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The J. Res. PJTSAU 44(1&2)114-117, 2016

EFFECT OF TEMPERATURE ON RICE BROWN PLANT HOPPER *(Nilaparvata lugens* Stall)

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Date of Receipt : 30.4.2016 Date of Acceptance : 24.6.2016

Rice (*Oryza sativa* L.) is one of the world's most important food crop and is the most widely consumed staple food for a large part of the world's human population, especially in Asia. The average per hectare yield in the country tends to be relatively low compared to China, Sri Lanka, mainly due to heavy losses caused by pests. Rice crop is attacked by 800 species of insect pests in both field and storage. Among these one of the most economically important insect pests is the Brown planthopper (BPH), *Nilaparvata lugens* (Stal.) (Homoptera: Delphacidae). The BPH has become more problematic, posing a threat to rice production throughout South and South East Asia. Due to infestation plants turn yellow and dry up rapidly. At early infestation, round and yellow patches appear, which soon turn brownish due to the drying up of the plants and is called as 'Hopper burn' which is reported to cause yield loss ranging from 10-75% (Tirumala rao, 1950).

The rice BPH occurs during both dry and wet seasons and survival, growth, development and multiplication are effected by several biotic and abiotic factors. Among the abiotic factors, temperature play a major role. As a result of climate change it is predicted that global mean temperature will increase by 1.5-6.0ºC by the end of the century (IPCC, 2001). Such changes will alter plant-herbivore interactions through effects on plant, insect growth, development and survival. The temperature effect on BPH studies will pave way for devising suitable management strategies against BPH under climate change scenario and to understand the impact of BPH on different rice varieties.

The effect of temperature on BPH studied at 25ºC, 30ºC, 35ºC and 40ºC, because in telangana region temperature present in between these temperature ranges among several seasons.

The Rice plants were maintained in the glass house at Rice Research Centre, ARI, Rajendranagar.

The brown planthopper populations were reared in insect rearing cages on the susceptible rice variety Taichung Native 1 (TN1) in poly house facility available at Rice Research Centre, ARI, Rajendranagar. The effect of four constant temperature levels *i.e.* 25ºC, 30ºC, 35ºC and 40ºC on BPH fecundity, nymphal survival, duration, adult longevity were studied in B.O.D at 75% RH. For fecundity studies one brachypterous female and one macropterus male were released per hill and each mylar tube was covered with muslin cloth to prevent escape of adults and to provide aeration. The pots were kept at the required temperature in B.O.D. and the BPH were confined for 4 days. The emerged nymphs were observed daily and the total number of emerged nymphs per hill were counted. After nymphal emergence is completed, the unhatched eggs were counted by dissecting leaf sheath and observed under binocular microscope.

Fecundity was calculated by using the following formula given by Manikandan and Kennedy (2013), Fecundity= no of nymphs hatched+unhatched eggs.

% Hachability = no of nymphs×100/no of nymphs + unhatched eggs.

%Unhatched eggs = Unhatched eggs×100/ no of nymphs + unhatched eggs

From 45 to 50 days old rice plants nine tillers were taken from the glasshouse. Each tiller was kept in a glass tube of 2cm diameter and 20cm height. A slice of sponge was placed at the bottom of glass tube to secure rice plant from quick moisture evaporation. The newly hatched nymphs were transferred to glass tubes @ 5 nymphs per glass tube. The glass tubes were covered with muslin cloth

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to prevent escape of nymphs and to provide aeration. After transfering the nymphs, the glass tubes were kept in B.O.D. at required constant temperature. The rice tillers in the test tubes were replaced by fresh rice tillers on alternate days. The nymphal survival data was recorded by observing the nymphs and the dead nymphs were removed with a fine brush. For observing total nymphal survival, five nymphs per glass tube were placed separately at respective temperatures and observed till they become adults. Percent nymphal survival was calculated by using the following formula given by Sucheta Rout and Mayabini Jena (2012),

$$\text{Percent nymphal survival} = \frac{\text{Number of adults emerged}}{\text{Number of nymph released}} \times 100$$

Data on nymphal duration was recorded by observing the exuviae of the nymphs and the mean time taken at respective instars and time from nymphal release to adult emergence was computed. Data on adult longevity was recorded by observing the adults from emergence till death and mean adult longevity was computed in days. For adult longevity studies at 40ºC temperature, the newly emerged adults were released in to glass tubes @ 5 adults per glass tube, the data was recorded by observing the adults from release till death and mean adult longevity was computed in days.

Present results revealed that the temperature of 30ºC resulted in significantly higher nymphal emergence (132.89/female). The next effective temperature was 25ºC (116.78/female) which was significantly different from 35ºC (90.00/female). Compared to 25 and 30ºC, very less number of eggs were laid at 35ºC (90.00/female).There was no egg laying at 40ºC, because the adults did not survive at 40ºC. The per cent hatchability of eggs recorded was significantly higher at 30ºC (100%). The per cent hatchability at 25ºC was found to be 90.02 which was significantly higher than at 35ºC (80.09%). Since the adults did not survive at 40ºC, no hatching was noticed at this temperature.

Table 1. Effect of Temperature on BPH fecundity (Egg/Female)

Treatment	Temperature regimes	Emerged nymphs*	Unhatched eggs*	Total eggs*	%Hatchability*	%Unhatchability
T_1	25°C	105.11[b] (10.27)	11.67[b] (3.48)	116.78[b] (10.83)	90.02[b] (71.62)	9.98[b] (18.38)
T_2	30°C	132.89[a] (11.55)	0.00[c] (0.71)	132.89[a] (11.55)	100.00[a] (85.95)	0.00[c] (4.06)
T_3	35°C	72.00[c] (8.51)	18.00[a] (4.29)	90.00[c] (9.51)	80.09[c] (63.52)	19.91[a] (26.48)
T_4	40°C	0.00[d] (0.71)	0.00[c] (0.71)	0.00[d] (0.71)	0.00[d] (4.06)	0.00[c] (4.06)
C.D.at 5%		0.19	0.20	0.22	0.87	0.87
SE(m)±		0.06	0.07	0.08	0.30	0.30
C.V. (%)		2.51	8.88	2.88	1.61	6.86

* Figures in parantheses are Squre root transformed values

** Figures in parantheses are ARC SIN transformed values

These results are in agreement with the findings of Sucheta Rout and Mayabini Jena (2012) who reported that at a temperature range of 27-33ºC, maximum eggs were laid and the egg laying was completely stopped above 40°C. Manikandan *et al.* (2015) revealed that total number of eggs recorded was more (233) at 30.0°C and less (116) at 36.0°C.

Temperature of 30ºC resulted in highest per cent nymphal survival (Table 4.2) compared to the 25ºC and 35ºC while nymphs could not survive at

constant temperature of 40ºC. Incase of 1st instar nymphs, all the nymphs survived at 25ºC and 30ºC while at 35ºC, the nymphal survival was significantly reduced to 95.56 per cent. In case of 2nd instar nymphs, 95.56 per cent of nymphs survived at 25ºC and 30ºC which was on par with 88.33 per cent nymphal survival at 35ºC. However, compared to 25ºC and 30ºC, slight reduction in nymphal survival was observed at 35ºC. No significant differences were observed across different temperature regimes (25, 30 and 35ºC) with regard to 3rd, 4th and 5th instar. However, relatively higher survival (95.56, 93.33 and 97.22 per cent respectively at 3rd, 4th and 5th instars) was observed at 30ºC. At 40ºC, none of the nymphal instars survived.

The total nymphal survival at 25ºC was 68.89 per cent and at 30ºC it was 71.11 per cent and both were on par with each other. At constant temperature of 35ºC, total nymphal survival was found to be significantly reduced (40.00%) while none of the nymphs developed into adults at 40ºC.

Table 2. Effect of temperature on BPH nymphal survival

Treatment	Temperature regimes	1st instar**	2nd instar**	3rd instar**	4th instar**	5th instar**	TNS**
T1	25°C	100.00^{a} (85.95)	95.56^{a} (80.94)	91.11^{a} (75.94)	92.22^{a} (77.68)	92.22^{a} (77.68)	68.89^{a} (56.40)
T2	30°C	100.00^{a} (85.95)	95.56^{a} (80.94)	95.56^{a} (80.94)	93.33^{a} (78.44)	97.22^{a} (83.06)	71.11^{a} (57.81)
T3	35°C	95.56^{b} (80.94)	88.33^{a} (73.06)	90.56^{a} (75.56)	88.89^{a} (74.41)	91.67^{a} (77.30)	40.00^{b} (39.11)
T4	40°C	0.00^{c} (4.06)	0.00^{b} (4.06)	0.00^{b} (4.06)	0.00^{b} (4.06)	0.000^{b} (4.06)	0.00^{c} (4.05)
C.D.at 5%		4.77	8.95	9.51	10.39	9.58	5.39
SE(m)±		1.65	3.11	3.31	3.61	3.32	1.87
C.V. (%)		7.73	15.60	16.75	15.08	16.48	14.26

TNS=Total Nymphal Survival

** Figures in parantheses are ARC SIN transformed values

Krishnaiah *et al.* (2005) reported that temperatures ranging from 25 to 30ºC are most favourable for multiplication of BPH and the insect cannot tolerate > 35ºC of constant temperature. Sucheta Rout and Mayabini Jena (2012) found that BPH thrived and multiplied well at a temperature of 30 ± 3ºC and temperatures above 30ºC, *i.e.* 33ºC to 35ºC are unfavourable for insect survival.

The developmental time taken by five nymphal stages varied significantly with respect to the temperature. Among different temperature regimes, the nymphal duration at 30°C was lowest during most of the instars except at 3rd to 4th instar, wherein the nymphal duration was lowest at 35°C (2.18 days) as against 2.74 days at 30°C. At 40°C, none of the nymphs survived and reached to respective instars.

During 1st to 2nd instar, lowest developmental time (2.02 days) was recorded at 30°C which was significantly different than at 25 and 35°C. At both the temperatures, the duration was 3.00 and 2.87

days respectively and both were on par with each other. Similar observations were made during 2nd to 3rd and 4th to 5th instars also. However, during 5th instar to adult emergence, all the temperature regimes differed significantly with each other with lowest duration at 30°C, 25°C and 35°C (2.04, 2.27 and 2.96 days respectively). The total nymphal duration was significantly highest at 25°C (12.09 days) while it was significantly lowest at 30°C (9.93 days). The total nymphal duration at 35°C was on par with 30°C (10.73 days).

Sucheta Rout and Mayabini Jena (2012) reported that at mean temperature of 30°C, the nymphal duration was shortest (9-15 days). N.V. Krishnaiah *et al.* (2005) found that the total nymphal duration was 13.68 and 11.88 days at 25 and 30°C respectively. Ramya *et al.* (2012) reported that total life span of BPH at 38°C decreased significantly than at 30°C.

The adult longevity was highest at 25°C (14.97 days) while at 30°C and 35°C the adult longevity was 12.59 and 7.72 days, respectively and at all the three temperature regimes, adult longevity differed significantly with each other. However, at 40°C, adults lived for 2.38 days. Manikandan and Kennedy (2013) reported that the longevity of adult male was 13.25 and 8.5 days at 28.3°C and 36°C, respectively.

REFERENCES

IPCC, Climate change 2001: The scientific basis. Cambridge univ. Press, Cambridge.

Krishnaiah, N.V., Rama Prasad, A.S., Ragavendra Rao,C., Pasalu ,I.C., Jhansi Lakshmi ,V., Lakshmi Narayana ,V and Lingaiah ,T. 2005. Effect of constant and variable temperatures on biological parameters of rice brown plant hopper *Nilaparvata lugens (*Stal) . Indian Journal of Plant Protection 33 (2):181-187**.**

Manikandan, N and Kennedy, J.S. 2013. Influence of temperature on egg hatching and development time of brown plant hopper. International Journal of Plant Protection. 6 (2): 376-378.

Manikandan, N., Kennedy, J.S and Geethalakshmi, V. 2015. Effect of temperature on life history parameters of brown planthopper, *Nilaparvata lugens* (Stal). African Journal of Agricultural Research. 10 (38): 3678-3685.

Ramya, M., Kennedy,J.S., Geetha Lakshmi, V., Lakshmanan, A., Manikandan, N and Udaya Sekhar, N. 2012. Impact of elevated temperature on major pests of rice. CLIMARICE technical Brief. 1-6.

Sucheta Rout and Mayabini Jena. 2012. Effect of high temperature on the multiplication of brown plant hopper *Nilaparvata lugens* (Stal.). Oryza 49(4): 288-291.

Tirumala Rao, V. 1950. Nilaparvata lugens (Stal.) as a pest of paddy cultivation in north Madras and its control. Indian Journal of Entomology. 12:241-246.