Agri. Res. J.Kerala, 1972, 10 (2): *141—151*

EFFECT OF PLANTING SEASONS AND THE ASSOCIATED WEATHER CONDITIONS ON THE INCIDENCE OF THE RICE STEM BORER TRYPORYZA *INCERTULAS* (WALKER)

C. C. Abraham*, **B. Thomas, K.** Karunakaran **and R. Gopalakrishnan**
Rice *Research Station, Pattambi.*

The stem borer *Tryporyza incertulas* (Walker) is one of the major pests of rice in Kerala. The occurrence of seasonal variations and the variations in the intensity of pest infestation have been reported by different workers (Khan and Murthy 1955, Pawar and Rajagopalan 1956, CRRI 1960, ICAR 1963, Banerjee and Pramanik 1964). The information on seasonal variations would be helpful either to use resistant varieties for growing in those seasons during which maximum infestation can be expected or to undertake adequate prophylatic measures against the pests. But very little information is available regarding the influence of different planting seasons and the associated climatic factors on stem borer infestation. The present paper deals with the result of studies carried out at the Rice Research Station, Pattambi, Kerala during the years 1967-68 to 1971-72 to ascertain the exetent of damage caused by *Tryporyza incertulas* to paddy crops planted at different periods of the year.

Materials and Methods

Twenty five days old seedlings of the variety IR 8 were planted in doubles with a spacing of 20 cm x 15 cm in 25 m X 4 m plots at regular fortnightly intervals for 5 years during the period 1967-68 to 1971-72. The periodic plantings were made commencing from the first fortnight of June of one year to the second fortnight of January of the next year. Cattle manure at 5 tonnes per hectare and fertilizers to supply N, P_2O_5 and K_2O fit 100, 50, 50 kg/ha respectively were applied to each plot. Insecticidal applications were withheld so as to allow maximum infestation by the pest, Dithane Z-78 at 2 kg/ha was applied at 20 and 60 days after planting for protection against diseases. The stem borer population was estimated in terms of the percentage incidence of dead hearts at 45 days after planting and of white earheads at 75 days after planting from randomly located sample plots of 1 sq. m. size. The weather data collected daily at the Agricultural Meteorological Observatory of the Research Station were utilized for the study. From the daily observations on the maximum and minimum temperatures, rainfall and relative humidity the daily means for the period of 45 and 75 days afterplanting were calculated.

* Present address: Research Officer, Entomology Division, College of Agriculture, Vellayani.

Table 1

Correlation between the percentage of dead hearts caused by T. *incertulas* at 45 days after **planting** and the associated climatic factors

Correlations			Correlation coefft: (n = 78)
Percentage dead hearts (1)	Vs.	Mean rainfall (2)	
Percentage dead hearts (1)	Vs.	Mean relative humidity (3)	$r_{13} = -0.0930$ NS
Percentage dead hearts (1)		Mean minimum temperature	–
Percentage dead	Vs	Mean maximum temperature	

* Significant at 5% level. ** Significant at 1% level. NS Non significant.

It is observed that the percentage of dead hearts is unaffected by the fluctuations in relative humidity but is correlated negatively with rainfall and mean minimum temparature. It is also seen that the mean maximum temperature and the incidence of dead hearts are positively correlated.

The partial correlation coefficients are furnished in Table 2. The negative correlation existing between the percentage of dead hearts and rainfall becomes non-significant when the minimum temperature and maximum temperature are eliminated individually and jointly ($r_{12\cdot4}$, $r_{12\cdot5}$, , $r_{12\cdot45}$). This indicates the joint influence of the weather factors, namely, rainfall, minimum and maximum temperatures on the pest population.

When rainfall and maximum temperature are jointly eliminated, the relationship between dead hearts and minimum temperature retains strong negative correlation ($r_{14\cdot25}$). It is thus revealed that fluctuations in minimum temperature can independently influence stem borer infestation in the tillering phase of the crop irrespective of the changes occurring in rainfall and maximum temperature. But when these factors are individually eliminated the correlation fails to attain significance ($r_{14\cdot2}$ and $r_{14\cdot5}$).

The positive relationship between percentage dead hearts and the mean maximum temperature retains the same association even when rainfall and minimum temperature are eliminated both individually and jointly (Sl. Nos. 7, 8, 9 of Table 2). This clearly shows that irrespective of the changes occurring in rainfall and minimum temperature, the maximum tempersture can itself influence stem borer infestation.

Table 1

Correlation between the percentage of dead hearts caused by T. *incertulas* at 45 days after **planting** and the associated climatic factors

Correlations			Correlation coefft: (n = 78)
Percentage dead hearts (1)	Vs.	Mean rainfall (2)	
Percentage dead hearts (1)	Vs.	Mean relative humidity (3)	$r_{13} = -0.0930$ NS
Percentage dead hearts (1)		Mean minimum temperature	–
Percentage dead	Vs	Mean maximum temperature	

* Significant at 5% level. ** Significant at 1% level. NS Non significant.

It is observed that the percentage of dead hearts is unaffected by the fluctuations in relative humidity but is correlated negatively with rainfall and mean minimum temparature. It is also seen that the mean maximum temperature and the incidence of dead hearts are positively correlated.

The partial correlation coefficients are furnished in Table 2. The negative correlation existing between the percentage of dead hearts and rainfall becomes non-significant when the minimum temperature and maximum temperature are eliminated individually and jointly ($r_{12\cdot4}$, $r_{12\cdot5}$, , $r_{12\cdot45}$). This indicates the joint influence of the weather factors, namely, rainfall, minimum and maximum temperatures on the pest population.

When rainfall and maximum temperature are jointly eliminated, the relationship between dead hearts and minimum temperature retains strong negative correlation ($r_{14\cdot25}$). It is thus revealed that fluctuations in minimum temperature can independently influence stem borer infestation in the tillering phase of the crop irrespective of the changes occurring in rainfall and maximum temperature. But when these factors are individually eliminated the correlation fails to attain significance ($r_{14\cdot2}$ and $r_{14\cdot5}$).

The positive relationship between percentage dead hearts and the mean maximum temperature retains the same association even when rainfall and minimum temperature are eliminated both individually and jointly (Sl. Nos. 7, 8, 9 of Table 2). This clearly shows that irrespective of the changes occurring in rainfall and minimum temperature, the maximum tempersture can itself influence stem borer infestation.

Table 2

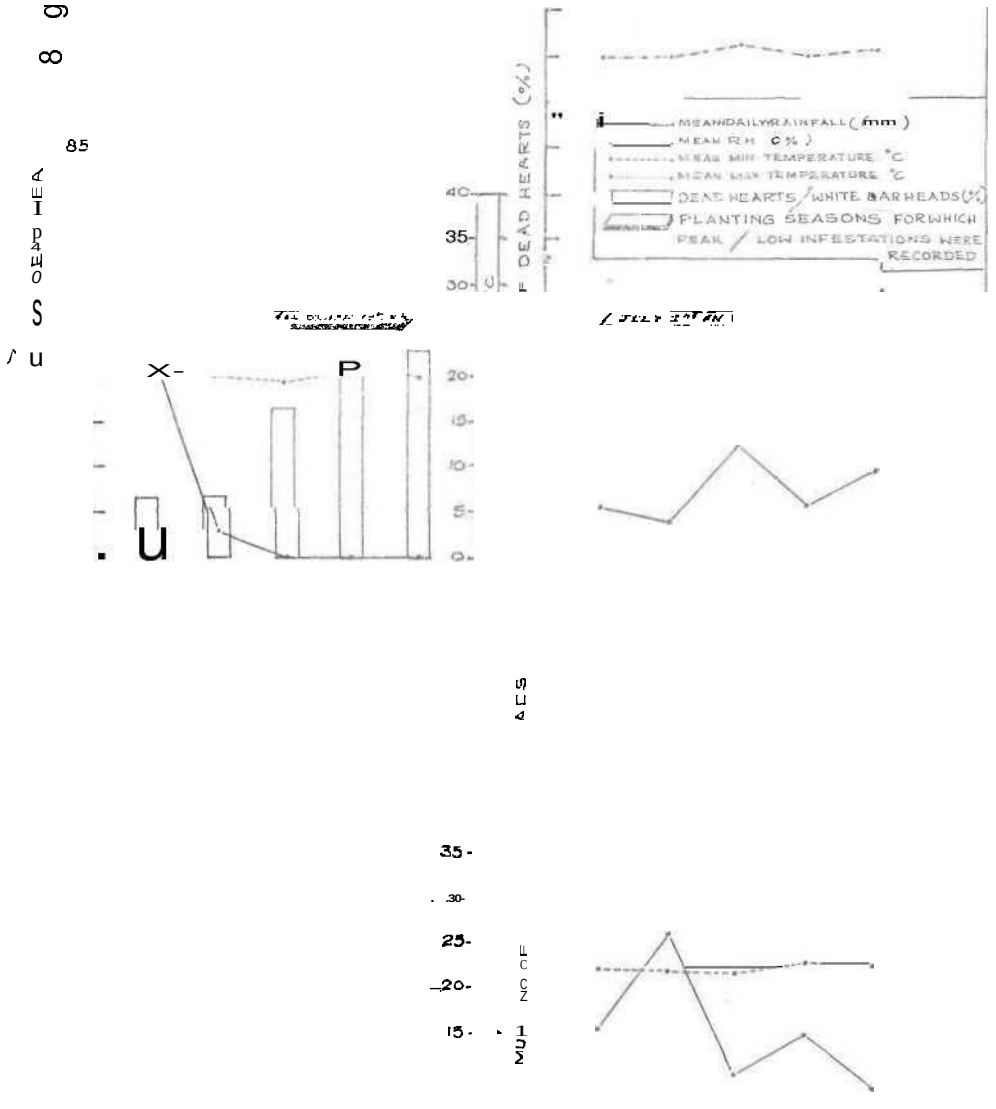
Partial correlation coefficients between percentages of dead hearts caused by T. *incertulas* at 45 days after planting and the associated climatic factors.

SI. No.	Factor associations			Factor eliminated	Partitial correlation coeffts (n = 78)
1.	Percentage dead hearts (1)	Vs.	Mean rainfall (2)	Mean minimum temperature °C (4)	$r_{12.4}$ = -0.1773 NS
	Percentage dead hearts (1)	Vs.	Mean rainfall (2)	Mean maximum temperature C (5)	$r_{12.5}$ = +0.2200 NS
3.	Percentage dead hearts (1)	Vs.	Mean rainfall (2)	Mean minimum temperature °G (4) ttd mean maximum temperature (5)	$r_{12.45}$ = -0.2210 NS
4.	Percentage dead hearts	Vs.	Mean minimum temperature °C (4)	Meanrainfall(2)	$r_{14.2}$ = -0.1490 NS
	dead hearts		Mean temperature °C (4)	Mean maximum temperature °G (5)	$r_{14.5}$ = -0.1941 NS
6.	Percentage dead hearts (1)	Vs.	Mean minimum temperature °G (4)	Mean rainfall (2) and mean maximum temperature °G (5)	
1.	Percentage dead hearts (1)	Vs.	Mean maximum temperature °G (5)	Meanrainfall(2)	$r_{15.2}$ = +0.4370
8,	Percentage dead hearts (1)	Vs.	Mean maximum temperature °G (5)	Mean minimum temperature °C (4)	$r_{15.4}$ = +0.4008
9.	Percentage dead hearts (1)	s.	Mean maximum temperature °C (5)	Mean rainfall (2) and mean minimum temperature °C (4)	$r_{15.24}$ = +0.5672 **

** Significant at 1% level. NS Non-significant.

The weather conditions associated with peak and low infestations by T. *incertulas* during the years 1967-68 to 1971-72 are furnished in Fig 3. It will be seen that for the years 1968-69 to 1971-72 the peak incidence of dead hearts (6.62 to 22.98%) was manifested for the plantings made during the period from the second fortnight of November to the first

WEATHER CONDITIONS ASSOCIATED WITH PEAK AND LOW INFESTATIONS BY THE RICE STEM BORER TRYPORYZA INCERTULAS DURING THE YEARS 1967-68 TO 71-72



fortnight of January. These peaks at 45 days after planting were associated with the occurrence of very low to no rainfall and a comparatively low relative humidity ranging from 77.80 to 84.00%. The temperatures during the period up to 45 days after planting fluctuated within a relatively wider range from 19.2° to 34.9°C. For these years the dead hearts induced by the stem borer were minimum (0 to 0.76%) for the crop planted from the second fortnight of July to the second fortnight of September. The associated weather conditions for low infestations were markedly different from those preceeding the peaks and these were characterised by the occurrence of moderate rainfall ranging from 4.4 to 13.6 mm , higher relative humidity (95.4 to 96.6%) and a narrow range for temperature fluctuations, the minimum and maximum in the range being 21.3° and 31°C respectively. The striking variations in the meteorological conditions leading to high and low dead hearts incidence are in accordance with the expected trend indicated py the correlation studies, viz., the occurrence of a negative correlation with rainfall and minimum temperature and a positive correlation with maximum temperature.

It will, however, be noted that the occurrence of peak pest infestation during 1967-68 is unexpectedly in association with detrimental weather conditions characterised by a relatively higher rainfall (25.2mm) accompanied by a high relative humidity of 95-7% and temperature fluctuation within a narrow range from 21.8°C to 28 6°G. The adverse effect of rainfall on borer population has been reported by earlier workers (Banerjee and Pramanik 1964, Tao and Tang 1960, Koshy and Lakshmy 1969). It is quite likely that in the year 1967-68 the rainfall was so distributed that the vulnerable stages escaped from its deleterious effects.

The correlation coefficients between the percentage of white earheads and the climatic factors are furnished in Table 3.

It will be observed that the relations between rainfall, minimum and maximum temperatures on the one hand and incidence of white earheads on the other are analogous to those existing between these weather components and the occurrence of dead hearts. Unlike in the case of dead hearts, it is observed that there exists a significant negative relationship between the incidence of white earheads and relative humidity. The nature of associations established in the present studies is in consonance with those observed by Banerjee and Pramanik (1964).

The favourable temperature for *T. incertulas* ranges from 17° to 35°G (Harukawa *et al* 1931, Doke 1936, Lin *et al.* 1959, Kiritani and Iwao 1964). In the present studies the lowest recorded minimum temperature was 19.1°C and the highest maximum temperature was 34.9°C. It is quite likely that

Table 3

Correlation between the percentage of white earheads caused by T. fncertufas at 75 days after planting and the associated climatic factors

Correlations			Correlation coeffts (n=78)
Percentage of white earheads (1)	Vs.	Mean rainfall (2)	$r_{12} = -0.3494^{**}$
Percentage of white earheads (1)	Vs.	Mean realtive humidity (3)	$= -0.3340^{**}$
Percentage of white earheads (1)	Vs.	Mean minimum temperature °C (4)	$r_{14} = -0.2305^{*}$
Percentage of white earheads (1)	Vs.	Mean maximum temperature °G (5)	$r_{15} = +0.2770^{*}$

* Significant at 5% level. Significant at 1% level.

under temperatures fluctuating within these favourable limits an acceleration of the developmental velocity is realised (Peairs 1927, Parker 1930). The negative relation with minimum temperature and the positive relation existing with maximum temperature can be explained on this basis.

For the years 1967-68 to 1970-71 the peak incidence of white ear heads (13 85 to 21.85%) was revealed for the crops planted from the first fortnight cf October to the second fortnight of November (Fig. 3). The weather conditibns preceeding the peaks were characterised by the occurrence of scanty rainfall (nil to 5.6 mm.), comparatively low levels of relative humidity (78.8 to 82.5% and 93.31% for 1969-70), and a wider range between minimum and maximum temperatures (19.9° to 33.3°C). It will be noted that peaks in the occurrence of dead hearts were also associated with similar meteorological conditions The general pattern of occurrence of dead hearts and white earheads in different years thus indicates that the crop planted from first fortnight of October to the first fortnight of January suffers relatively higher losses. The higher susceptibility of the crops raised in December-May (Khan and Murthy 1955, CRRI 1960, ICAR 1963) is explicable on basis of the associated weather conditions that are favourable to pest multiplication.

During the year 1971-72, the peak white earhead incidence was revealed for the crop planted in the second fortnight of July though the

associated weather conditions were apparently unfavourable. It is probable that the relatively higher rainfall (1433 mm.) was so distributed that the susceptible stages of the pest could have escaped its adverse effects.

During the years 1967-68 to 1971-72, the lowest incidence of white earheads was recorded for the plantings made from the first fortnight of June to the first fortnight of October (Fig. 3) and the associated weather conditions were characterised by a moderately higher rainfall (8.0 to 26.2 mm.) and a uniformly high level of relative humidity and the fluctuation of temperatures within a comparatively narrow range from 21.5° to 29.8° G. The minimum occurrence of dead hearts were recorded for the crop planted within the same period i.e. from the first fortnight of June to the first fortnight of October.

Table 4

Partial correlation coefficients between the percentage of white earheads caused by *T. incertulas* at 75 days after planting (I) and climatic factors.

Rainfall for upto 75 DAP (2)	Mean relative humidity for upto 75 DAP (3)	Mean minimum temperature °C for upto 75 DAP (4)	Mean maximum temperature °C for upto 75 DAP (5)
NS	NS	NS	NS
$r_{2\cdot3}$ = -0.1142	$r_{13\cdot2}$ = -0.019	$r_{14\cdot2}$ = -0.0720	$r_{15\cdot2}$ = -0.0347
= -0.2773	= −0 2834	NS = -0.1584	NS = -0.0383
= -0.2242	NS $r_{13\cdot5}$ -0.104	NS = -0.1272	NS r_{1} = +0.2015
NS $r_{12\cdot34}$ = -0.0273	NS $r_{13\cdot24}$ = −0 0645	NS $_{3}$ = -0.1118	NS r_{1} $_{4}$ = -0.0068
* $r_{12\cdot35}$ = -02264	NS $r_{13\cdot25}$ = +0.1796	NS $_{5}$ = −0.0692	NS r_{15} 0.1378
NS .45 = -0.1981	NS $r_{13\cdot45}$ = −0.1289	NS $r_{14\cdot35}$ = −0.1114	NS $r_{15\cdot34}$ = 0.0986
NS $r_{12\cdot345}$ = −0.1560			

Significant at 5% level. ** Significant at 1% level. NS Non significant.

Table 5 gives the partial correlation coefficients involving the percentage occurrence of white earheads at 75 days after planting and the different weather components. It is indicated that the significant negative correlation between the percentage occurrence of white earheads and rainfall remains negative even after eliminating the effects of minimum and maximum temperature individually ($r_{12.4}$ and $r_{12.5}$). But joint elimination of these two factors and on additional elimination or mean relative, humidity, the correlation coefficient fails to attain significance ($r_{12.45}$ and

The significant negative relationship beetween the percentage of white earheads and relative humidity fails to attain significance on elimination of rainfall ($r_{13.2}$ and maximum temperature ($r_{13.5}$) and jointly ($r_{13.25}$). But when minimum temperature is eli correlation retains significance and maintains the negative trend ($r_{13.4}$). This evidently suggests the manifestation of the association between these variables independent of the fluctuations occurring in minimum temperature. However, when both these factors viz., minimum and maximum temperatures are jointly eliminated, the correlation coefficient ($r_{13.45}$) becomes non-significant indicating the joint influence of these two meteorological factors on the incidence of white earheads.

The negative relationship detected to occur between percentage of white earheads and minimum temperature and the positive relation existing between the former and the maximum temperature loose their significance when other meteorological components are eliminated jointly and individually. This leads to the conclusion that the association between minimum and maximum temperatures on the one hand and the percentage incidence of white earheads on the other is influenced by fluctuations in the rest of the weather factors.

Summary

Studies were carried out at the Rice Research Station, Pattambi, Kerala to ascertain the extent of damage caused by the rice stem borer *Tryporza incertulas* Walker) to IR 8 paddy crop planted at different fortnightly intervals commencing from the first fortnight of June to the second fortnight of January during the years 1967-68 to 1971-72. The influence of rainfall, relative humidity, minimum and maximum temperatures on infestation by the pest WES also asses ed.

The pest incidence was assessed on the basis of the occurrence of dead hearts at 45 days after planting and of white earheads at 75 days after planting. Maximum borer infestation was recorded in the plantings

done during the period from the first fortnight of October to the first fortnight of January, while the lowest pest incidence was observed in the plantings done during the period from the first fortnight of June to the first fortnight of October.

The percentage incidence of dead hearts and white earheads were both correlated negatively with rainfall and minimum temperature and positively with maximum temperature. The percentages of white earheads and relative humidity were negatively correlated. Partial correlation studies revealed the joint influence of rainfall, relative humidity and mean minimum temperatures on stem borer infestation.

Acknowledgement

The authors are grateful to Sri. E. J. Thomas, Professor of Statistics, College of Agriculture, Vellayani, for the help rendered in statistical analysis of the data and interpretation of results.

REFERENCES

Banerjee, S. N. and Pramanik, L. M. 1964. Lepidopterous stalk borers of rice and their life cycles in the tropics. *Proc. Symp. at the Int. Rice Res. Inst.*, Sep. 1964, Johns Hopkins Press, Baltimore, 1967: 103-124.

Central Rice Research Institute. 1960. Annual report, 1957-58, Cuttack, 6 : 53-59.

Doke, N. 1936. On the effect of temperature and moisture on the biology of *Chilo simplex* Butler; I *Oyo Doubts. Zasshi*, 8: 87-93.

Harukawa, C., Takato, R. and Kumashiro, S. 1931. Studies on the rice borer *Chilo simplex* Butler. II. Effect of constant temperature upon the development of the rice borer (I). *Ber. Ohara Inst. Landwirt Forsch.*, Kurashiki, **5**(1) : 209-220.

Indian Council of Agricultural Research, 1963. Coordinated scheme for research on the rice stem borer. Report for *1962-63,* ICAR Rice Comm. Meet., May, 1964.

Kiritani, K. and Iwao, S. 1964. The biology and life cycle of *Chilo suppressalis* (Walker) and *Tryporyza Incertulas* (Walker) in temperate - climate areas. *Proc. Symp. at the* tot. *Rice Res. Inst* , Sept. 1964, Johns Hopkins Press, Baltimore, 1967: 57.

Khan, M. Q. and Murthy, D. V. 1955. Some observations on the rice stem borer *(Schoenobius incertulas* Walker) in Hyderabad State. *Indian J. Ent.* **17** (2) : 175-182.

Koshy, E. P. and Lakshmy, T. R. 1969. The seasonal occurrence of the rice stem borer in Kuttanad (Kerala). *Agri. Res. J. Kerala,* 7(2) : 132.

Lin, Y , Zhu, Z Q., Hu, J. Q., Pei, S. W. and Yeh, J. C. 1959. Studies on the prediction of the outbreak of the paddy borer *Schoenobius incertulas* Walker with effective thermal summation I the minimum temperatures of development and effective thermal summations. *Acta. Entomol. Sinica, 9 (5)* : 423-425

Parker, J. R. 1930. Some effects of temperature and moisture upon *Melanoplus mexicanus* Saussaue and *Camnula pellucida* Scudder (Orthoptera) *Bull. Univ. of Montana Agrl. Expern. Sta.,* 223 : 1-132.

Pawar, M. S. and Rajagopalan, K. 1956. Rice cultivaiion in Nizamabad (Hyderabad). *Rice News Teller, 4* (2): 87-102.

Peairs, L. M. 1927. Some phases of the relation of temperature to the development of insects. *Bull.* West *Va. Agrl. Exper. Sta.* 208 : 1-62.

Tao, R. H. and Tang, R. R. 1960. An ecological study of rice borers in Taiwan and a discussion on the proper period for insecticide control, *Plant Prot. Bull.* Taiwan, 2 (3): 75-82.

(MS. *received: 5-7-1973)*