

Effect of the meteorological factors on the incidence of paddy stem-borer (*Tryporyza Incertulas Walker*) and its zonal apportionment

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सार— धान के तना छेदक कीड़े के हमले पर मौसम विज्ञानी तत्वों का बहुत अधिक प्रभाव पड़ता है। वर्तमान सांख्यिकीय विश्लेषण में इन कीड़ों के प्रकोप पर मौसम के तत्वों के प्रभाव को समझने का प्रयास किया गया है। ऐसा पाया गया है कि पौध की बड़वार की अवस्था में वायुमण्डल में नमी की कम मात्रा तथा 23° सेल्सियस के कम न्यूनतम तापमान तथा फूल आने की अवस्था में 8 घण्टे से अधिक की धूप भुवनेश्वर स्थित धान की ग्रीष्मकालीन फसल की बालें लगने की अवस्था में लाखों के अनुकूल होती है। भारत के उत्तर पूर्वी क्षेत्र में ग्रीष्म तथा शरद कालीन धान की फसलों की बालिया आने की अवस्था में तना छेदक के भारी हमले का खतरा रहता है। धान में तनाछेदक के आक्रमण की पूर्व चेतावनी में प्रयुक्त होने वाले मौसम विज्ञानी परिमाणकों के आंशिक मानों के बारे में एक सामान्य निष्कर्ष निकालने के लिये अन्य स्थानों पर भी ऐसा ही अध्ययन करने की आवश्यकता है।

ABSTRACT. Paddy stem-borer (*Tryporyza Incertulas Walker*) infestation is very much influenced by meteorological factors. The effect of various weather elements on its incidence is endeavoured in present statistical analysis. It is found that less moisture content in the atmosphere in the elongation stage and a minimum temperature lower than 23 deg. C and sunshine hours more than 8 hours in flowering stage are favourable for increased larval activity in the earing stage of summer paddy crop at Bhubaneswar. Northeast region of India are prone to heavy attack in summer and winter crops earing stage. Similar studies for other stations are necessary to draw general conclusion about threshold values of meteorological parameters to be used in forewarning of the infestation of stem-borer in paddy.

1. Introduction

Stem-borer is a very serious pest for areas growing more than one paddy crop in a year. The role of various meteorological factors played in the life cycle of this pest was earlier worked out by various workers (Rao *et al.* 1971, Kazi *et al.* 1982, 1983). Paddy being the important crop of several countries, this pest has a very high price on its head. Weather can encourage its appetite and make the paddy more receptive to it by lowering its resistance. Climatic differences from year to year and place to place have an effect also on the incidence and spread of this insect. It can well be controlled by the knowledge of the relationship between the pest and the environment. Weather is the most important factor because it controls the density of the pest population, its expansion and contraction. Thus every insect must have a natural geographic distribution determined by climate, food supply and competition with other species. Therefore a clear knowledge of such relationship and a map showing the insect distribution which have been

endeavoured in the present work, is helpful in involving a pest management scheme,

2. Materials and methodology

Under the "All India Co-ordinated Crop Weather Scheme" a systematic and detailed observations relating to the growth and development of crops, incidences of pests/diseases as well as the weather elements experienced by the crops during their life history were recorded at a network of "selected experimental" farms in India since 1954.

The details of the plan of the scheme, a general layout of the sampling observations and measurement techniques are given in Agricultural Meteorology Tech. Circular No. 50. The pest population was estimated on the basis of damaged tillers 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 total number of plants in sampling unit of the experimental

block earmarked for the estimation of plant diseases and pests. The categories light, moderate and heavy indicate infection of 25, 50 and 75 per cent respectively. The meteorological observations were recorded in the nearby observatory enclosure, at 0700 LMT and 1400 LMT. These data were available and used in this study.

The methodology and discussions about the different parts of investigation are described below under sub-headings.

2.1. *Effect of meteorological factors on the incidence of stem-borer*—In this study the data of the summer crop of paddy at Bhubaneswar (20 deg. 15' N, 85 deg. 52' E) available for the period 1966 to 1981 are utilised. The yearly univariate seasonal index of the pest attack is worked out as the average percentage of incidence throughout the crop life, *i.e.*, December/January to March/April. It measures the effect of changes over a period of time. The seasonal indices were correlated with the weekly means of various weather parameters for every standard week of the crop period separately. The weeks having highest correlation coefficients and statistically significant at 5, 10 and few at 20 per cent levels were selected for individual parameters. The student 't' test was worked out for this purpose. Then a multiple correlation coefficient was calculated taking all the meteorological parameters for the selected weeks only. Soil temperature at 5 cm depth and maximum temperature did not have the significant correlation for any week during crop season. So their correlation was calculated for the weeks before the crop plantation. The multiple correlation coefficient of these two parameters was worked out separately for the weeks having highest and statistically significant correlation coefficients.

3. Results and discussions

During the crop period the highest correlation coefficient between various weather parameters and seasonal indices of infestation was found to be in the 5th standard week (*i.e.*, 29 January to 4 February) for rainfall, 6th standard week (*i.e.*, 5 to 11 February) for evaporation, 12th standard week (19 to 25 March) for morning relative humidity and minimum temperature and 13th standard week (*i.e.*, 26 March to 1 April) for sunshine hours.

Lesser rainfall in the 5th standard week, more evaporation rate (*i.e.*, > 4 mm) in the 6th standard week, minimum temperature lower than 23 deg. C in 12th standard week and sunshine hours more than 8 hours in 13th standard week may cause higher degree of infestation. The correlation coefficients between seasonal indices for the year 1966 to 1981 and various weather parameters alongwith their 'T' values and level of significance are shown in Table 1. The multiple correlation coefficient values along with its 'F' value and level of significance are also tabulated there. It is seen that the multiple correlation coefficient is 0.79380 with calculated 'F' value 19.3148 significant at 1 per cent level and it accounts for 63% of total variation in infestation of paddy summer crop at Bhubaneswar.

TABLE 1

Meteorological parameter	Std. week No.	Correlation coefficient	T	Degree of freedom	% Significance
Rainfall	5 (29 Jan-4 Feb)	-0.52979	2.25	13	5
Evaporation	6 (5-11 Feb)	0.50130	2.09	13	10
Relative humidity	12 (19-25 Mar)	0.60248	2.72	13	5
Minimum temperature	12 (19-25 Mar)	-0.37787	1.47	13	20
Sunshine hours	13 (26 Mar-1 Apr)	0.35981	1.39	13	20

Multiple correlation is 0.7938 with 'F' value 19.3148 which is significant at 1% level and accounts for 63.1% of total variation in percentage of incidence.

The highest correlation of 0.60248 was obtained between morning relative humidity and seasonal index of infestation. Relative humidity more than 95% in the 12th standard week (19-25 March) had caused heavier infestation. The lowest correlation was found for sunshine hours. The multiple linear regression equation between seasonal index of infestation and five weather parameters was derived and expressed as below:

$$Y = -195.8316 - 3.001 X_1 + 6.746 X_2 + 3.109 X_3 - 1.646 X_4 - 2.985 X_5$$

where,

Y=Estimated value of percentage of infestation of stem-borer of paddy.

X_1 =Weekly mean of rainfall of 5th standard week.

X_2 =Weekly mean of evaporation of 6th standard week.

X_3 =Weekly mean of morning relative humidity of 12th standard week.

X_4 =Weekly mean of minimum temperature of 12th standard week.

X_5 =Weekly mean of sunshine hours of 13th standard week.

3.1. The correlation coefficient between seasonal indices of infestation and two weather parameters, *i.e.*, maximum temperature and evening soil temperature at 5 cm depth, for the weeks falling during the crop period were not found to be statistically significant. Therefore, an attempt was made to study the effect of these parameters in the pre-sowing weeks (*i.e.*, from last week of November to 1st week of January) on the intensity of attack on the actual crop. The most significant correlation of -0.47132 for maximum temperature was found to be in 49th standard week (3 to 9 December) and that of -0.55927 for evening soil temperature at 5 cm depth in the 3rd standard week (15-21 January). It is found that whenever the evening soil temperature at 5 cm depth of 3rd

standard week is lower than 27 deg. C, the infestation of the paddy stemborer in the next paddy crop season is higher and when the maximum temperature in the 49th standard week exceeds 30 deg. C the seasonal index of infestation is quite low. These two weeks were grouped for combined regression analysis of variation in seasonal indices of infestation of stemborer. The resultant M.C.C. (multiple correlation coefficient) was found to be 0.57709, significant at 1% level and it accounted for 33.4% of the total variation, in the seasonal indices. These are tabulated in Table 2.

Although the effect of these parameters are lower than other five parameters considered during the crop period but their correlation is also significant. This shows the influence of the weather on the larval diapause and over wintering of the pests.

The regression equation in this case is

$$Y = 311.8230 - 4.834 X_1 - 4.028 X_2, \text{ where,}$$

Y = Estimated value and percentage of infestation of stemborer of paddy.

X_1 = Weekly mean of maximum temperature in the standard week No. 49.

X_2 = Weekly mean of evening soil temperature at 5 cm depth in standard week No. 3.

3.2. The monthly frequency of infestation was worked out combining the pest data for the year 1966 to 1981 at Bhubaneswar and a histogram is plotted and shown in Fig. 1. It was found that the maximum frequency of occurrence is in the month of March which is one to two months before harvest. As we know the effect seen on the plants vary with the stage at which infestation of the plant commences. In this case the attack is found at the maximum vegetative stage where the holes are made at the place of entry of the caterpillars. Plants which have started bearing panicles give rise to "white heads" or discoloured panicles with empty or partially filled grains. Sometimes they can kill the panicle even after grain formation has started.

3.3. Seasonal infestation and its zonal distribution

Qualitative data of visual observations on winter, summer and autumn paddy collected from a network of agricultural farms/stations have been analysed based on the procedure adopted by Dubey (1984) and an attempt has been made to delineate the areas of heavy, moderate and light attacks of paddy stemborer. Because its regional distribution and extent of damage depend upon the environmental and climatic factors, it was possible to estimate the months of various types of attacks in all the five rice growing regions.

The whole country can be grouped into five regions according to paddy growing seasons (Ghose *et al.* 1960). These are North-eastern region (Assam, West Bengal, Bihar and Orissa), Southern region (Tamil Nadu, Andhra Pradesh, Kerala and Karnataka), Central region (Madhya Pradesh, Part of Andhra Pradesh and Karnataka), Western region (Maharashtra and Gujarat) and Northern region (Jammu & Kashmir Punjab, Himachal Pradesh, Haryana, Uttar Pradesh and northern parts of Bihar). Similarly, the rice crop

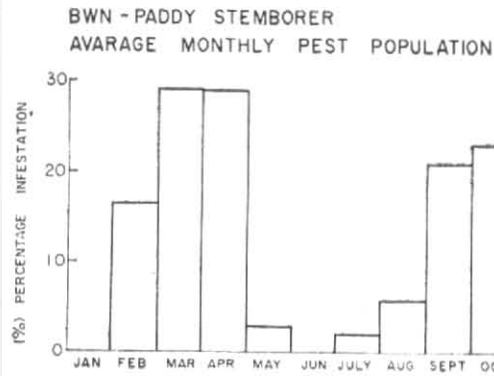


Fig. 1

TABLE 2

Meteorological parameters	Std. week No.	Correlation coefficient	T	Degrees of freedom	% Significance
Maximum Temperature	49 (3-9 Dec.)	-0.47132	1.77	11	10
5 cm depth evening soil temperature	3 (15-21 Jan)	-0.55927	2.24	11	5

Multiple correlation is 0.577090 with 'F' value 8.9524 which is significant at 1% level and account for 33.4% of total variation in percentage of incidence.

also can be classified broadly into 3 groups according to the season when it is harvested (Ghose *et al.* 1960). These are winter summer and autumn crops having their growing periods, June/July to November/December, December/January to March/April and May/June to September/October respectively. The vast contiguous areas under rice cultivation and its seasonal spread throughout the year affords continuous food supply and shelter for the uninterrupted breeding and dispersal of the pest.

The frequency of attack of any intensity at a particular station was calculated from the number of attacks reported out of the total number of observations during 1954-81. The only stations reporting heavy attack of the frequency 10%, moderate of the frequency $\geq 20\%$ and that of light attack $\geq 25\%$ were selected out arbitrarily to have uniformity with earlier work (Dubey 1984) and marked on the map. Thus the areas prone to different intensities of attack are estimated and shown in Fig. 2.

The above selected stations falling in particular rice growing region were grouped together regionwise. The number of monthly events from all the stations of a particular group were combined together. The months showing maximum number of events in different regions are given in Table 3. This may help in selecting a particular area/month for further study of the environmental/climatic effects on the pests.

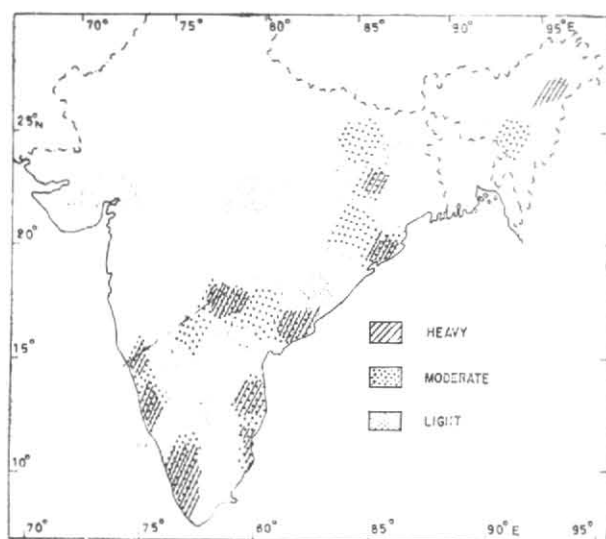


Fig. 2. Areas showing the different intensities of stem-borer attack on paddy

TABLE 3
Seasonal attacks of stem-borer (*Tryporyza Incertulas Walker*) in various regions

Intensity of attack	Regions			
	Northeast	Southern	Central	Western
Heavy	Apr, Oct	Jan, Nov	—	—
Moderate	Mar, Oct	Jan, Nov	—	—
Light	Feb, Sep	Jan, Oct	Mar, Oct	Mar, Sep

4. Conclusions

The result of this study shows that less rainfall in 5th standard week and more evaporation rate (*i.e.*, more than 4 mm) in the 6th standard week which mainly covers the elongation stage of the crop grown, are favourable for infestation in the coming stages of the crop. Minimum temperature lower than 23 deg. C in the 12th standard week and sunshine hours more than 8 hours in the 13th standard week cause higher degree of infestation of stemborer on paddy crop by increasing the larval activity. The plants attacked in these weeks when they generally start bearing panicles give rise to "White heads" or discoloured panicles with empty or partially filled grains.

The pest is carried over to the next crop season by hibernating larvae in stubbles remaining in fields after harvest. Whenever the evening soil temperature at 5 cm depth in 3rd standard week is lower than

27 deg. C and the maximum temperature in the 49th standard week is lower than 30 deg. C, the infestation in the next crop increases.

It is seen from Fig. 2 that southern part of Bihar, coastal part of Orissa and north eastern part of Assam, northern parts of Andhra Pradesh eastern and western coasts of the Peninsular India are affected by heavy attacks. Moderate attacks are localised in the extended parts of these areas. The light attack is reported from all over Kerala, Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, parts of Bihar, eastern parts of Madhya Pradesh and northern part of Assam. From Table 3, it is clear that the attacks are mostly noticed in the earing stage of the summer crop. The northeast region has heavy attack in summer and winter crops and light attack in winter and autumn crops. The southern regions has all types of attacks in summer and winter crops. Central region has winter and summer crops only and both are affected by light attacks. Western region has generally one growing season and so no heavy attack is found. It means the large growing areas having more than one crop have more chances of the heavy attacks of stemborer. An attempt is being made to make similar studies of stemborer attacks at all the observing stations in India utilizing upto date data. The combined results will facilitate to draw a solid conclusion and formulate a rule for seasonal forewarning against the incidence of this pest in different zones in India.

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