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Forewarning of stem-borer attack on paddy — A feasolatory study at Pattambi

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सार – पत्तम्बी (केरल राज्य) में धान की फसल के तना-वेधकों के आक्रमण का मौसम संबंधी विश्लेषण यह दर्शाता है कि बुवाई के पूर्व और वास्तविक फसल दोनों सीजनों में कुछ विशेष अवधि में तापमान, आपेक्षित आर्द्रता, धूप के घंटे पीड़ा के अधिकांश विचरण के प्रतिशत के कारक होते हैं। इस प्रकार मौसम के आंकड़ों से पत्तम्बी में धान की फसल पर तना-वेधकों के आक्रमण का पूर्वानुमान संभव हो सका है।

ABSTRACT. Meteorological analysis of stem-borer attack on paddy crop at Pattambi (Kerala State) shows that both in pre-sowing season and the actual crop season, temperature, relative humidity and sunshine hours at some critical periods account for most of the variations in the percentage of infestation. Thus forewarning of the stem-borer attack on paddy crop at Pattambi from weather data appears feasible.

1. Introduction

Incidence of stem-borer of paddy (*Typoryza incertulas Walker*) occurs year after year but with varying intensities. The work of Prakash Rao *et al.* (1971) on the role of a few meteorological parameters, like mean daily temperature, minimum temperature and soil temperature at 5 cm depth in maximum moth emergence, duration of diapause, pupation etc indicates that the variations in yearly incidence may be due to both pre-seasonal and intra-seasonal weather situations. For example, the larval diapause of the stem-borer is held to be a function of temperature. During the winter, the minimum temperature of the atmosphere lowers down considerably, resulting in a corresponding lowering of soil temperatures at different depths. As the grown up larvae are known to undergo diapause in stubbles of Kharif crops even at the depth of 5 to 7 cm below ground when the temperature is optimum the diapause comes to an end and the extent of survival of the larvae in the post-diapause periods depends on the temperature regime of the soil at shallow depths, which in turn is influenced by the air temperature regime. Thus the air temperature regime exerts an indirect effect on the extent of survival of the larvae through winter summer brood and hence on the level of threshold of infection at the start of the crop season. It is also a matter of experience that incidence of stem-borer of paddy is strongly influenced by 'break' monsoon conditions in certain critical phases.

With a view to explore the feasibility of meteorological forewarning of stem-borer attack on paddy, an attempt has been made in this paper to investigate the relationship between intensity of stem-borer attack and a few meteorological elements like rainfall, maximum and minimum temperatures, soil temperatures at 5 cm depth and relative humidity during the pre-crop and the crop seasons.

2. Materials and methods

The entomological as well as meteorological observations recorded periodically at crop-weather station at Pattambi, Kerala State, were a part of the "All India Co-ordinated Crop-Weather Scheme".

The layout plan of the scheme, the sampling and measurement techniques for recording crop growth as well as entomological observations under this scheme are given in details in Agricultural Meteorology Technical Circular Nos. 50 and 51 issued by the Director of Agricultural Meteorology, Met. Office, Pune.

As per the instructions contained in these technical circulars, the Rice Research Station at Pattambi had been recording every week the incidence and intesity of stem-borer on the paddy varieties PTB-1 and PTB-5 in a qualitative way, under three categories, *i.e.*, 'Light', 'Moderate' and 'Heavy'. Each category represents the ratio of paddy plants infested with stem-borer to the

TABLE 1

Year	Percentage of incidence	Soil temp. 51st week (17-23 Dec)	Max. temp. 14th week (2-8 Apr)
1954	25.0	26.4	35.8
1955	25.0	26.8	37.2
1956	50.0	24.1	35.6
1957	25.0	25.1	36.7
1958	50.0	27.2	36.5
1959	50.0	26.6	34.6
1960	25.0	25.4	35.0
1961	25.0	24.3	37.3
1962	25.0	28.1	36.9
1963	25.0	24.1	35.1
1964	50.0	24.1	36.0
1965	60.0	23.6	34.6
1966	60.0	23.4	36.6
1967	25.0	23.8	36.6
1968	50.0	25.2	34.3
1969	25.0	26.5	37.2
1970	50.0	24.2	35.2
1971	50.0	24.7	35.6
1972	75.0	20.4	35.8
1973	75.0	24.2	35.2
Mean	42.25	24.91	35.89
S.D.	17.14	1.67	0.92
C.V.	40.56	6.71	2.56

Multiple correlation is 0.6477 which accounts for 42.0 % of total variation in % of incidence.

total number of plants in the sampling unit. The categories 'Light', 'Moderate' and 'Heavy' indicate infection of 25, 50 and 75 per cent respectively.

The weather parameters had been recorded in a nearby observatory enclosure. For the purpose of this study a "seasonal index" expressed as an average of the incidence during the entire crop season was computed. Such indices were computed for the period of 20 years from 1954 to 1973.

The seasonal indices of the year under investigation were correlated with the weekly means of soil temperatures of standard weeks, 49 to 52 (*i.e.*, from 3 to 31 December of the previous year and then with those of standard weeks 1 to 5 (1 January to 4 February) of the year under investigation to study the influence of weather on the larval diapause and the oversummering of the pest, the seasonal indices were also correlated with the weekly means of maximum temperature for the period from 9th to 26th standard weeks (*i.e.*, 26 February to 30 June).

To assess the role of meteorological parameters within the life-cycle of the crop, the seasonal indices were again correlated with weekly means of each of the meteorological parameters, like maximum and minimum temperatures, afternoon relative humidity, hours of bright sunshine and also weekly totals of rainfall for the period beginning with the week of transplantation, *i.e.*, standard week 27 (2 to 8 July) and ending with 39th standard week (*i.e.*, 24-30 September).

3. Result and discussion

It was found that the correlation coefficient between seasonal index and soil temperature was the highest for the 51st standard week (17-23 December) and was — .0.55217. As the mean soil temperature for the 51st week was seen to be 24.9° C, it was obvious that the temperatures lower than this induced a longer diapause at this station.

The mean maximum temperature of the 14th standard week (*i.e.*, from 2 to 8 April) gave the highest correlation of – 0.46041 with the seasonal index. When the same seasonal indices were subjected to regression analysis with weekly means of soil temperature for 51st standard week and maximum temperature for 14th week, it was observed that the M.C.C. in this case was 0.6477, significant at 1 per cent level and accounted for 42 per cent variation in the total percentage of infestation of stem-borer. Even when weekly means of soil temperatures for weeks other than 51st standard week and of maximum temperature for weeks other than 14th standard week are taken into account along with these two variables, the M.C.C. does not show any radical change. Hence the regression equation in this case is :

$$Y = 395.3193 - 4.808X_2 - 6.501X_3$$

where, Y = Estimated value of percentage of incidence of stem-borer of paddy.

X_2 = Weekly mean of soil temperature for 51st Std. week.

X_3 = Weekly mean of maximum temperature for 14th Std. week.

Table 1 gives the figures of seasonal indices of infestation of paddy plants by stem-borer for the years 1954-1973 with weekly mean values of soil temperatures at 5 cm depth (for morning epoch) for 51st standard week of the previous year and also weekly means of maximum temperature for 14th standard week of the year under investigation. It is seen from this table that

TABLE 2

Year	Percentage of incidence	S.S. hours for 30th week (23-29 Jul)	Max. temp. for 31st week (30 Jul-5 Aug)	Aternoon humidity for 36th week (3-9 Sep)
1954	25.0	2.4	27.1	74.0
1955	25.0	1.8	28.6	77.0
1956	50.0	2.0	28.5	70.0
1957	25.0	4.3	28.6	70.0
1958	50.0	4.5	30.5	66.0
1959	50.0	1.1	30.1	76.0
1960	25.0	0.2	28.1	67.0
1961	25.0	1.3	29.5	71.0
1962	25.0	3.6	29.1	77.0
1963	25.0	3.5	27.5	75.0
1964	50.0	3.2	27.8	77.0
1965	60.0	4.5	28.6	67.0
1966	60.0	1.2	30.2	74.0
1967	25.0	1.1	28.2	69.0
1968	50.0	2.1	28.6	70.0
1969	25.0	1.4	29.5	76.0
1970	50.0	2.2	28.1	67.0
1971	50.0	0.5	29.5	60.0
1972	75.0	7.5	29.5	66.0
1973	75.0	8.1	29.2	66.0
Mean	42.25	2.82	28.84	70.75
S.D.	17.14	2.08	0.89	4.70
C.V.	50.56	73.72	3.09	6.64

Multiple correlation is 0.71762 which accounts for 51.3% of total variation in % of incidence.

whenever the soil temperature in the 51st standard week is lower than 24°C there is a higher infestation of stem-borer in the next paddy crop season. Data for the years 1965 and 1972 illustrate this point. When the maximum temperature in the 14th standard week exceeds 37°C, the seasonal index is quite low. This is confirmed in the years 1955, 1961 and 1969.

In the crop period, weekly totals of rainfall were found to have no statistical significance. The highest correlation coefficient with the seasonal indices was found to be 0.55322 for sunshine hours of 30th standard week, 0.39511 for maximum temperature of 31st standard week, 0.44931 for afternoon relative humidity of 36th standard week and 0·43583 for minimum temperature of 39th standard week. When all these four factors were again used for combined regression analysis of variation in seasonal indices of infestation of stem-borer the resultant M.C.C. was found to 0.71762, significant at 5 per cent level and it accounted for 51.5 per cent of the total variation in seasonal indices. It was also seen that of these four factors, the statistical significance of the weekly means of minimum temperature for 39th standard week was lowest as its T value was only 0.030. Hence this factor was dropped from the group. It was noticed that with the three remaining meteorological factors, the M.C.C. was 0.715632 significant at 1 per cent level and it accounted for 51.3 per cent of total variation in infestation of paddy plants. Further exclusion of a meteorological factors like afternoon relative humidity of 36th standard week or maximum temperature of 31st standard week showed a marked reduction in the percentage of variation accounted for by the meteorological factors. Hence the regression equation in this case is :

$$Y = -61.0116 + 3.834X_2 + 5.868X_3 - 1.086X_4$$

where,

Y = Estimated value of percentage of incidence of stem-borer of paddy

X_2 = Weekly mean of hours of bright sunshine for 30th Std. week

X_3 = Weekly mean of maximum temperature for 31st Std. week.

X_4 = Weekly mean of afternoon relative humidity for 36th Std. week.

Table 2 gives the seasonal indices for the years 1954-1973 along with weekly mean values of bright hours of sunshine for 30th standard week (23-29 July), maximum temperature for 31st standard week (30 July to 5 August) afternoon relative humidity for 36th standard week (3-9 September).

It is seen from Table 2 that in the 30th standard week, if the crop is exposed to more than four hours of bright sunshine there is a heavier infestation in the subsequent weeks. The years 1958, 1965, 1972 and 1973 illustrate this point. In 31st standard week, maximum temperature of 28.8°C with a standard deviation of 0.9°C emerges as a significant factor. Rise in hours of bright sunshine in 30th standard week and in maximum temperature in 31st standard week is a result of disappearance of clouds suggesting thereby a weekening of, or a break in monsoon.

Again whenever the relative humidity in 36th standard week is less than 71 per cent, the paddy crop seems to be heavily infested by the stem-borer. The years, 1958, 1965, 1970, 1971, 1972 and 1973 substantiate this proposition.

The year 1960 in this series is interesting. Here the hours of bright sunshine are the lowest, *i.e.*, 0.2, the maximum temperature (28.1°C) is lower than mean value (28.8°C), the relative humidity (67 per cent) is lower than mean value. Hence the infestation is quite low (25 per cent).

4. Scope

For the regression analysis, only the series of twenty years (*i.e.*, from 1954 to 1973) was used in this paper. An attempt is being made to extend it further by including the subsequent years also.

Similarly, the same type of analysis is being attempted in other paddy growing stations where a sufficiently long series of stem-borer infestation and meteorological data are available for such analysis. The results will be sent for publication in due course of time.

Reference

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