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RESEARCH ARTICLE

MODELING AND ANALYSIS OF DISCRETE POPULATION GROWTH MODELS OF ENTOMOLOGICAL DATA COLLECTION FOR TRICHOGRAMMA JAPONICUM

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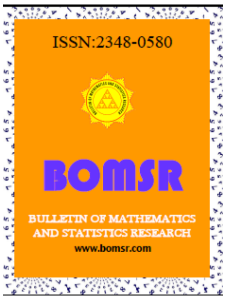

ABSTRACT

Rice is the most important food crops in worldwide. In Tamil Nadu rice is cultivated in three season of each year. Total cultivated area in Tamil Nadu 18lacs hater. The state achieved high record production of 10.1 million tons of food grains and it ranked second in the productivity of paddy. Among the various pests of rice inflicting yield loss. This model is developed for discrete population growth model of the data collections using in entomology are considered. The most important pest in paddy field is yellow stem borer. Behavior of variation data with respect to changing optimal age of sexual maturity and generation time intrinsic rate of natural increase is analyzed. In particular it was shown that dependence of generation time at age weighted fecundity is maximum. This above value is also calculating by set of Euler equation to improve the value of intrinsic rate of natural increase by applying Newton Raphson Method.

1. INTRODUCTION

One important aspect of the biological processes is their evolution over time. This includes their growth in isolation and in interaction with the environment. The dynamic behaviors of these processes have been extensively studied both by biologists and mathematicians to develop and empirical studies. In mathematical models these concepts are translated into the mathematical equations the solution of which predicts the behavior of the biological population under study. In population ecology the number of individuals (size) at time ‘t’. The model is describe the size population at time‘t’ by differential difference equation. In discrete models time is divided into discrete unit generations. The life table studies survivorship development and expectation of life (Ali and Rizvi; Yzdani and samih 2012 gabre et al., 2004). Specific mortality factor acting on insect population (Harcourt, 1969; Bellows etal.,1992; Mohapatra,2007).

2. Materials and Methods

2.1. Materials.

A non-replicated field experiment on rice field was conducted at the farm of Agricultural Engineering College, 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. 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 instar larvae was done on the basis of development of the pests in laboratory reared culture. At each observation, it was carefully examined on day to day in a week days for the number of larvae of target pests. The field collected larvae were brought to the laboratory and reared on paddy. This was referred to as field culture. Fresh paddy leaves were provided as and when required. The culture was reared till adult emergence.

2.2. Net reproduction rate

Net reproduction rate is average number of offspring produced per individual per generation the value of individuals who survive to the age x. Let us divide each of these quantities by the radix, the initial population size l_x .

$$l_x=\frac{Number\ \ of\ individuals\ \ who\ survive\ \ to\ the\ begining\ \ of\ age\ x}{redix}$$

The ratio of l_x gives the proportion of individuals who survive to the age x. m_x be the age-specific fecundity. The product $l_x m_x$ gives the expected number of offspring an individual of age x will produce summing over all possible ages of life span and denoting the sum by R_0.

$$R_0=\ \sum_{x=0}^{x=k} l_x m_x$$

where k is maximum life span of individual R_0 is a measure of average number of offspring an individual in a population produce in life time is net reproductive rate per generation. If R_0 >1 the population increasing if R_0 <1 it is decreasing, and If R_0=1 on an average an individual produces one offspring during its life time and also the population size is stable.

2.3. Mean Generation Time

The average age at which an individual birth to new offspring is T

$$T=\frac{\sum_{x=0}^{x=k}\ x l_x m_x}{\sum_{x=0}^{x=k}\ l_x m_x}$$

Using Exponential growth model

$R_0=\frac{N_{t+T}}{N_t}$ and $N_t=N_0\mathbf{e^{rt}}$ r is intrinsic rate of natural increase on the innate capacity for increase .

$R_0=e^{rT}$ $r=\frac{\log R_0}{T}$

If the population is grow geometrically in discrete time $R_0=\lambda^T$ $e^r=\lambda$.

2.4. Euler Equation

The intrinsic rate of natural increase r reaches a maximum and is r_m

$$\sum e^{-r_m x} l_x m_x = 1$$

B(t) is total number of births produced for the whole population of the current time t. The new births are produced by individuals of different age category at time t. consider individuals of age category x they all are born at time (t-x) and B(t-x) is the total number of births at that time. $B(t-x)l_x m_x$ is the contribution to the total pool of new births at the current time t by individuals are currently age x.

$$B(t)=\sum B(t-x) l_x m_x$$

The population has reached stable age distribution is exponentially

$$B(t)=B_0e^{r_m t}$$

$$B(t-x)=B_0e^{r_m(t-x)}$$

$$B_0e^{r_m t} = \sum e^{r_m(t-x)} B_0\, l_x m_x$$

$$1=\sum e^{-r_m x}\, l_x m_x \text{ is Euler equation.}$$

This is non linear in r and hence numerical methods can be applied to obtain the value using Newton Raphson method gives the recurrence relation between successive approximation of r_m.

$$r_m^{(n+1)}=r_m^{(n)}+\frac{\sum e^{-r_m^{(n)}x}\, l_x m_x - 1}{\sum x e^{-r_m^{(n)}x}\, l_x m_x}.$$

Result and Discussion

The number of alive n_x is high at first larval instar, it highly decreased form 50-10 at the second larval instar. The Net Reproductive Rate is 5.51. The Generation Time 4.9365 and the intrinsic rate of a stable age distribution are 0.15014. The net reproductive is more than one then population growth function is normally increasing. The more accurate value of r estimated using Euler's equation and applying Newton – Raphson method by the recurrence relation using MATLAB programme .The r value is 0.15391 and the optimal age for sexual maturity is 5 days age.

Table: 1

Age x (Days)	Number of survivals at the beginning of age x(n_x)	No. of offspring produced per individuals (m_x)
0	200	0
1	190	0
2	157	1
3	130	1
4	102	2
5	80	3
6	76	2
7	50	1
8	49	1
9	40	3
10	0	0

Table: 2

Age x (days)	Survival Rate $l_x = \frac{n_x}{n_0}$	Fecundity m_x	Offspring/individual $l_x m_x$	Age weighted Fecundityx$l_x m_x$
0	1.000	0	0	0
1	0.950	0	0	0
2	0.785	1	0.785	1.50
3	0.650	1	0.65	1.95
4	0.510	2	1.02	4.08
5	0.400	3	1.2	6.00
6	0.380	2	0.76	4.56
7	0.250	1	0.25	1.75
8	0.245	1	0.245	1.96
9	0.200	3	0.6	5.40

10	0.190	0	0	0
Total			R_0=5.51	27.2

Net Reproductive Rate R_0 = 5.51

The generation time T=4.9365 days

The intrinsic rate r = 0.15014

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