ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 12, Issue, 10, pp.14542-14544, October, 2020

DOI: https://doi.org/10.24941/ijcr.40080.10.2020

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

FORMATION FOR MATHEMATICAL MODELING OF *TRICHOGRAMMA JAPANICUM* AGAINST YELLOW STEM BORER (*Scirpophaga Incertulas*)

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ARTICLE INFO

Article History:
Received 20th July, 2020
Received in revised form
27th August, 2020
Accepted 19th September, 2020
Published online 30th October, 2020

Key Words:

Yellow Stem borer, *Trichogramma japanicum*, Life table, Equilibrium Point.

ABSTRACT

Food is the basic human need and producing enough to feed the growing population of developing nations is one of the biggest challenges faced by modern world. Next to wheat rice is one of the top most food grain consumed worldwide. Rice production plays a major role of the national agricultural economy of India. India holds the second position in rice production of all over the world. International Rice Research Institute (IRRI) finds that on average, farmers lose 37 percent of their rice yield to pest and diseases. In India the annual crop losses due to insect pests and diseases are about 38 percent. Worldwide more than 100 species of insects are recorded in rice production, out of which about 20 species cause significant economic damage amongst various pests affecting the paddy crop. The yellow stem borer (*Scirpophaga Incertulas*) contributes 90 percent of damage in the paddy field, especially during the rainy season. The four different methods are generally practiced to control yellow stem borer are cultural control, varietal resistance, chemical control and biological control. The chemical control method may contribute to decline in wildlife and create harmful impact on human health; through the biological control method the pest can be controlled by stirring up other living organisms. The biological control method helps to destroy only the harmful pests and it does not affect any beneficial insects like a human being. Hence this study was taken up and its result will be useful for scientist's to work out for a biological control to support the ultimate beneficiary of the farming community.

Citation: ***Dr. P. Sujatha, Dr. P. Yasodha and Dr. S. Anandhi.*** **2020.** "Formation for mathematical modeling of *trichogramma japanicum* against yellow Stem borer (Scirpophaga Incertulas)", *International Journal of Current Research*, 12, (10), 14542-14544.

INTRODUCTION

Mathematical models are intellectual tools. This model is defines and understands the system of pest and beneficial insects. The life cycle of yellow stem borer, different methods to control stem borer, advantages and disadvantages of various pest controlling methods are analysed. Ecological processes are usually specific to organism's age or stage. The biological events such as birth and death are usually specific to the age or stage of development of individuals. The pest reproduction takes place only during a part of life time of the female insects. The life cycle of insects is egg, larvae, pupae and adults stages. The reproduction takes place only at the adult stage but egg and larvae are infesting the paddy crop. The two types of life tables are age dependent and stage dependent life tables. The age dependent life tables are constructed for the beneficial insects. Age dependent life tables are used to find out the life expectancy of beneficial insects. The stage dependent life tables are constructed for the pest to measure the mortality at different stages.

This Research was undertaken with an aim to construct the life table of key mortality factors of rice stem borer and *Trichogramma japanicum*. The population growth cannot grow exponentially only on logistical model. The logistical model is the most important and commonly used models both by the biologists and by the mathematicians.

By fitting the logistical model for the life table analysis data, the density dependent relationship in rice stem borer and its equilibrium level is calculated the qualitative behavior of populations of steady and equilibrium states of logistical model with harvesting stage are calculated. By applying logistical model to develop a simple mathematical model of interaction between the rice stem borer and its egg and larvae parasitoid *Trichogramma Japanicum*. The relation between yellow stem borer toward the egg parasitoid can be found.The proposed model is attempted to solve the values at stability of equilibrium points. The economic threshold level is calculated by applying the present market value of paddy and it is compared with the results of stability conditions.

REVIEW LITERATURE

There are several articles (D.D. Patait 2009, Arshad Ali 2010, D. Pratissoli 2004, A.M. Kakde 2014) dealing with life table analysis on sugarcane, cabbage and other such crops. Roy and Bains, Marat Rafikov have applied mathematical model and stability condition for controlling sugarcane borer. Yet, none of the study has been taken up by applying mathematical models for analyzing paddy crop pest. Hence the present study was undertaken to construct a mathematical model for controlling pests in rice. A simple mathematical model was constructed to study interaction between rice stem borer (*Sciropophaga Incertulas*) and its egg parasitoid *Trichogramma Japanicum*. In this model the yellow stem borer is represented by the egg and the larval stages, and the parasitoid is considered in terms of parasitized eggs. It is proposed to indicate the number of natural enemies to be introduced into the environment with an aim to control the rice stem borer and its economic benefits are compared with the economic threshold level of the present paddy value.

METHODOLOGY

A non-replicated field experiment on rice field was conducted at the f Agricultural Engineering College farm Kumulur during the rainy season of 2014-15 and the variety ADT 49 was transplanted with a spacing 1' feet of three week old seedlings to the main field. Frequent field visits were made on daily known number of eggs were collected along with the plant material. On hatching the tiny larvae were reared in small plastic boxes individually on paddy till the cessation of pest population in the field. The *Trichogramma Japonicum* egg mass are spread in the rice field. The enhanced *Trichogramma Japonicum* in the field has been observed every day. It was identified that *Trichogramma Japonicum* eggs are emerged in 0 to 10 days.

This age specific life table is used to calculate the expected life time of the *Trichogramma Japonicum*. Non-replicated field experiment on life tables and key mortality factors of yellow stem borer (*scirpopherga incertulas*) infesting rice field was also conducted in the same field. Frequent field visits were made in alternative days. The appeared eggs in the field were collected along with the plant material. The individual tiny larvae were reared in small plastic boxes and paddy was laid upon it till it is hatching. This laboratory culture was used as a check culture for deciding on the number of regular generations of the pests in the field conditions. The sampling of early and late inster larvae was conducted on the basis of development of the pests in laboratory reared culture. The number of larvae of target pests are carefully observed and examined on alternative days for a week. The larvae collected in the field are reared on paddy in the laboratory. This is referred to as field culture. Fresh green straw were applied on the larvae till it emerges as an adult. Three new differential equations are formed at egg and larval stages of yellow stem borer (*scirpopherga incertulas*). By using these three equations and linear feedback control strategy that were proposed to indicate the natural enemies introduced into the environment the stability condition and equilibrium point were applied to solved the differential equations.

- Two types of life table were constructed for field data.
- Age specific life table was constructed for the values of net reproductive rate, Mean generation time and calculating intrinsic rate of beneficial insect (*Tricogramma Japanicum*).
- Stage specific life table was constructed for the value of expected egg, trend index, generation survival, Killing power are calculated by the targeted pest yellow stem borer (*scirpopherga incertulas*) .
- Stage specific life table data is fit with the density dependent logistic growth model of yellow stem borer (*scirpopherga incertulas*). To find out the carrying capacity of stem borer. Stability of equilibrium states of single spices model is also used.
- Logistical model is also correlated and the same model is tested with harvesting technology. To find the quantity maximum sustained yield in rice.
- By adopting the logistical model and its interaction between the rice stem borer and parasitoid *Trichogramma Japanicum*, differential equations were formulated.
- Three different equilibrium points were calculated by applying logistical differential equations. The three points are trivial point, non-negativity of larvae population and non-negativity of parasitized egg population.
- Economic threshold level (ETL) is calculated by present values of paddy per kilogram and the cost of cultivation of rice per acre and the same has been compared with the result of the present study.

CONCLUSION

This research work established a suitable the logistical model to control the yellow stem borer (*Scirpophaga Incertulas*) biologically (*Trichogramma Japonicum*) in paddy crop at the field condition. The application of logistical model becomes mandatory as several experts practice this model to fit the curves. The results of this mathematical study are applied in agricultural field experiments, that explicit the positive results. The strength of the pest population and its life cycles were calculated and it is fit with the corresponding model. Further the logistical curves were expended to single species into two different stages of three differential logistical equations and they were solved. The three equilibrium points and their stability conditions were calculated.ETL was calculated by using cost cultivation for paddy per acre and the present value of paddy price was taken for consideration. These two results were compared at three stages adopting life table analysis data to release the *Trichogramma Japonicum* egg in the paddy field. Biological control method is economical, eco friendly and feasible from farmer's point of view.

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