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Effect of Seasonal Variation on Life Table of Brown Plant Hopper *Nilaparvata lugens* Stål on Rice Plant in Eastern India

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Abstract: The seasonal variation on life table of the brown planthopper *Nilaparvata lugens* Stål(BPH) in Eastern India indicated that the net fecundity rate (R_o) is higher in rainy season (79.24) than winter (36.43). Identical trends of the net reproductive rate (R_t) and intrinsic rate of increase (r_m), finite rate of increase were observed as 31.51 and 0.1286023, 1.1372370 in rainy/kharif season and 9.38, 0.0702774, 1.0728057 in winter respectively. Although the weekly multiplication (r_w) of BPH is higher in rainy/ kharif (2.4601354) than winter/ rabi (1.66469120) but the mean length of generation (T) and doubling time of population (DT) were lower in rainy/ kharif (34.00,5.38) than winter/ rabi as recorded 51.16, 9.86 in the plains of west Bengal during 2010-2011. Likewise the instars wise life table study also showed that the maximum234 eggs were laid by single female of which ultimately 96 adults were produced after 23 days during the month of October and November 2010 (from 14 th October to 10th November2010). Different mortality factors causes 23.50%,17.87%, 21.76%,and7.82%,and7.76%and 2.0 % death on egg, first, second, third, fourth, fifth instar stages of this insect respectively. Among the different factors so far recorded in side the laboratory the unhatched egg, mechanical injury during coming out through the slit, dispersal, some spider, wrong selection of hostsite particularly the initial settlement on dried part of the tiller were predominant.

Key words: Brown planthopper · Lifetable · Instar · Intrinsic rate · Finite rate · Fecundity

INTRODUCTION

Brown planthopper(BPH) *Nilaparvata lugens* Stål belonging to the order Homoptera is a serious pest causing damage to rice in Eastern India. Though this insect is known to occur in Asia since late forties, it was earlier only a minor pests of rice [1]. During the 1970s and early 1980s the pest poses tremendous problems and was referred to as "a threat to Asian rice production [2]. Although BPH was observed in rice in West Bengal as early as 1968 it was first noted as serious proportions in small areas of Hooghly district in 1973. In the year 1975, it was spread to 2000 hectors area, while in 1977 more than 4000 hectors in Midnapur, 24 parganas, Malda, Mursidabad, Howrah and Hoogly were affected [3]. At present BPH is the major pests of entire West Bengal except the hilly areas [4]. The Specific regions to the outbreak of BPH involved wide cultivation of susceptible variety specially MTU -7029,availability of right stages (active tillering) of rice in any of the district though out the year in West Bengal and eventually the effect of global warming which leads to discard the dormant phases of this insect in the plains of West Bengal . Thus an attempt has been undertaken to study the life table of BPH in eastern India.

MATERIALS AND METHODS

The brown planthopper *Nilaparvata lugens* Stål was reared in the laboratory on potted rice plant cultivar MTU-7029 at our research station RRSS, Chakdaha, BCKV,WB, India.The adult just after mating from a mass culture were transferred to another plant covered with glass chimney whose mouth was open so that plant get the suitable atmosphere for normal growth and development. The experiment was performed 5 times by introducing the

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female of each cohort in the laboratory at 25° to 30° temperature and 70 to 80% R.H. for corresponding temperature. Under shady condition the rice variety (MTU-7029) remainS in vegetative stage for more than 240 days and gradually it also produces the ratoon which can be used for successful rearing of BPH throughout the year. The population parameter known as intrinsic rate of natural increase (r_m) was first devised for the study of insect population by Birch [5].

A close approximation of rm was made using trial and error substitute of r_m in the Lotka- eutor equation

$$L: \square e^{-mx} l_x m_x = 1$$

Where x pivotal age (mean development period+ age of female during oviposition), l_x is the survival potential of the female (proportion of the surviving parents female) of the particular age group (x), m_x is specific fecundity rate(effective number of female offspring /female on age x.) The equation is solved by iteration taking arbitrary values of r_m until the left side equation is close to unity. Satpathi[6] have estimated the intrinsic rate of increase r_m of brinjal shoot and fruit borer *Leucinodes orbonalis* Guen from a relationship between prereproductive time. The net fecundity rate (R_0) and the finite rate of increase (λ_m) were computed as $R_0 = \square l_x m_x$ and $\lambda_m = e^{rm}$. Net reproductive rate (total progeny/female) $R_t = \square\, l_x t_x$ and the intrinsic rate of total fecundity (r_t) was derived using (5) formula $\square\, l_x t_x e^{-rtx} = 1$

Where t_x= mean number of total progeny/female at age x. Certain other measurements were also performed as: (I) mean generation time (T) in days=ln R_0/r_m (ii) Weekly multiplication of the population (r_w)= $(e^{rm})^7$, doubling time of the population (DT) in days=ln2/r_m.

RESULTS AND DISCUSSIONS

Before calculation the lifetable some parmeters *viz* the net fecundity rate, net reproductive rate, mean length of generation, finite rate of increase,mean generation time, weekly multiplication of population and doubling time of population were also calculated and the results are given in Table 1 and 2.

The Table 1 showed the effect of seasonal variation on life table of brown planthopper *Nilaparvata lugens* Stål in eastern india where the net fecundity rate (R_o) is higher in rainy season (79.24) than winter (36.43). Identical trends of the net reproductive rate (R_t) and intrinsic rate of increase (r_m), finite rate of increase were observed as 31.51 and 0.1286023, 1.1372370 in rainy/ kharif season and 9.38, 0.0702774, 1.0728057 in winter respectively. Although the weekly multiplication (r_w) of BPH is higher in rainy/ kharif (2.4601354) than winter/ rabi (1.66469120) but the mean length of generation(T) and doubling time of population(DT) were lower in rainy/ kharif (34.00,5.38) than winter/ rabi as recorded 51.16, 9.86 during 2010-2011.

Table 1: Effect of seasonal variation on lifetable of Nilaparvata lugens Stål

	l_x	mx	lx mx	x lx mx	tx	lx tx	x lx tx
Pivotal age(x)	R **W**	R **W**	R **W**	R **W**	R **W**	R **W**	R **W**
0-24.5	0.39						
32.5	0.38	21.00	7.9	256.75	8.00	3.04	98.80
33.5	0.35	80.00	28.00	938.00	32.00	11.20	375.20
34.5	0.34	110.00	37.40	1290.30	44.00	14.96	516.12
35.5	0.33	18.00	5.94	210.87	7.00	2.31	82.05
36.5	0.13						
37.5	0.10						
40.5	0.05						
0-24.5	**0.28**						
48.5	**0.26**						
49.5	**0.26**						
50.5	**0.25**						
51.5	**0.23**	**78.00**	**17.94**	**923.91**	**20.00**	**4.60**	**236.9**
52.5	**0.21**	**85.00**	**17.85**	**937.13**	**22.00**	**4.62**	**242.55**
55.5	**0.18**						
58.5	**0.04**	**16.00**	**0.64**	**3.74**	**4.00**	**0.16**	**9.36**
65.5	**0.02**						
Total			79.24	2694.8		31.51	990.12
			36.43	**1864.0**		**9.38**	**488.81**

R = Kharif/ Rainy, **W= Winter/ Rabi**

Table 2: Lifetable parameters of brownplanthopper *Nilaparvata lugens* Stål

		Calculated data		
SL NO	Parameters	Rainy/ Kharif	Winter/ Rabi	Reference
1	Net fecundity rate (R_0)= □ $l_x m_x$	79.24	36.43	144.7(Liang-Xiang *et. al* 2010) 67.82(Do)
2	Net reproductive rate (Rt) or total progeny / female = □ $l_x m_x$	31.51	9.38	10.02(San san *et al* 2011)
3	□ $l_x m_x$ Mean length of generation (T)= -------------- R_0	34.00	51.16	34.05(San San *et .al.*2011) 37.20 and36.80(Liang-Xiang *et. al* 2010)
4	Intrinsic rate of natural increase (r_m)=log $e^{R}{}_0$ / T	0.1286023	0.0702774	0.0677(San San *et .al.*2011) 0.1340(Liang-Xiang *et. al* 2010)
5	Finite rate of ncrease((λ_m)=e^{rm}	1.1372370	1.0728057	1.0688/female/day (San San *et .al.*2011)
6	Mean generation time T days)=$l_n R_{0/} r_m$	34.00	51.16	34.05(San San *et .al.*2011
7	Weekly multiplication of population $r_w = (e^{rm})^7$	2.4601354	1.6646912	
8	Doubling time of population (DT) in days= ln 2/m	5.38	9.86	

Table 3: Instarwise study of life table of *Nilaparvata lugens* Stål under laboratory condition during the month of October and and November 2010.

Stage of the insect	Number living (lx)	Factors responsible for dying (dx)	Number dying (dx)	dx as % of lx (in qx)
Eggs	234	•Unhatched	55	23.50
Ist instar nymph	179	•Dispersal •Mechanical injury during coming out through slit	21 11	17.87
2nd instars nymph	147	•Wrong selection of host site specially the dried sheath/straw • Dispersal • Predation by domestic spiders	22 5 5	21.76
3rd instars nymph	115	•Dispersal •Predation by domestic spiders	5 4	7.82
4th instars nymph	106	•Dispersal •Predation by domestic spider	5 3	7.76
5th instars nymph	98	•Predation by domestic spiders	2	2.10
Adult	96	• Nil	-	-

Instrinsic rate of increase (r_m) can be practical use[7] by measuring it under laboratory condition for three graminivorous beetles over a wide range of temperature and humidity. It was found for each species there was an optimum zone of certain combination of conditions under which r_m reached its highest value and each of the factor under study departed from the optimum, r_m fell off until the population could not balance the mortality by reproduction and later the insect could reproduce. The data also support the observation of [8] and [9] here net facundity rate (R_o), net reproductive rate (R_t), mean length of generation (T), Intrinsic rate of natural increase (r_m), finite rate of increase e^{rm}, mean generation time (T) of brown planthopper *Nilaparvata lugens* Stål varies 67.00-144.77, 10.02, 34.05-38.60, 0.0677-0.1340, 1.0688 female/ female/ day, 34.05 respectively.

Latka [10] showed mathematically distribution of age in population in which birth rate (m_x) and death rate (lx) for each group remain constant and which increase in an unlimited space, approach a certain distribution which is called ‘ the stable age distribution’. The study also showed that BPH does not approach stable age distribution and its rate of increase is also not constant. In this case BPH population cannot maintain its r_m over an indefinite period under a given set of environmental condition

Instarwise study on the lifetable of BPH also showed different factors responsible for mortality of this insect and the results are given in table 3.

From the table 3 it is also evident that the maximum 234 eggs were laid by single female which ultimately produces 93 adults with 1.2:1 (male: female) sex ratio during the month of October 14 to November10, 2010, Different mortality factors causes 23.5%, 17.87%,21.76%, 7. 82%,7.76% and 2.0% death on egg stage, Fist, second, third, fourth andfifth instar stages respectively. Among the different abiotic factors egg mortality or unhatched egg, mechanical injury during coming out through the slit,,dispersal and wrong selection of host sites particularly the dried part of the tiller at initial stage were predominant. Although the biotic factor was not considered in laboratory but the predation by spider could not be avoided which causes 5%, 3% and 2% mortalities were at 3rd,fourth and fifth instar stage of this insect respectively.

From the results obtained it may be concluded that brown planthopper *Nilaparvata lugens* Stål has an optimum zone of certain combination of condition under which intrinsic rate of increase reaches maximum but the different biotic and abiotic factors causes to fell off until the population could not balance mortality by reproduction.

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