# A STUDY OF PADDYSTEM BORER (SCIRPOPHAGA INCERTULAS) POPULATION DYNAMICS AND ITS INFLUENCE FACTORS BASE ON STEPWISE REGRESS ANALYSIS

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Abstract: Paddystem borer (Scirpophaga incertulas) is a serious rice pest. The damaged plants wither into dead tassel or white tassel. Such damage leads to decreased in rice production. In order to control the damages of paddystem borer efficiency, it is very important to analyze and study the regulation of population dynamics and the related factors affecting the development. This investigated the population dynamics of paddystem borer by means of light trap in JianShui County in Yunnan of China during 2004 to 2006, and analyzed the meteorological conditions affecting the population dynamics. The research suggests that: there exists a significant relationship between the population dynamics of paddystem borer and meteorological factors, among it, The most influenced are the average minimum temperature per month and relative humidity (RH).

KeyWords: paddystem borer (scirpophaga incertulas), stepwise regress analysis, population dynamics, meteorological factors

## 1. INTRODUCTION

Paddystem borer (Scirpophaga incertulas) is commonly known as borer, belong to Lepidoptera, Pyralidae, and a serious rice pest in tropical to sub tropical Asia. It is in the South Asian subcontinent, Southeast Asia , south of Japan and in most rice areas of south of the Yangtze in China. Paddystem borer feeding a single, designed to rice for food, Insect larvae bore the rice plant the damaged plants wither into dead tassel in stooling stage, and by boot stage to heading stage, it becomes death booting and white tassel, and heteroicous cause to the incidence of damaged rice plants. The "dead tassel" and “white tassel” are the main symptoms of rice seedlings damaged(Li Y R, 2002).

Paddystem borer (Scirpophaga incertulas) overwintering in rice stubble with mature larva, when temperature was about 16℃ in Spring, the pupation emergence and fly to paddy to spawn. There are 2-4 generations in a year, the occurrence period and the harm of each generation are as the followings: the first generation is in the first and second decade of June, do harm to the early rice and early medium rice, cause the plant to appear to dead tassel; the second generation is in July, do harm to the single late rice and Middle-Large Rice, cause the plant to appear to dead tassel, and do harm to the early rice and early medium rice, cause the plant to appear to white tassel; the third generation are from the middle ten days of August to the first ten-day of September, do harm to the Double-cropping Late Rice, cause the plant to appear to dead tassel, do harm to the Middle-Large Rice and single late rice, cause the plant to appear to white tassel; the forth generation is in September and October, do harm to the Double-cropping Late Rice and cause the plant to appear to white tassel(Lan X M,Yang F,Liang K Z,2002. Sun J,Wei G,Zhou X et al.,2003).

This paper utilize the pest population data which collected in JianShui County in Yunnan during the years 2004-2006, while the meteorological data in the corresponding period were acquired from JianShui County Meteorological Observatory, built the model of Stepwise Regress on Paddystem borer population Dynamics. First based on the 6 meteorological factors which effect Paddystem borer population, With the methods of regression, choose the most significant factor which influence the population, then establishes the corresponding models, and examine the pest population data in 2004-2006, finally obtain the most significant factor which influences the population.

# 2. MATERIALS AND METHODS

## 2.1 Datasets

The staff investigated the cardinal number of paddystem borer every November to December in JianShui County in Yunnan, in main rice producing area in JianShui County in Yunnan,. And observed the paddystem borer population in XiZhuang Town and recorded the data of the pest dynamics in next March to October.

The distribution of the paddystem borer in the field depends on the rice variety. The samples wouldn't correspond the actual field situation if the samples number is too small, because lots of different conditions in the field parcels affect pest population. Phototaxis of the paddystem borer is very strong. So black light trap for catching moth is useful because that the trapping area is large and fixed; the trapping data is representative. Though weather condition such as, raining or windy, is harmful for light trap catch of the moth, it effects the emergence period of the moth only, does not affect the quantity of the moth. Thus, the moth data from the light trap is effective for the primary data analysis.

*Tab 1* Collecting Data of Paddystem Borer's Monthly Occurrence Quantityin Jianshui County from 2004-2006

| Year | Jan | Feb | Mar | Apr | May | June | July | Aug. | Sep. | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | 0 | 0 | 15 | 190 | 2 | 0 | 0 | 1654 | 7456 | 0 | 0 | 0 |
| 2005 | 0 | 0 | 0 | 156 | 838 | 1342 | 677 | 18744 | 4206 | 0 | 0 | 0 |
| 2006 | 0 | 0 | 0 | 122 | 6 | 516 | 890 | 15748 | 838 | 0 | 0 | 0 |

The meteorological data such as the monthly average temperature, the high and the low temperature, Rainfall, evaporation and relative humidity are acquired from JianShui County Meteorological Observatory and were used for the primary data analysis.

## 2.2 Paddystem borer

There are 4 generations paddystem borer in a year in JianShui County. Usually the first generation lasts between last ten-days of March until the beginning of May. The pest devours the rice sprouts and the early transplanted rice seedling during this generation. The damaged plants wither in the actively growing shoots. The second generation often lasts between the first ten-days of June and mid July. Mid-season planted rice suffers damage from this generation and plants appear to have white tassels. The third generation lasts from the beginning of August until the last ten-days in

September. Late-growing plants suffer from the pest damage in this period. The last generation always begins in October and it over winters.

*Tab 2* Meteorological Data in Jianshui County from 2004-2006

| Years | Month | Jan | Feb | Mar | Apr | May | June | July | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2004 | Average Temperature (℃) | 13.2 | 14.2 | 19.6 | 20.1 | 22.1 | 23.1 | 23.1 | 23.2 | 21.8 | 18 | 15.9 | 12.1 |
| | Max-temperature (℃) | 24.6 | 26.9 | 31.6 | 32.5 | 32.5 | 31.8 | 32.7 | 32 | 30.1 | 29 | 27.3 | 22.6 |
| | Min-temperature (℃) | 3 | 1.6 | 6 | 11.4 | 11.9 | 15.4 | 17.3 | 17.6 | 14.4 | 8.7 | 5.1 | 2.1 |
| | Rainfall (mm) | 8.6 | 24.3 | 0.2 | 104 | 133.5 | 151.5 | 162 | 96.8 | 196.1 | 13.3 | 22 | 4.6 |
| | Evaporation (mm) | 151.6 | 168 | 250.9 | 213.7 | 231.5 | 185.4 | 166.3 | 158.3 | 131.4 | 124.7 | 121.1 | 116.9 |
| | relative humidity (%) | 64 | 65 | 57 | 67 | 67 | 73 | 76 | 81 | 79 | 77 | 74 | 69 |
| 2005 | Average Temperature (℃) | 13.1 | 17.7 | 16.6 | 21.6 | 25 | 24.3 | 23.6 | 22.8 | 21.8 | 19.4 | 16.2 | 12.3 |
| | Max-temperature (℃) | 27.5 | 27.3 | 30 | 31.1 | 33.4 | 31.6 | 31.6 | 31.5 | 29.7 | 30.1 | 29 | 26.5 |
| | Min-temperature (℃) | 3.8 | 5 | 2.5 | 8.8 | 15.4 | 18.4 | 17.5 | 17.4 | 14.3 | 10.2 | 7.4 | 2.2 |
| | Rainfall (mm) | 26.6 | 0.3 | 44.5 | 37.9 | 22.3 | 165.7 | 103.5 | 163.6 | 39.8 | 89 | 46.9 | 36.3 |
| | Evaporation (mm) | 144 | 230.2 | 201.8 | 258 | 347.1 | 196.7 | 219.2 | 183.2 | 144.5 | 103.6 | 79.6 | 72.8 |
| | relative humidity (%) | 68 | 50 | 64 | 60 | 52 | 75 | 78 | 82 | 77 | 76 | 78 | 77 |
| 2006 | Average Temperature (℃) | 13.7 | 16.9 | 19.5 | 22.3 | 21.7 | 24.4 | 23.8 | 22.5 | 21.2 | 20.1 | 16.9 | 13 |
| | Max-temperature (℃) | 25.4 | 27.2 | 30.3 | 32.8 | 32.7 | 32.2 | 31.1 | 30.4 | 31.7 | 28.9 | 27.9 | 24.3 |
| | Min-temperature (℃) | 3.5 | 8.4 | 6.2 | 12.4 | 10.4 | 17 | 17.1 | 16.8 | 13.1 | 13.6 | 5.3 | 1.9 |
| | Rainfall (mm) | 0 | 5.9 | 1.3 | 85.7 | 88.1 | 94.4 | 205.9 | 75.4 | 65.9 | 143.6 | 9.2 | 0.9 |
| | Evaporation (mm) | 125.2 | 141.3 | 226.7 | 241.2 | 172.8 | 176.1 | 132.6 | 121.9 | 120.6 | 93.3 | 125.1 | 88.8 |
| | relative humidity (%) | 65 | 64 | 53 | 54 | 67 | 70 | 80 | 81 | 74 | 80 | 67 | 73 |

## 2.3 Stepwise Regress Analysis

This paper analyzes and studies the relationship between the paddystem borer population and meteorological factors by means of Stepwise Regress Analysis.

Stepwise Regress Analysis is to choose the Variables which has effective influence among the Variables related to Y(dependent variable) ,then use this variable to establish regression equation. Namely, include the factors which influenced Y as much as possible, and outstand some main factors at the same time. Mainly concludes the following steps: 1) Calculate the simple correlation coefficient matrix between each Variables, the Correlation of preliminary analysis, and the correlation between each Variables. and observe whether it has multicollinearity phenomenon. 2) Establish multiple

linear regression equation with least square method, and do the Goodness-of-Fit Test for the equation. 3) If multiple linear regression equation has a good Goodness-of-Fit Test, it will calculate the T statistic of each regression parameter, Significance test on each Parameters, to reject non-significant factors under the level of significance a. 4) After rejecting non-significant factors, Re-establish multiple linear regression equation to the other variables, and do the significance test on each parameter till each factor is significance under the given level of significance a, under above conditions, the regression equation is the high Goodness multiple linear regression equation(WANG M C,SHENG H F, 1999).

## 3. RESULTS AND ANALYSIS

### 3.1 Data Selections

This paper get the monthly Occurrence Quantity of paddy borer adult by means of the traps quantity 10 areas per week in three years in Jianshui County in Yunnan Province of China from 2004-2006; choose 6 meteorological factors-monthly Average Temperature, monthly relative humidity, monthly rainfall, monthly evaporation, monthly max-temperature and min-temperature-as the influence factors to analyze. The reason to choose monthly max-temperature and min-temperature is because the pest will inhibit paddy borer larvae development and reproduction lower than 15℃ or higher than 35℃, this will effect the population of adult directly; the reason to choose monthly rainfall and monthly evaporation is because these two factors decide the humidity, it will effect the pest's development; the reason to choose monthly relative humidity and monthly rainfall is because the two factors effect the larvae survival

Law of Occurrence Quantity of paddy borer adult in 2004-2006

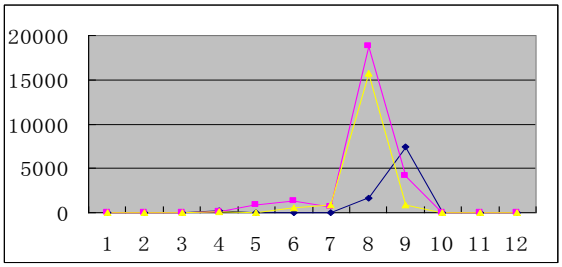


*Fig 1* Occurrence Quantity of Paddy Borer Adult in 2004-2006

## 3.2 Stepwise Regress Analysis

Set up population of adult(Y), monthly Average Temperature(X1), monthly max-temperature(X2) , monthly min-temperature(X3), rainfall(X4), evaporation(X5), relative humidity(X6). To deal with these relative data by means of regression method, then get correlation coefficient matrix are as the following

| | | | | | | |
|---|---|---|---|---|---|---|
| 1.000 | 0.825 | 0.927 | 0.675 | 0.493 | 0.146 | 0.299 |
| 0.825 | 1.000 | 0.735 | 0.525 | 0.443 | 0.062 | 0.161 |
| 0.926 | 0.735 | 1.000 | 0.773 | 0.232 | 0.428 | 0.414 |
| 0.675 | 0.525 | 0.773 | 1.000 | 0.000 | 0.545 | 0.332 |
| 0.493 | 0.443 | 0.232 | 0.000 | 1.000 | -0.674 | -0.060 |
| 0.146 | 0.062 | 0.428 | 0.545 | -0.674 | 1.000 | 0.414 |
| 0.299 | 0.161 | 0.414 | 0.332 | -0.060 | 0.414 | 1.000 |

partial regression square sum is:

V( 1 )= 0.089 V( 2 )= 0.026 V( 3 )= 0.171 V( 4 )= 0.110

V( 5 )= 0.004 V( 6 )= 0.171

F3( 3 )= 7.034

So we can get the important of each effected factors, the effect of X3 is equal to the effect of X6.

First introducing a variable X3 in regression model, then get correlation coefficient matrix is as the following

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.142 | 0.144 | -0.927 | -0.041 | 0.279 | -0.250 | -0.085 |
| 0.144 | 0.460 | -0.735 | -0.044 | 0.272 | -0.253 | -0.143 |
| 0.926 | 0.735 | 1.000 | 0.773 | 0.232 | 0.428 | 0.414 |
| -0.041 | -0.044 | -0.773 | 0.403 | -0.179 | 0.214 | 0.012 |
| 0.279 | 0.272 | -0.232 | -0.179 | 0.946 | -0.773 | -0.156 |
| -0.250 | -0.253 | -0.428 | 0.214 | -0.773 | 0.817 | 0.236 |
| -0.085 | -0.143 | -0.414 | 0.012 | -0.156 | 0.236 | 0.829 |

Table of Variance Analysis :

| Source of variation | DF | SS | MS | F |
|---|---|---|---|---|
| Regression | 1 | 0.171 | 0.171 | 7.034* |
| Off-regression | 34 | 0.829 | 0.024 | |
| Total | 35 | 1 | | |

Second introducing a variable X6 in regression model, then get correlation coefficient matrix is as the following

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.065 | 0.066 | -1.058 | 0.025 | 0.042 | 0.306 | -0.012 |
| 0.066 | 0.381 | -0.868 | 0.023 | 0.033 | 0.310 | -0.070 |
| 1.058 | 0.868 | 1.224 | 0.660 | 0.637 | -0.524 | 0.290 |
| 0.025 | 0.023 | -0.660 | 0.346 | 0.024 | -0.263 | -0.050 |
| 0.042 | 0.033 | -0.637 | 0.024 | 0.215 | 0.947 | 0.067 |
| -0.306 | -0.310 | -0.524 | 0.263 | -0.947 | 1.224 | 0.289 |
| -0.012 | -0.070 | -0.290 | -0.050 | 0.067 | -0.289 | 0.760 |

Table of Variance Analysis :

| Source of variation | DF | SS | MS | F |
|---|---|---|---|---|
| Regression | 2 | 0.24 | 0.12 | 5.204* |
| Off-regression | 33 | 0.76 | 0.023 | |
| Total | 35 | 1 | | |

Regression Equation:

Y= -9936.184+(211.567)*X( 3 )+(132.899)*X( 6 )

So the best regression equation of the model:

Y= -9936.184+(211.567)*X( 3 )+(132.899)*X( 6 )

Through the calculation we can drawn, after we introduce two factors, monthly min-temperature and relative humidity, standard deviation of the model of data simulation is 3720.721, multiple correlation coefficient is 0.49, it has already reached the acceptable results to over 75%.

According to the final regression equation, we know that the main factors which influence the Paddystem borer Population Dynamics are monthly min-temperature and relative humidity. That means along with the raise of monthly min-temperature and increase of relative humidity, the quantity of Paddystem borer adult has been increased. When enter into March in there, the average temperature may reach 16℃, Paddystem borer begins to propagation, and along with the coming of raining season and the further upturn of the temperature, the occurrence quantity of Paddystem borer rapid increment from July to September, and it will reach peak value in September, In October, along with the end of raining season, the quantity of Paddystem borer begins to decrease, till not appear any more. In Fig 1, we can see, the occurrence quantity in 2004 is different from the other two years, after comparing 3years temperature information, we found the raining season was later in 2004, the temperature was higher, the evaporation was also higher, and the rainfall amount was few obviously, these reason cause the difference of occurrence quantity of Paddystem borer between 2004 and other two yeas.

## 4. CONCLUSION

This paper analyze and study the paddystem borer population and meteorological factors such as the monthly average temperature, the high and the low temperature, Rainfall, evaporation and relative humidity in the same period by means of Stepwise Regress Analysis. Establish the relative regression model, and examine the data from 2004-2006, get the result that the occurrence quantity of Paddystem borer has a tight relationship with the monthly min-temperature and relative humidity in the same period. This research result laid a foundation of the further research work such as the

research of the occurrence period of Paddystem borer, the occurrence quantity of Paddystem borer, the prediction of high peak period of Paddystem borer, etc.

## ACKNOWLEDGEMENT

The findings and the opinions are partially supported by the Mega-projection of National Key Technology R&D Program for the 11th Five-Year Plan "Research on Information Technology of the ecological environmental protection in rural areas" (2006BAD10A14) and by the Technological Innovation projection of Yunnan Province "Research on Standard Producing Information Project of Organic Vegetables". This work is also supported by the Yunnan Agricultural University (China) and by the University of Electronic Science and Technology (China).

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