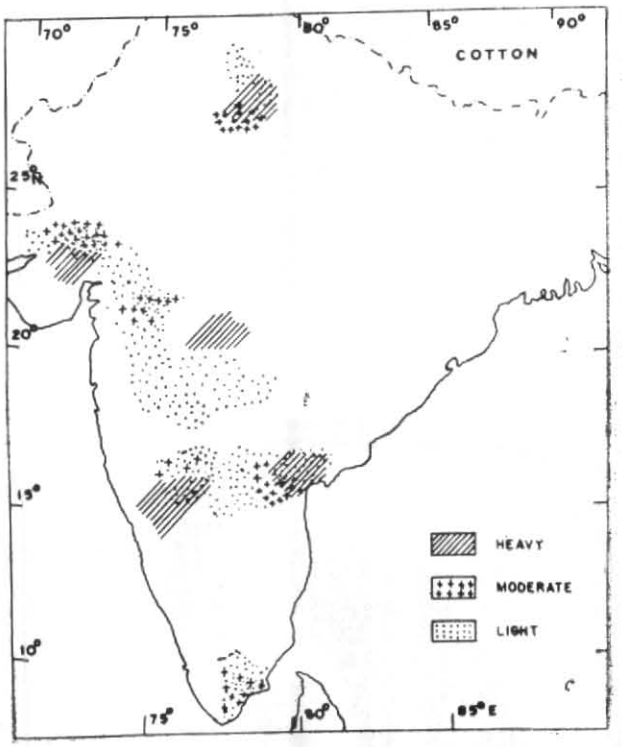


Fig. 3. Areas prone to light, moderate and heavy attack of spotted bollworm of cotton in India

map. Thus the areas prone to different intensities of attacks were approximately estimated and shown in *Fig. 3, delineating the zones* of different intensities of attacks. It is found that October to December months are very congenial for the infestation of spotted bollworm in cotton.

3. Discussion and results

The factors reflecting the moisture in the atmosphere, *i.e.,* rainfall and relative humidity, during last week of August and sunshine hours in the last week of July may be controlling the adult's activity. It makes

the conditions favourable for mating and egg laying. In this period the crop is generally in the squarring or bud formation stage. The optimum values of sunshine hours are 5 to 7 and morning relative humidity is between 95 & 100%. The weekly rainfall values should be between 170 & 210 mm which was recorded during maximum infestation period. By the time the crops are in the boll stage in the months of October and November, the insect is in its active larval stage. Its activity is mainly controlled by environmental temperatures. The optimum values of T_{min} and T_{max} are 19-20 deg. C and 30-32 deg. C respectively. It shows at Surat boll stage of crop is much congenial to the attack.

It is seen from Fig. 3 that the areas prone to the severe attacks are interior parts of coastal Andhra Pradesh, north Interior Karnataka, Vidarbha, central parts of Gujarat and southern parts of west Uttar Pradesh. The areas of moderate attacks are south Tamil Nadu, north Interior Karnataka, Telangana, parts of west Uttar Pradesh, north Gujarat, west of Madhya Pradesh and adjoining Gujarat. The light attacks are found in west Uttar Pradesh, north Gujarat, Madhya Maharashtra, Marathwada, north Interior Karnataka, Telangana and south Tamil Nadu.

This type of study is being endeavoured taking as a case study at different stations. After combining all the results, it may be possible to prepare the cotton pest calendar for different regions. It will help in proper implementing pest management scheme in the country. It may help in increasing the crop yield in India, which is perhaps lowest in the world at present and the insufficient profilatic measures is one of the several factors responsible for the poor yield in the country.

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