Journal of Entomology

ISSN 1812-5670

Academic Journals Inc.

www.academicjournals.com

OPEN ACCESS Journal of Entomology

ISSN 1812-5670
DOI: 10.3923/je.2017.96.103

Research Article
Studies on Incidence of Jute Semilooper in Relation to Weather of Uttar Dinajpur, India

[1,2]Abdul Sadat and [2]Kaushik Chakraborty

[1]Department of Sericulture, Raiganj University, Raiganj, West Bengal, 733134, India
[2]Department of Zoology, University of Gour Banga, Mokdumpur, Malda, West Bengal, 732103, India

Abstract

Background and Objective: Jute is an economically important fibre crop of India but its' national production rate is lower than theoretical values due to attack of Jute semilooper, *Anomis sabulifera* Guen. Pest population in jute crop (*Corchorus olitorius* L.) was assessed during two consecutive year of 2015-2016 at Uttar Dinajpur, West Bengal, India (i) To define the population dynamics of jute semilooper (ii) To understand relation between that pest and climate (iii) To apply the generated information relating to jute semilooper population dynamics in integrated pest management. **Materials and Methods:** To achieve this objective, field observation for plant incidence, leaf incidence and visual count of the pest was conducted and their correlation with climatic parameters were statistically analyzed by one way ANOVA and KyPlot. **Results:** In 2015 the population was initiated at about 22 Standard Meteorological Weeks (SMW) and attained the maximum at about 28 SMW. The pest incidence then decreases slowly with time and it maintained a lofty abundance up to crop harvesting. In 2016, the population dynamics was quite different with changing weather. Grossly abiotic conditions such as temperature, relative moisture and rainfall showed a key role in incidence of *Anomis sabulifera*. **Conclusion:** It was concluded that, the provided data on insect pest incidence give better understanding in effect of weather on seasonality of the pest. That indulgent will be very helpful to construct an appropriate strategy in pest management for sustainable agriculture.

Key words: Jute semilooper, *Anomis sabulifera*, tosa jute, seasonal incidence, climatic condition, pest management, sustainable agriculture

Received: December 13, 2016 Accepted: January 27, 2017 Published: February 15, 2017

Citation: Abdul Sadat and Kaushik Chakraborty, 2017. Studies on incidence of jute semilooper in relation to weather of uttar dinajpur, India. J. Entomol., 14: 96-103.

Corresponding Author: Abdul Sadat, Department of Sericulture, Raiganj University, Raiganj, West Bengal, 733134, India Tel: +919932341504

Copyright: © 2017 Abdul Sadat and Kaushik Chakraborty. This is an open access article distributed under the terms of the creative commons attribution License, which permits unrestricted use, distribution and reproduction in any medium, provided the original author and source are credited.

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Incidence study of jute semilooper (*Anomis sabulifera* Guen.) in relation to weather become awfully fundamental task for improvement of jute fiber yield in Uttar Dinajpur, India. Commercial importance of jute in lieu of synthetic fiber is ever increasing for Indian agrarian economy[1]. It is mostly cultivated in the eastern part of India covering the Gangetic plains of West Bengal[2]. Chapke *et al.*[3] reported that West Bengal share grossly 80% national production. Out of the all of the administrative districts of West Bengal, Uttar Dinajpur produces 51554 metric tons jute[4]. Though India holding large landmass as jute field but never reach national demand of jute fiber due to pest attack. Pests become resistant to different pesticides due to non-target insecticide treatments. For the execution of jute-IPM protocol for bio-friendly fiber production knowledge on insect pest dynamics is required as bench mark[5].

Jute semilooper is one of the most destructive insect pests which attack both jute pods and unripe seeds accounting 30.50-37.50% fiber loss[6,7]. Rahman and Khan[8] from West Bengal had noted that semilooper was still a major pest and responsible for 31-34% fibre yield loos though uses of chemical pesticides increase day by day. They also advocated that adoption of management practice should be depends on the insect pest dynamics[9]. Agro-climatic conditions dictates and modulates the incidence of insect pest in relation to the crop phenology[10]. Sense on climatic parameters is thus found indispensable and obligatory to forecast insect pest incidence and accordingly to predict the extent of damage[11].

Jute has covered an ample agricultural land in the District Uttar Dinajpur[4].The incidence of jute semilooper in Uttar Dinajpur, in relation to agro-climatic factors was not investigated so far. In this contemplation, study was undertaken with an aim to unfold the incidence of *A. Sabaulifera* for two consecutive years in relation to climatic conditions of the district Uttar Dinajpur, West Bengal.

Grossly, there are three definite objectives of this study. Primarily (i) To define the population dynamics of jute semilooper (ii) To consider the effect of weather parameters on the incidence of that pest population (iii) To apply the generated information relating to jute semilooper population dynamics in integrated pest management decision-making for appropriate timing and dose of applied pesticide to control jute semilooper.

MATERIALS AND METHODS

Location and agro-climatic condition: Raiganj [26°35′15″ (N)-87°48′37″ (W)] is the administrative head quarter of the district Uttar Dinajpur and is situated within the upper *Gangetic* plain. The climate of this zone is sub-tropical humid in nature. The average annual rain fall varies from 2100-3000 mm, the maximum rainfall occurs during the rainy months of June-September amounting to more than 80% of the total rain fall for last 10 years (2006-2016). The annual average day night temperature ranges between 19.7 and 29.9°C with the mercury soaring even as high as 33°C in April and cascading to a low of 3°C in January. The relative humidity at 8:30 h is 58 and 88% in March and July, respectively. The relative humidity in the afternoon at 17:30 h is 48 and 84% in March and November, respectively.

Jute plant: *Corchorus olitorius* are flowering plants belongs the family Malvaceae. The plants are tall, usually annual herbs which reaches a height of 2-4 m[12]. These plants are mostly unbranched or with only a few side branches. The leaves are simple and arranged in alternate fashion. It produces small yellow flowers of 2-3 cm diameter and five petals. These flowers resulted into fruits which encapsulates many seeds. It thrives almost anywhere and can be grown year-around[12].

jute pest: Jute semilooper, *Anomis sabulifera* (Lepidoptera: Noctuidae) is a monophagus insect pest predominantly present in the upper Gangetic plains of West Bengal. It completes its lifecycle in an average 30 days. Adult is stoutly built with dark brown patches on the apex of forewing. Females lay eggs on both surfaces of top ten leaves. After hatching larvae loop their body as they crawl. Larvae vigorously feed on leaves specially confined up to top 9th leaf[13,14].

Experimental design: The jute seeds were sown in a row spacing of 25 cm in small plots of 4×4 m with a gap of 1 m between each plot. At completely grown condition, plant to plant distance was maintained at 6-8 cm apart after thinning. Fertilizer treatment and the necessary field management were done following national protocol with suitable modifications. The soil of the experimental field was sandy loam with pH value 6.8 and EC value 0.28 mmhs cm^{-1}. N, P_2O_5 and K_2O contents were 280, 26 and 265 kg ha^{-1}, respectively. However no insecticide was applied during the period of study. There were three replications for each of the experiment years.

Record on Agro-ecological parameters: Weekly noted pest incidence were correlated with the prevailing climatic factors such as maximum temperature (Tmax), minimum temperature (Tmin), temperature gradient (Tgr), maximum humidity (RHmax), minimum humidity (RHmin), humidity gradient (RHgr) and rainfall (Rfall). Further inter relationship of the climatic factors was also worked out and then tabulated in matrix pattern.

Record on *A. sabaulifera* incidence: Larval population of *A. sabulifera* was assessed by both (i) direct visual counting of larvae and (ii) by assessing the extent of infestation to plant and leaves of jute crop at 7 days interval in relation to Standard Meteorological Week (SMW) as delineated below:

- **By visual counting:** About 10 jute plants from each of the three replication sites were randomly selected. From each plant top ten leaves were considered to count the insect incidence and subsequently averaged. Counting was started from 16-35 SMW that covers the seedling stage to the harvest of the crop
- **By assessing extent of damage:** About 1 m^2 area in each of the selected site were observed for pest related damage and then (i) Percentage of plant infested with *A. Sabulifera* larvae and (ii) Number of infested leaves out of the top eight leaves of each plant was counted following Rahman and Khan[9]

Statistical analysis: The polled data were analyzed by one way ANOVA with 5% level of significance[8] after square root transformation and mean was compared using INDOSTAT (DGW8) computer programmed. Linear regression and correlations analysis were calculated using KyPlot version 2.0 beta 15 (32 bit)[6].

RESULTS AND DISCUSSION

Study on the incidence of jute semilooper, *Anomis sabilifera* in jute field was assessed by randomized block design during two consecutive *kharif* crop seasons (2015-2016) at Raiganj, Uttar Dinajpur, West Bengal. The results are delineated below.

Incidence of semilooper population: During *kharif* season, initially very low number of semilooper population was recorded up to 19 SMW. The population then gradually increased from about 20-23 SMW. The number then further improved gradually up to 28 SMW then steadily up to about 31 SMW. The appearance of peak population was restricted to about 27 SMW. Persistent high population was noted from 25-31 SMW. The population then subsumed at first slowly then abruptly. Incessantly low number was counted from 32 SMW. After 34 SMW very low detectable range of population was noted.

However, variation in semilooper incidence was noted in 2 years of observation. In 2015, semilooper infestation started at 22 SMW. The extent of plant and leaf injuries was at low level respectively. Damage gradually increases up to 27 SMW attaining peaks during 28 SMW with high plant infestation and leaf injury respectively. Semilooper remained active till harvest of the crop though the presence was sporadic.

In 2016 semilooper infestation was started quite earlier at 19 SMW 19 with a higher plant and leaf infestation respectively in comparison to previous year (2015). The rate of infestation gradually increased up to 29 SMW. Incidence of this pest reached the peak during 30 SMW with very colossal plant and leaf infestations and slowly declined thereafter but remained active till harvest of the crop.

In visual count, the number of individuals in general was 1 larvae/plant. Rarely in some occasions was 4 larvae/plant observed. In 2015 semilooper population was first visually traced at 23 SMW. The number was then gradually increased up to 27th SMW and attained a peak at 28 SMW and then the population slowly decreased with trace population un till crop harvested.

In 2016, visually semilooper population was first noted at 19 SMW. Though it was early infestation but numbers of pest was almost same as the year 2015. The number was then gradually increased up at 29 SMW with a peak at 30 SMW which showed very high pest incidence in comparison to previous year (2015). However, though in trace, the population remained active till harvest of the crop (Table 1).

Correlation of the semilooper population with climatic factors: In 2015, the incidence of semilooper showed negatively significant correlation with the Tmax ($p \leq 0.0001$) and with Tmin ($p \leq 0.001$), but incidence of semilooper showed positively significant correlation with RHmax ($p \leq 0.0001$) and RHmin ($p \leq 0.05$). Insignificant negative relations were noted between RHgr and pest in all the experimental years. However significant positive influence of RHavg ($p \leq 0.0001$) was noted with the pest incidence in all the years. Showery Rain fall had a significant positive effect ($p \leq 0.001$) on the pest dynamics. But heavy rainfall within a short period had imparted significant negative effect ($p \leq 0.0001$) on semilooper incidence. Waines *et al.*[15], Ahirwar *et al.*[16] and Ali *et al.*[17] reported in their literature that lepidopteran larva population

Table 1: Incidence of jute semilooper, *A. sabulifera* on olitorius jute at Raiganj, Uttar Dinajpur, West Bengal

	Pest incidence					
	Years					
	2015			2016		
Week of Observations (SMW)	Percent incidence in Plant (plant/m^2)	Percent incidence in Leaf (Leaf/plant)	Visual count (No. of larvae/plant)	Percent incidence in Plant (plant/m^2)	Percent incidence in Leaf (Leaf/plant)	Visual count (No. of larvae/plant)
18	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00
19	0.00±0.00	0.00±0.00	0.00±0.00	9.31±0.47	6.84±0.65	0.13±0.02
20	0.00±0.00	0.00±0.00	0.00±0.00	11.45±0.45	7.44±0.55	0.17±0.02
21	0.00±0.00	0.00±0.00	0.00±0.00	15.10±0.36	13.14±0.56	0.23±0.03
22	4.86±0.23	2.50±0.32	0.00±0.00	27.84±0.56	20.93±0.45	0.67±0.02
23	6.89±0.36	4.85±0.36	0.13±0.02	30.15±0.36	22.84±0.57	0.73±0.04
24	8.54±0.35	5.48±0.62	0.17±0.02	33.82±0.53	26.12±0.27	0.83±0.03
25	11.76±0.56	6.21±0.27	0.23±0.03	35.78±0.26	26.57±0.65	0.90±0.05
26	12.26±0.34	8.56±0.40	0.37±0.06	38.22±0.45	27.49±0.39	1.16±0.06
27	14.88±0.73	11.56±0.76	0.80±0.04	41.12±0.75	29.37±0.45	1.23±0.03
28	15.84±0.33	12.76±0.36	0.83±0.04	41.38±0.52	29.88±0.33	1.30±0.06
29	13.66±0.36	10.77±0.74	0.77±0.04	42.72±0.37	31.48±0.36	1.33±0.03
30	12.48±0.37	8.88±0.38	0.77±0.03	43.88±0.42	32.47±0.64	1.43±0.06
31	9.86±0.61	6.24±0.48	0.37±0.07	39.28±0.55	27.88±0.36	1.43±0.04
32	11.28±0.27	5.96±0.34	0.43±0.06	35.63±0.34	26.35±0.55	0.93±0.07
33	8.84±0.23	5.72±0.46	0.27±0.08	32.41±0.75	23.55±0.67	0.90±0.05
34	6.47±0.18	4.22±0.28	0.23±0.03	25.22±0.56	22.87±0.67	0.80±0.06

Data are expressed in Mean±SD

Table 2: Correlation coefficient of incidence of the pests with the climatic factors indicating the level of significance in Raiganj

	Years of observation	
Climatic parameters	2015	2016
Maximum temperature (Tmax)	-0.9324***	-0.4859**
Minimum temperature (Tmin)	-0.9641***	-0.9815***
Temperature gradient (Tgr)	-0.5456***	-0.3957*
Average temperature (Tavg)	-0.2967^{NS}	-0.3572^{NS}
Maximum humidity (RHmax)	0.9660***	0.7795***
Minimum humidity (RHmin)	0.5712*	0.7587***
Humidity gradient (RHgr)	-0.0240^{NS}	-0.5877^{NS}
Average humidity (RHavg)	0.7811***	0.6991**
Rainfall (Rfall)	0.6489**	0.6192**

Significant at: *p≤0.05, **≤0.001, ***≤0.0001, NS: Not significant

decreased down due to heavy rainfall. Ahmad and Ansari[18] documented that 1 h of heavy rain resulted 95.30 and 42.70% decrease of first instar and last instar, respectively (Table 2).

In 2016, the incidence of *A. sabulifera* showed significant negative correlation with Tmax (p≤0.0001), Tmin (p≤0.0001) and RHgr (p≤0.05). A negative impact of temperature on different pests also reported by Hafeez *et al.*[19], Chakraborty[20] and Harish *et al.*[21]. Whereas data shows a significant positive correlation between pest and with the RHmax (p≤0.0001), RHmin (p≤0.0001), RHavg (p≤0.001) and Rfall (p≤0.001). Like previous year (2015) an insignificant negative correlation maintained with Tavr and RHgr, respectively (Fig. 1 and 2).

Present study showed that in 2015 the population was initiated at about 22 Standard Meteorological Weeks (SMW) and attained the maximum at about 28 SMW. The pest incidence then decreases slowly with time and it maintained a lofty abundance up to crop harvesting. In 2016, the population dynamics was quite different as early infestation and higher abundance was recorded with changing weather. Grossly abiotic conditions such as temperature, relative moisture and rainfall showed important influences in incidence of *Anomis sabulifera.*

The plant growth stage and agro-climatic conditions seems to be the main factors affecting the field distribution of the *A. sabulifera*[9]. As the growth stage of jute crop advances, it produces more leaves. Adults of *A. sabulifera*

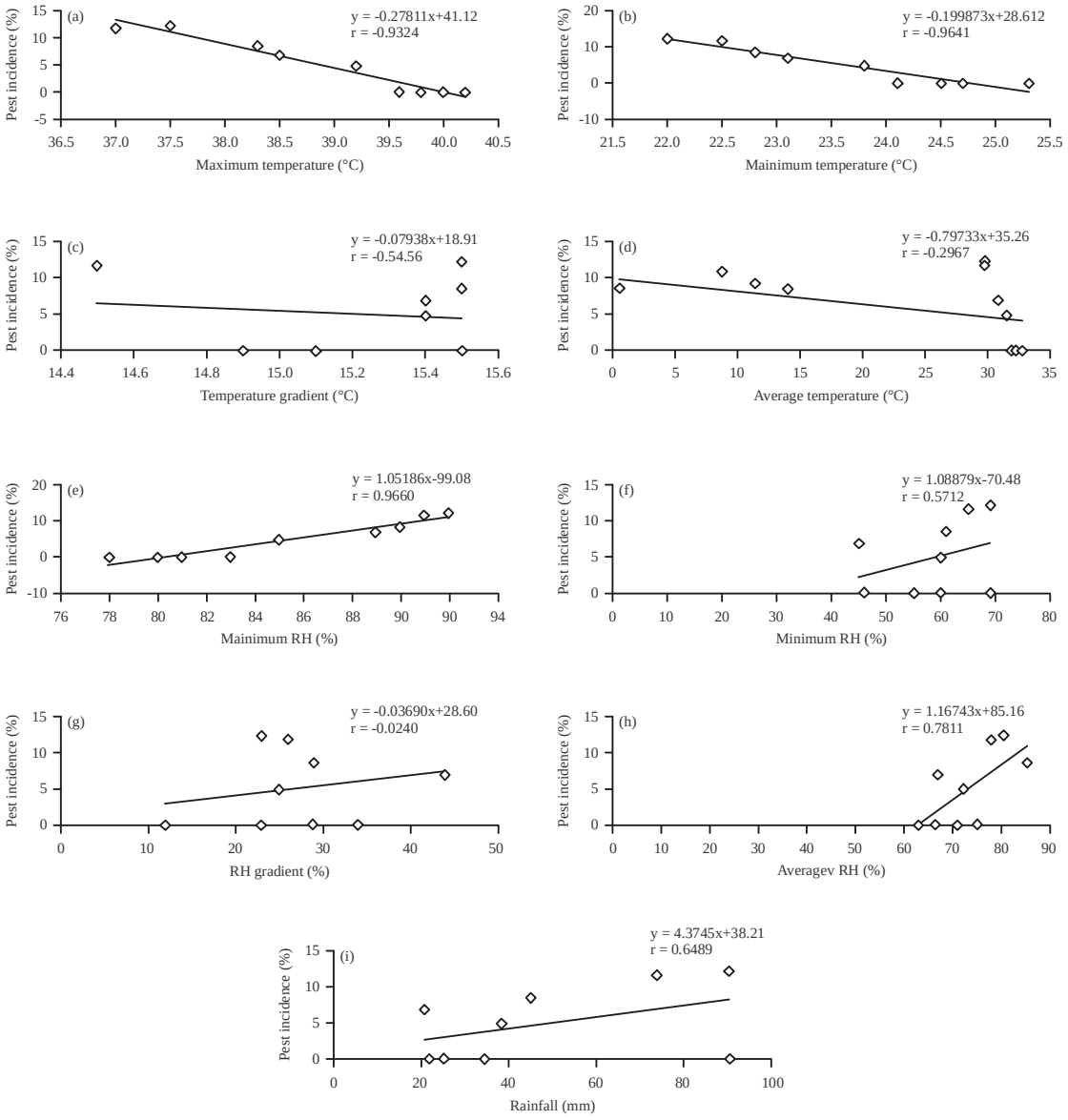

Fig. 1(a-i): Correlation between incidence the incidence of *A. sabulifera* and climatic parameters in 2015 (a) Maximum temperature (Tmax), (b) Minimum temperature (Tmin), (c) Temperature gradient (Tgr), (d) Average temperature (Tavg), (e) Maximum RH (RHmax), (f) Minimum RH (RHmin), (g) RH gradient (RHgr), (h) Average RH (RHavg) and (i) Rainfall (Rfall)

settle down, lay eggs and from that larvae develop; as a consequence the population increased[22]. Roul[23] and Rahman and Khan[24] reported that *A. sabulifera* was predominant species throughout the jute growing region of India and Bangladesh. Present study is in consonance with Sadat and Chakraborty[25]. They had also observed that leaves of the top region of the jute plant are more affected by the pest. Rahman and Khan[9,10] from southern parts of West Bengal have noted that the incidence of that *A. sabulifera* was least in early vegetative stage of jute plant covering the calendar month April-May and had registered 3.58% damage. At maximum mature stage jute pant that coincides the calendar month of mid to late July the extent of loss was about16.56%. Present study corroborates with that study made by Rahman and Khan[9]. Pre monsoon rains followed by drought condition are congenial for the outbreak of semilooper and may lead up to 50% loss of crop as reported by Sadat and Chakraborty[26].

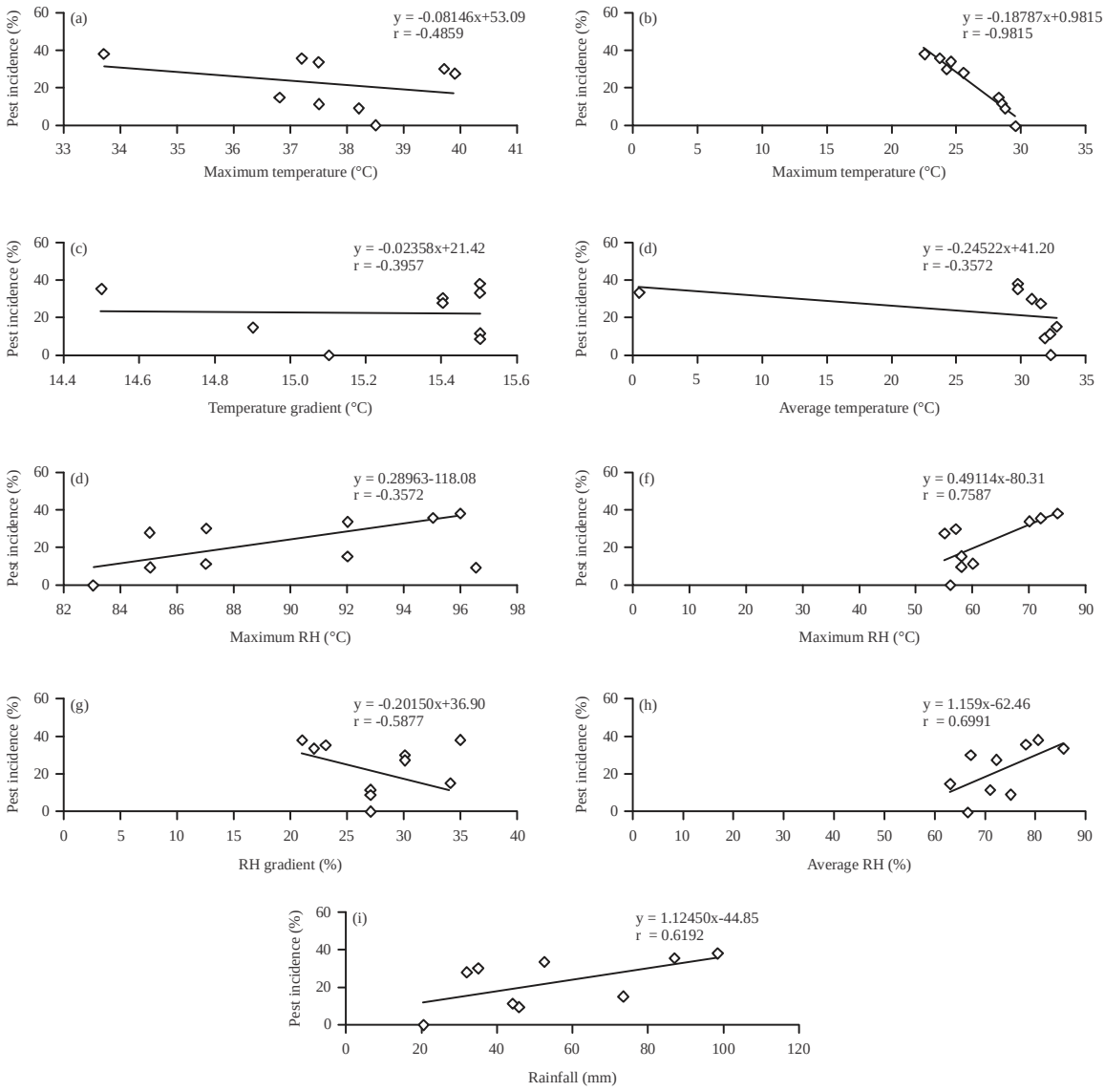

Fig. 2(a-i): Correlation between incidence the incidence of *A. sabulifera* and climatic parameters in 2016: (a) Maximum temperature (Tmax), (b) Minimum temperature (Tmin), (c) Temperature gradient (Tgr), (d) Average temperature (Tavg), (e) Maximum RH (RHmax), (f) Minimum RH (RHmin), (g) RH gradient (RHgr), (h) Average RH (RHavg) and (i) Rainfall (Rfall)

This kind of findings was also observed in present study during the year 2016 where pest population achieved highest peak of 43.88% which was almost four times greater than its incidence (15.84) of the previous year (2015).

Waterhouse[27,28] in southeastern part of Asia and Rahman and Khan[9] in southern part of West Bengal have observed that the semilooper population gradually increased during early crop growing stages, but had gained momentum and upsurge from early mature stage coupled with favorable agro-climatic conditions.

CONCLUSION

It was concluded that present study evicted a clear relation between jute semilooper and different parameters of weather. Abundance of pest population changes with changing climatic conditions throughout the jute growing season. The information about the seasonal incidence may be utilized for planning the appropriate time fitted insect pest management strategies for sustainable agriculture. Stipulated data in the present study may provide foundation to other

researchers for developing their research model and understanding the pest-weather relation.

SIGNIFICANCE STATEMENTS

This study discover the influence of region based climatic condition on occurrence of jute semilooper pest which are major threat to jute cultivation that can be beneficial for construction of time fitted pest management to minimize pest menace and increase jute production to achieve sustainable development. This study will help the researcher to uncover the critical areas of pest weather relation and pest seasonality in the upper Gangatic plains that many researchers were not able to explore. Thus a new theory on jute pest management may be arrived at an earliest.

ACKNOWLEDGMENT

We acknowledge technical assistance from University of Gour Banga, Malda, India and we are thankful to the Additional Director of Agriculture Department and Mr.J. N. Laskar (Senior Meteorologist), North Bengal Region, India for providing meteorological data of Uttar Dinajpur district for the consecutive study period.

REFERENCES

1. FAO., 2014. FAO statistics 2014. Food and Agriculture Organization of United Nations, Department of Economic and Social, The Statistical Division.
2. Raja, K., 2012. Complete information on area and production of jute in India. http://www.preservearticles.com/2012020322586/complete-information-on-area-and-production-of-jute-in-india.html.
3. Chapke, R., C.R. Biswas, S.K. Jha and S.K. Das, 2006. Technology evaluation through frontline demonstrations and its impact. Central Research Institute for Jute and Allied Fibres, Bulletin No. 03.
4. Anonymous, 2005. Hand Note Book of Principal Agricultural Office, U/D, India. Agricultural Office, U/D., Uttar Dinajpur District, India.
5. Gold, M., 2009. What is sustainable agriculture? Department of Agriculture, Alternative Farming Information Center, USA.
6. Anonymous, 2014. Attack of jute semilooper. Department of Agriculture, Government of West Bengal, India.
7. Anonymous, 2017. Jute semi-looper (Anomis sabulifera). Plantwise Knowledge Bank. http://www.plantwise.org/nowledgeBank/Datasheet.aspx?dsid=15500.
8. Rahman, S. and M.R. Khan, 2006. Incidence of pests and avoidable yield loss in jute, *Corchorus olitorius* L. Ann. Plant Prot. Sci., 14: 304-305.
9. Rahman, S. and M.R. Khan, 2012. Incidence of pests in jute (*Corchorus olitorius* L.) Ecosystem and pest-weather relationships in West Bengal, India. Arch. Phytopathol. Plant Prot., 45: 591-607.
10. Rahman, S. and M.R. Khan, 2012. Effect of plant characteristics of jute varieties on incidence of pests in West Bengal, India. Arch. Phytopathol. Plant Prot., 45: 606-619.
11. Kawakami, Y., K. Yamazaki and K. Ohashi, 2016. Population dynamics, seasonality and aphid prey of *Cheilomenes sexmaculata* (Coleoptera: Coccinellidae) in an urban park in Central Japan. Eur. J. Entomol., 113: 192-199.
12. Islam, M.M., 2013. Biochemistry, medicinal and food values of jute (*Corchorus capsularis* L. and *C. olitorius* L.) leaf: A review. Int. J. Enhanced Res. Sci. Technol. Eng., 2: 35-44.
13. Srivastava, K.P., 2004. A Textbook of Applied Entomology. 2nd Edn., Vol. 2, Kalyani Publishers, New Delhi, pp: 176-184.
14. Anonymous, 2014. Major pests of jute. Development of a Course of Agriculture, Tmilnadu University, India.
15. Wains, M., M. Ali, M. Hussain, J. Anwar, M. Zulkiffal and W. Sabir, 2010. Aphid dynamics in relation to meteorological factors and various management practices in bread wheat. J. Plant Prot. Res., 50: 386-392.
16. Ahirwar, R., P. Devi and R. Gupta, 2015. Seasonal incidence of major insect-pests and their biocontrol agents of soybean crop (*Glycine max* L. Merrill). Scient. Res. Essays, 10: 402-406.
17. Ali, F., I. Khan, Zakirullah, A. Ali and Anees-ur-Rahman, 2016. Study on the population trend of brinjal fruit borer *Leucinodes orbonalis* Guen. (Lepidoptera: Pyralidae) and its susceptibility to different insecticides. APRN J. Agric. Bio. Sci., 11: 262-2666.
18. Ahmad, T. and M. Ansari, 2010. Studies on seasonal abundance of diamondback moth *Plutella xylostella* (Lepidoptera: Yponomeutidae) on cauliflower crop. J. Plant Prot. Res., 50: 280-287.
19. Hafeez, A., R.B. Khan, D. Sharma, V.V.S. Jamwal and S. Gupta, 2010. Seasonal incidence ant trap catches of *Cnaphalocrocis mendinalis* (Guen.) in rice. Ann. Plant Prot. Sci., 18: 380-383.
20. Chakraborty, K., 2013. Population dynamics of *Orseolia oryzae* (Wood-Mason) on rice crop at gangetic plains of West Bengal. Ann. Plant Prot. Sci., 21: 13-16.
21. Harish, G., M.V. Nataraja, P. Jasrotia, P. Holajjer, S.D. Savaliya and M. Gajera, 2015. Impact of weather on the occurrence pattern of insect pests on groundnut. Legume Res., 38: 524-535.
22. Bhattacharya, B., 2013. Advance in Jute Agronomy, Processing and Marketing. 1st Edn., PHI Learning Private Ltd., New Delhi, India.
23. Roul, C., 2009. The International Jute Commodity System. 1st Edn., Northern Book Centre, New Delhi, India.
24. Rahman, S. and M.R. Khan, 2010. Integrated management approach for control of the pest complex of olitorius jute, *Corchorus olitorius* L. J. Plant Prot. Res., 50: 340-346.

25. Sadat, A. and K. Chakraborty, 2015. Insect pest constrains of jute and its control by biological agents under modern eco-friendly sustainable production system. Int. J. Multidiscip. Res. Dev., 2: 316-321.
26. Sadat, A. and K. Chakraborty, 2015. Feeding Behaviour and Dynamics of Lepidopteran Insect Pests of Jute in Response to the Plant Phenology and Phyto-nutrients: An Overview. Asian J. Biochem. Pharm. Res., 5: 162-177.
27. Waterhouse, D.F., 1991. Guideline for biological control project in Pacific, South Pacific commission information: Document No. 57. South Pacific Commission, Noumea, New Caledonia, pp: 33.
28. Waterhouse, D.F., 1998. Biological Control of Insect Pests: Southeast Asian Prospects. Australian Center for Agricultural Research, Canberra, pp: 29-30.