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A COMPARATIVE STUDIES ON THE POPULATION DYNAMIC AND SURVIVAL OF GREEN LEAF HOPPER AND ZIGZAG LEAF HOPPER TRANSMITTING RICE TUNGRO VIRUS IN WEST BENGAL

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ABSTRACT
A study to find out the population dynamic and survival characteristics of both the rice tungro vectors, Green Leafhopper (GLH), *Nephotettix virescens* and Zigzag Leafhopper (ZLH), *Recilia dorsalis* was undertaken during 2015-16 at Regional Research Station (OAZ), UBKV, Majhian, Dakshin Dinajpur West Bengal. Result revealed that average population (average of 10 sweeps) of ZLH was high at the early stage during the month of June (4.5/sweep) and July (12.5/sweep) compare to GLH population which was found to increase from the month of June (11.5/sweep) and reached its peak in October (38.8/sweep). But in general GLH population was high as compare to ZLH and a highest population (25.4 -28.5/sweep) of GLH was found at maximum tillering stage irrespective of varieties followed by flowering stage (16.5 -21.6), panicle initiation stage (13.5 - 18.4/sweep) and seedbed (2.6 -8.4/weep). Both GLH and ZLH were found in rice as well as in weed host but the GLH population was high in rice (4.2-8.6/sweep) and low in weed host (0.14-2.2/sweep) whereas ZLH population was high in weed (2.8-5.3/sweep) and low in rice (2.7-3.2/sweep). It was also found that the survival period of GLH in rice varieties was high (8-21 days) compare to ZLH (6-18 days).

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important cereal crop in the world. About 90% of rice in the world is grown and consumed by the population of the Asian countries(Samanta,2014). Rice is using as staple food for about 50% the world population (Rout,2012) and 65% of Indian population. It contributes about half of the total food grain and 55% of total cereal production (Anonymous,2005). India has the largest acreage under rice, about 44.6 m ha of land with a production of about 90 MT (Roy *et al*.,2013). Even though, there are many constraints in rice production, insect pests remain a constant problem in all the rice growing regions. Leafhoppers, belonging to the Cicadellidae are considered as pest and vectors of economically important crops (Das and Devee, 2017). The rice green leafhoppers (GLH) are one of the most devastating rice pests throughout the rice growing areas of Asia Dey,2016). Among leafhoppers species, the green leafhopper (GLH) *Nephotettix virescens* (Distant), Nephotettix *nigropictus(stal)* and zigzag leafhopper(ZLH), *Recelia dorsalis* (Motschulsky) T) are the important pests throughout the rice growing areas. They cause damage to the rice crop by either directly sucking the sap or indirectly by transmitting virus diseases such as dwarf, transitory yellowing, tungro, yellow dwarf and yellow-orange leaf (Dale, 1994). Among the diseases transmitted by GLH and ZLH, tungro is the most destructive. It is associated with two viruses—rice tungro bacilliform virus (RTBV) and rice tungro spherical virus (RTSV). Both viruses are transmitted in semi-persistent manner by the green leafhopper (GLH), *Nephotettix virescens* (Distant), *Nephotettix nigropictus*(Stal) and zigzag leafhopper (ZLH)), *Recelia dorsalis* (Motschulsky) T). The onset of the disease depends on the presence of a susceptible host, a virus source, and the vector (Dey, 2016)

Population of GLH in West Bengal is abundant during kharif season which appears from the month of July and increased gradually in September to October and declined from the beginning of December. In extreme cold and in hot summer they are almost absent (Mallik and Chowdhury, 2000). A study on population of GLH in different cropping season in Bangladesh revealed that the GLH population was more during April, May, October and November (Begum *et al*.,2014). Besides rice, some gramineous weed species may also serve as host of tungro viruses (Anjaneyulu *et al*.1988; Hino *et al*.,1974; Parejarearn *et al*.,1990). Tungro is important disease of rice because of its damages and it causes an explosion if occurred in the early vegetative stage (Hasanuddin, 2002). A major outbreak of this disease occurred in Tamil Nadu in 1984 and 1992. Whereas, an epidemic outbreak of tungro during 2001 in three districts of West Bengal caused an un-milled rice production loss of 0.5 million tonnes valued at Rs. 2911 million at current prices. So far reported, the sporadic appearance of the disease caused significant grain yield losses (Muralidharan *et al*., 2003). The epidemics of tungro disease in the last century caused famines and great loss of human life (T. Mew *et al*., 2004). So insects cause millions of dollars' worth of losses annually to food crops and other plants all over the world.

Although GLH and ZLH are the important pests and vectors of rice tungro virus (RTV), the ecology and seasonal abundance are little known. The present study is aimed to investigate the

abundance of both the vector of tungro in different habitats, species composition and abundance pattern in successive crop seasons. This study will provide baseline data about incidence, population and survival of both the vectors over the year to establish and evaluate future management practices for rice fields in this area. Therefore, keeping the above information in view the present investigation was undertaken to find out population dynamic and survival characteristics of both the vectors of RTV.

MATERIALS AND METHODS

The present experiment was conducted at Regional Research Station (OAZ), UBKV, Majhian, Dakshin Dinajpur West Bengal 2015-16 using six rice varieties viz., IR – 36, IR – 62, IR – 64, IET 1444, IET 4786 and TN1 (Taichung Native 1).

Vector monitoring

Sweep net sampling method (10 sweeps/sample) was used to collect the leafhopper species (Rubia *et al.*,1988; Satapathy *et al.*,1997; Dahal *et al.*,2010). Sampling was done from four fields of each varities, each field represents a replication. Both zigzag leafhoppers (*Recilia dorsalis*) and green leafhoppers (*Nephotettix virescens*) were monitored from rice seedbeds and transplanted rice fields by usual hand sweeping technique at weekly interval with the help of conical shaped sweeping net, made with fine nylon net of 30 cm. diameter fitted with iron ring having a handle of 60 cm. long. Leafhoppers (both types) caught in each sweep were sorted out with the help of aspirator and counted. The collected leafhoppers were placed in glass tube with rice plants and brought to the laboratory for rearing. The average population from 10 sweeps were taken into consideration to estimate the population of both the leafhopper.

Vector rearing in cage

Cage method of rearing for both the leafhoppers was used (Heinrichs *et al.*,1985). Both rice green leafhoppers (GLH) and zigzag leafhoppers (ZLH) collected from rice fields were released in rearing cage containing healthy rice seedlings in pot placed in the laboratory. For rearing of leafhoppers, generally TN1 (Taichung Native 1) seedlings were used. At 5 days interval rice plants were replaced by fresh plants and the used plants were placed in separate cages for development of fresh insect from eggs hatched in the rice plants. The nymphs that emerged from the eggs were allowed to grow for adult.

Survival of vector in different rice varieties

Survival period of both the leafhoppers was determined at room temperature under laboratory. Seedlings of all the varieties were raised in pots. 10 days old seedlings of each variety were uprooted from the pots and inserted in the test tubes with small amount of water. For each varieties 10 seedlings were used individually to test the survival period. Adult insects of both GLH and ZLH of same age were collected from rearing cages and inserted in the test tubes @ 1/seedling. Test tubes containing the insect and seedling were caped and placed in the test tube rack to record the survival period. Recording of survival of the insect was made every day at the morning and if necessary seedling was replaced by a fresh seedling of same variety. Minimum and maximum survival of the insects were recorded everyday until the death of the insects.

RESULTS AND DISCUSSION

Population of Green leafhopper (GLH) and Zigzag leafhopper (ZLH) in different months during kharif season

From the result (Table 1. And Figure.1) it was observed that

Table 1: Average population of Green leaf hopper (GLH) and Zigzag leaf hopper (ZLH) (sweeped at weekly interval; average of 10 sweep) in different month during kharif.

Month	No. of GLH / Sweep	No. of ZLH / Sweep
June	3.4	4.5
July	11.6	12.4
August	22.5	11.5
September	28.6	7.6
October	38.8	1.5
November	35.4	3.5
December	19.6	5.8

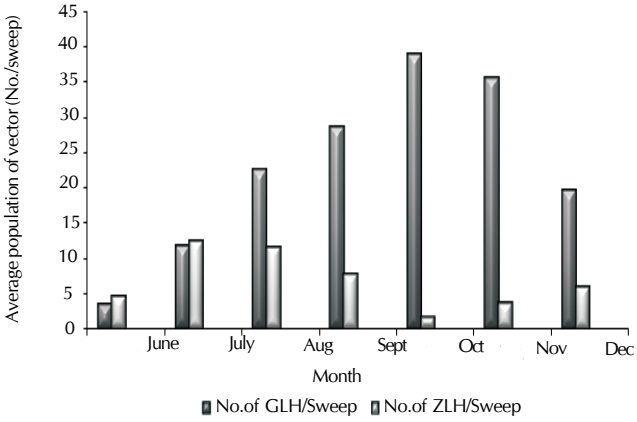

Figure 1: Average population of green leafhopper (GLH) and zigzag leafhopper (ZLH) in different months during kharif (Sweeped at weekly interval; Average of 10 sweeps)

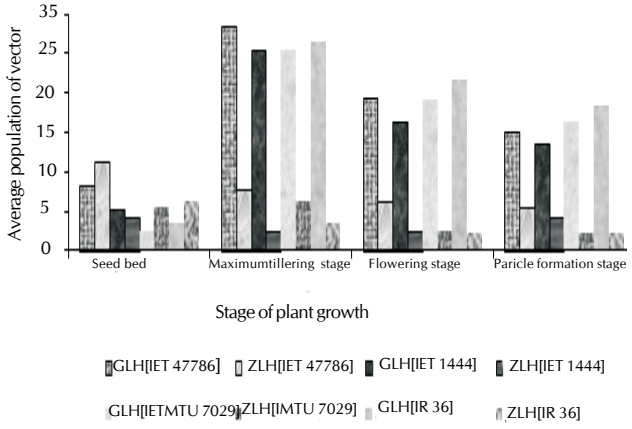

Figure 2: Average population of green leafhopper (GLH) and zig-zag leafhopper (ZLH) at weekly interval in different stages of plant growth in four rice varieties during kharif,2015.

Table 2: Average population of Green leaf hopper (GLH) and Zigzag leaf hopper (ZLH) at weekly interval in different stages of plant growth in four rice varieties during kharif, 2015

Stages of plant growth	Variety							
	IET 4786	IET 1444	MTU 7029	IR 36				
	GLH	ZLH	GLH	ZLH	GLH	ZLH	GLH	ZLH
Seed bed	8.4	11.25	5.25	4.25	2.6	5.5	3.4	6.25
Maximum tillering stage	28.5	7.75	25.6	2.5	25.4	6.25	26.5	3.5
Flowering stage	19.4	6.25	16.5	2.5	19.25	2.5	21.6	2.25
Panicle formation stage	15.25	5.5	13.5	4.25	16.5	2.25	18.4	2.25

Table 3: Comparison on the survival period of adult Green leafhopper (GLH) and Zigzag leafhopper (ZLH) on some selected rice varieties when confined in test tube with 7 days old seedling

Variety	Survival Period (in days)			
	GLH		ZLH	
	Minimum	Maximum	Minimum	Maximum
IR – 36	8	13	7	12
IR – 62	8	14	6	11
IR – 64	10	19	8	14
IET – 1444	10	20	7	15
IET – 4786	9	18	9	17
TN1	11	21	10	18

Table 4: Average population of Green leafhopper (GLH) and Zigzag leafhopper (ZLH) on rice and weed host during March to June by sweeping method.

Month	Average of 10 sweeps			
	GLH		ZLH	
	On rice	On weed	On rice	On weed
March	4.1	0.14	2.8	2.7
April	5.6	0.52	3.2	3.5
May	7.4	1.51	5.3	3.0
June	8.6	2.2	3.5	3.25

both green leafhopper (GLH) and zigzag leafhopper (ZLH) were present in the rice field in all the month of observation. The population presented in the table 1. and fig. 1 included the catches obtained from seedbed, maximum tillering stage and flowering stage. No restriction was made on the specific varieties but mostly they were collected from the high yielding varieties (HYV's) grown in the research farm. Both the insects were present in all the month but number of the GLH from August-December was higher than the ZLH.

A highest number of the GLH population (38.8/sweep) was obtained in the month of October followed by 35.4, 28.6, 22.5, 11.6 and 3.4/sweep in the month of November, September, August, December, July and June, 2015 respectively. In this context highest population of ZLH (12.4/sweep) was recorded in the month of July followed by August, September, December, June and October respectively. On comparing the data of monthly catch it revealed that the population of GLH was more from August-December whereas population of ZLH was slightly more than GLH in the month of June and July. In the month of June and July, population of both the insects were recorded from the seedbeds which suggest that at the beginning of kharif season, population of ZLH was more than the GLH. A study on population of GLH in different cropping season in Bangladesh revealed that the GLH population was more during April, May, October and November and (Begum *et al.*,2014). Population of GLH in different months in West Bengal was thoroughly studied by Mukhopadhyay and Chowdhury (1973). Later Mallick and Chowdhury (2000)

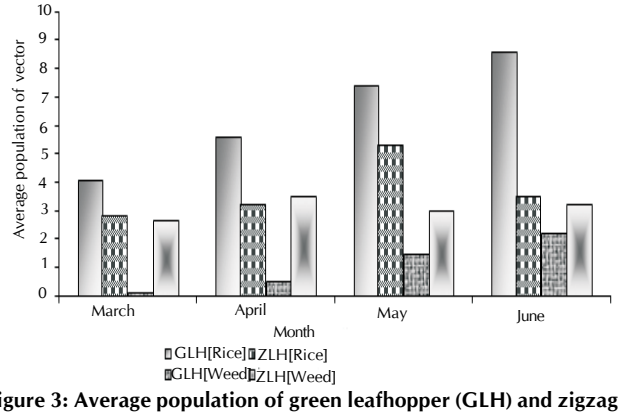

Figure 3: Average population of green leafhopper (GLH) and zigzag leafhopper (ZLH) on rice and weed host during March to June by sweeping method.

compared the population of GLH and ZLH both from light trap and field catches and result also showed that population of GLH was comparatively higher than ZLH and distribution of both type of the leafhopper followed the same pattern. They recorded two peak populations, one from March-June and another from September-October.

Zigzag leafhopper (*Recilia dorsalis*) has been recognized one of the vector of RTV (Hibino and Cabuagan, 1986) and it has been suspected that this insect might also play a significant role on the interseasoal carryover of RTV. In this observation

it has been observed that the population of ZLH was low in the month of October (1.5/sweep) and it started increasing gradually and reached 5.8 insects/sweep in the month of December. In extreme cold and in extreme summer when the GLH population declines, some population of *R. dorsalis* remain present which may help for carryover of RTV between interseasonal period (Mallick and Chowdhury, 1999).

The light trap data from rice fields of Nepal at low altitude (250 m) showed that both GLHs, *N. virescens and N. nigropictus* were caught throughout the year, with few or none caught during winter (December- February). The abundance of these two insects increased from April- May with a small peak in early July and a larger peak during September- October. In 1992- 1994 the highest numbers of insects were recorded during mid to the late October. In the field samples, leafhopper abundance varied depending upon the sampling year and location (Dahal *et al*.,2010).

Population of Green leafhopper (GLH) and Zigzag leafhopper (ZLH) at different stages of plant growth in four rice varieties

The result is presented in the table 2. and fig. 2 which showed highest population of GLH at maximum tillering stage irrespective of varieties followed by flowering stage, panicle initiation stage and seedbed.

A population of 28.5 in IET4786, 25.6 in IET1444, 25.4 in MTU7029 and in IR36 26.5 were recorded. In contrast to GLH, population of ZLH were 7.75, 2.5, 6.25 and 3.5 respectively on IET 4786, IET1444, MTU7029 and IR36. In seedbed a high population of ZLH was observed in 3 varieties namely, IET 4786, MTU 7029 and IR36. At maximum tillering stage, flowering stage and panicle formation stage in general ZLH population varied from 2.25 to 7.75.

Mallick and Chowdhury (2000) compared the population of GLH and ZLH in the seedbed for 2 years both in dry and wet season and obtained similar observation that incidence of GLH was more than the ZLH on the seedbed. Although the population of *Recilia dorsalis* was low when compared to GLH, nevertheless their presence in the seedbed might play an important role on the carryover of RTV from the standing crop, weed hosts and stubbles of previous crop to seedbed. In their studies they also recorded the population of *R. dorsalis* at tillering stage using the yellow sticky trap where they obtained higher population of *R. dorsalis* in boro crop than the GLH which indicates that *R. dorsalis* is present in the standing crop of summer rice. Cook and Perfect (1989) performed the similar studies on the population dynamics of tungro vector and they also obtained high population of *R. dorsalis* in the seedbed as well as on the weed host. The GLH population in the rice field of Bangladesh was higher in seedbed than transplanted rice (Begum *et al*.,2014.).

Comparison on the survival period of adult Green leafhopper (GLH) and Zigzag leafhopper (ZLH) on some selected rice varieties when confined in test tube with 7 days old seedling

Survival period of green leafhopper (GLH) and zigzag leafhopper (ZLH) were compared on the 6 rice varieties and the minimum and maximum survival period are presented in table 3. It was observed with GLH that a minimum survival period up to 8 days was recorded in IR 36 and IR 62 and maximum survival period upto 21 days in TN 1 respectively. Maximum survival period of GLH among the rice varieties was 13–21 days and the minimum survival period was 8–11 days. In case of ZLH minimum survival period varies from 6–10 days and maximum up to 11–18 days.

It appears from the result that both the insects can survive to a considerable period on different rice varieties. GLH particularly *Nephotettix virescens* is mostly monophagus to rice (Viswanathan and Kalode, 1975, 1981) whereas information on the host preference of GLH not well established in respect to rice and other alternate host.

Population of Green leafhopper (GLH) and Zigzag leafhopper (ZLH) on rice and weed host during March to June

Population of green leafhopper (GLH) and zigzag leafhopper (ZLH) were compared on rice and weed host during the period from March to June. Sweeping was made from the different rice varieties as well as on weed host and the results are presented in table 4. and fig. 3. In general, the result showed that the population of GLH was more in rice than the weed host while the population of ZLH was more or less similar on both rice and weed host. GLH population on rice in the month of March, April and June were 4.1, 5.6, 7.4 and 8.6 respectively while on weed on respective months they were 0.14, 0.52, 1.51 and 2.2. On comparison population of ZLH on rice and weed was not much different than GLH. Average population of ZLH during March, April, May and June were 2.8, 3.2, 5.3 and 3.5/sweep on rice respectively but on weed host their population were 2.7, 3.5, 3.0 and 3.5 during March, April, May and June respectively.

Information on the population dynamics of GLH has been studied in detail but information on the population of ZLH under West Bengal situation is very limited. Although *Recilia dorsalis* transmits the tungro virus and it has some role on carryover of virus in different cropping season under West Bengal condition as it has been observed by Mallick and Chowdhury (2000). *Nephotettix virescens*, the primary vector of tungro virus, is mostly monophagus. However, some weed hosts such as *Echinochloa colonum, E. crusgalli, Leersia hexandra, Ischne globosa* etc. on which leafhoppers fed and survive (Viswanathan and Kalode, 1975, 1981). In West Bengal some weeds have been identified which grow in rice field like *Cyperus rotundus, Cynodon dactylon, E. colonum* and *Ischaemum rugosum* act as reservoirs of tungro virus.

This studies on GLH and ZLH population clearly indicate that both types of leafhoppers are present during the month of March-June. It is interesting to know that the population of ZLH was comparatively higher or almost same on weed host than the rice during the months of March, April and June. During summer month population of GLH declines due to unsuitable environmental condition as well as non-availability of good rice host. Although boro rice may be present during March-April but most of them are in mature stage usually not favoured by GLH. High population of ZLH found on the weed host may help on carryover of the virus from weed host to early kharif seedbed. Delacruz and Litsinger (1986) examined the susceptibility of ratoon rice as a host for *Nephotettix virescens* and showed that survival and development of insect on ratoon crop were similar to transplanted rice. The present studies clearly indicate that there is a great role of the weed host on the population buildup of tungro vectors.

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