Original Research Article

Seasonal Abundance of Sugarcane Mealybugs and Their Natural Enemies

ABSTRACT

An experiment was conducted in two insect prone areas viz., Bangladesh Sugarcrop Research Institute (BSRI), Pabna and Regional Sugarcrop Research Station (RSRS), Thakurgaon to study the seasonal abundance of sugarcane mealybugs and their natural enemies during 2013-14 cropping season. The infestation was higher at Thakurgaon than Pabna during almost entire cropping season but a little higher at Pabna in November. The lowest infestation was recorded in Pabna (6.30%) in May and the highest (34.71%) in November. At Thakurgaon, the lowest infestation (7.48%) was found in May and the highest (29.30%) in September. Results revealed that percent loss in weight of sugarcane was 4.76 to 36.50 at 10% and 100% infestation level in Pabna. On the other hand, 6.57 to 33.55% loss of cane weight cause at 10% and 100% infestation level in Thakurgaon. The results proved that weight loss generally increases with the increase in infestation. Positive relationship was observed between infestation and relative humidity in the ecosystem, but negative relationship was evident with the temperature and rainfall. Different natural enemies viz., parasitic wasps, ladybird beetles, hover flies, brown lacewings, spider, cryptochaetum were found to be abundant in the study plot during the month of June to August.

Key words: Mealybugs; Natural enemies; Seasonal abundance; Sugarcane.

1. INTRODUCTION

Insects have a wide distribution from the equator to the poles. This wide distribution is correlated with extremely favourable conditions. The activities of insects are governed by several factors, both intrinsic and extrinsic. The essential components of the environment which often determine the survival of an insect species and influence their behavior, development and fecundity are temperature, humidity, light and rainfall (i.e., weather), food, other animals, disease producers and the habitats [1]. Climate and

weather can substantially influence the development and distribution of insects. It occurs throughout the year but distribution and infestation is not uniform throughout the seasons. Ebieda [2] found that there were positive relationships between the mean temperature and the possible sunshine duration. The timing of attack by insects can vary greatly both from region to region and from year to year because the rates at which insects complete their life cycles depend mainly on temperature [3]. Pandey and Kant [4] concluded that significant and positive correlation ('r' ranging from 0.465 to 0.541 for the crops) existed between the pest population and the maximum temperature whereas minimum temperature correlated negatively. A highly significant positive correlation with relative humidity ('r' ranging from 0.71 to 0.84) clearly showed a major role in pest build up. Hu [5] indicated that organisms can respond to variation in temperature on phenotypes or through long-term adaptation to temperature.

Thirty species of mealybugs are known to attack sugarcane in different countries of the world. In 1978, four species of mealybugs have been recorded from different ecological zones of Bangladesh [6] as a minor insect pest but they are occasional and recognized as important and appear to become a threat to all the sugarcane growing regions of Bangladesh. It's intensity of attack, speed of spread and symptoms of damage worries the farmers and scientists. Biswas [6] reported that 20% yield loss, 21.1 to 30% loss of sugar recovery and 16.2% loss of brix by mealybugs. Mealybugs only tend to be serious pests in the presence of ants because the ants protect them from predators and parasitoids [7]. Naidu [8] reported poor germination up to 35% and 16.2% loss of brix by mealybugs infestation. Prasad [9] stated that the mealybugs are gregarious in habit. The mealybugs main attack started after internode formation of the cane. In case of severely infested canes the sucrose content decreases by 24.1 percent, while the reduction in brix was 16.2 percent, besides this, the severely infested canes germinate poorly [9].

Natural enemies of insect pests play a key role in reducing the levels of pest populations below those causing economic injury. Abrupt environmental changes as induced by current climatic variability are likely to exert greater influence on pests and natural enemies than the gradual climate change. Many Hymenopteran wasp parasitoids and tachnid flies which feed on several host insects are likely to be less susceptible to the asynchrony with their hosts induced by climate change [10]. Mealybugs are attacked by

numerous natural enemies, which usually keep them under control. Most common natural enemies include parasitic wasps, ladybird beetles, hover flies and lacewings.

Seasonal abundance of different borers, grubs, termites etc., was reported earlier but no report is available on mealybugs in Bangladesh. Justification of management of any insect pests depends on the importance or economic loss. Therefore, the present study was undertaken to find out the seasonal abundance of mealybugs infesting sugarcane influenced by climatic factors, prevalence of natural enemies and assessing the extent of yield loss.

2. MATERIALS AND METHODS

2.1 Study Site

The study was conducted in two insect prone areas namely Pabna which belongs to the Agro-ecological zone-11 under high ganges river flood plain soils and Thakurgaon which belongs to the Agro-ecological zone-1 under the old himalayan piedmont plain soils. Physiographic unit of this zone is $25^0$38′ N latitude and $88^0$41′ E longitude [11].

2.2 Plantation, Fertilization and Irrigation

Based on the findings of Entomology Division, BSRI the most susceptible variety Isd 36 was used as planting material for recording seasonal abundance of mealybugs. The experiments were set up during the cropping season of 2013-14. After proper land preparation, 400 m^2 (20 m x 20 m) plots were made for sugarcane plantation at both locations. Two budded setts were planted in each trench through conventional method [12]. All recommended doses of fertilizers were applied following the procedures of fertilizer recommendation guide [13]. The study was undertaken at natural condition i.e., without any insecticides application in the experiment. The plots were left undisturbed to facilitate the desired insects for natural infestation. Irrigation was applied thrice at plantation, tillering and development stage.

2.3 Environmental and Soil Factors

Maximum and minimum air temperature, monthly average rainfall, relative humidity, Physical characteristics and chemical composition of soils were recorded from each experimental site from plantation to harvest.

2.4 Data Collection

The percent infestation of sugarcane by mealybugs was recorded at fortnight interval from vegetative stage to harvest. Total numbers of healthy and infested canes were counted from whole plot and percent infestations were calculated by following formula:

$$\text{Infestation (\%)} = \frac{\text{Number of infested cane}}{\text{Total number of healthy cane}} \times 100$$

The canes weight loss was recorded at harvest. The data were collected from 10 m^2 plot. Canes were sorted into several groups including the healthy and infested at different levels of infestations. Ten canes were selected randomly from each group and then weight measured separately. The weight loss (%) was estimated by using the formula:

$$\text{Weight loss (\%)} = \frac{A-B}{A} \times 100$$ where, A = weight of healthy cane, B = weight of infested cane.

At harvest, samples of ten canes were sorted having uninfested and infested comprising 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100% randomly. The investigation consists of eleven treatments including one untreated (uninfested canes). Ten sweeping was done per fortnight interval to observe the existing natural enemies. The treatments were replicated thrice and statistical analysis was done by Statistical Analysis Software (SAS) 9.1 Windows version for comparison.

3. RESULTS AND DISCUSSION

3.1 Seasonal Abundance of Mealybugs at BSRI, Pabna

Seasonal abundance of sugarcane mealybugs infestation with weather factors in BSRI is presented in Fig. 1 to highlight the influence on the incidence. The major weather factors such as the air temperature, average monthly rainfall and monthly relative humidity of experimental site were recorded during January to November. From January to April (germination and vegetative stage), there was no infestation of mealybugs observed. The infestation initiated just after internode formation and then increased rapidly. In May, the lowest infestation was recorded 6.30% at 28.58^{0}C temperature, 82.99% RH and 10.90 mm rainfall. Then infestation increased gradually and reached to peak (34.71%) in November when the average temperature, relative humidity and rainfall were 20.69^{0}C, 82.09% and 0.00 mm, respectively.

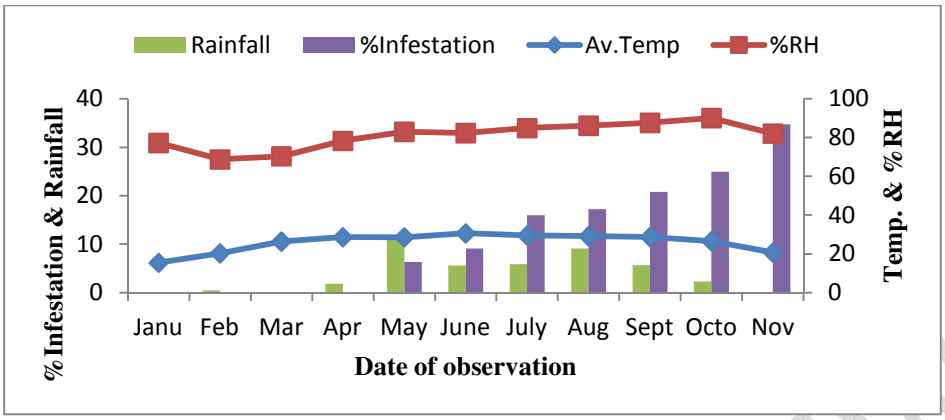

Fig. 1. Mealybugs infestation in relation to weather factors: temperature (^{0}C), relative humidity (%) and average rainfall (mm) at BSRI

At higher level of relative humidity, moderate temperature (20-30^{0}C) and lower rainfall the mealybugs infestation was also high. Relationship of mealybugs infestation was positively correlated with relative humidity i.e., when the relative humidity showed increasing trend then the infestation started to increase. Results indicated that rainfall has a strong inverse effect but temperature had negative effect (Fig. 1). The findings are at par with the findings of Watson and El-Serwy [14] who stated that the monthly average temperature 29.02^{0}C and 62.2% RH were favorable for the highest fecundity.

3.2 Relationship of Mealybugs Infestation with Temperature at BSRI

The relationship of mealybugs infestation with temperature was negative and linear, could be expressed by the regression equation, y = 0.299x + 3.989, where y = mealybugs infestation (%) and x = temperature (^{0}C). However, the relationship was very weak showing very low co-efficient of determination (R^2 =0.014).The value of co-efficient of determination indicates that influence of temperature on mealybugs was less than 1.4%. So, contribution of other factors to change mealybugs infestation was less than 98.6% (Fig. 2). The probable cause of negative relationship between infestation and temperature might be due to unfavorable condition for mealybugs reproduction which probably decreases infestation.

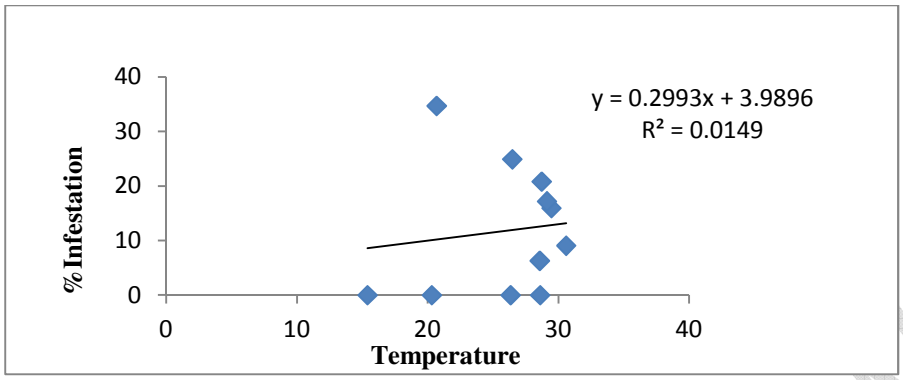

Fig. 2. Relationship between mealybug infestation and temperature at BSRI

3.3 Relationship of Mealybugs Infestation with Rainfall at BSRI

The relationship of mealybugs infestation with rainfall was weak inverse which means that increase in rainfall decreased the infestation. The probable cause of this relationship between these two parameters might be due to unfavorable situation for physiological activity which hinders their infestation. Their relationship could be expressed by a regression equation, y = 0.373x + 10.31 (Fig. 3).

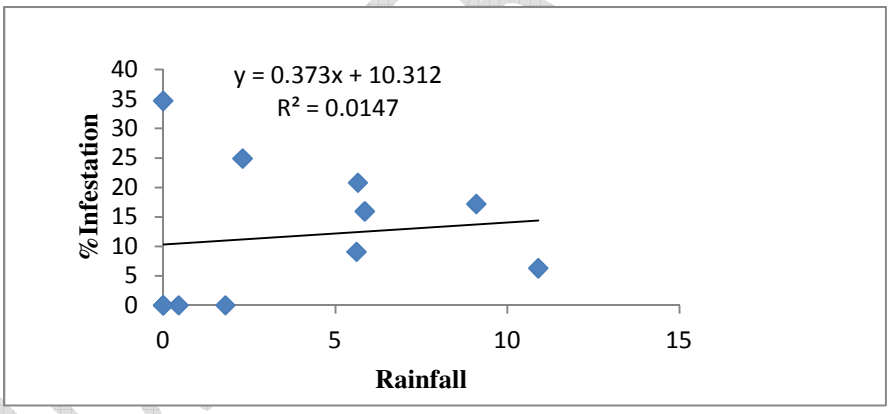

Fig. 3. Relationship between mealybugs infestation and rainfall at BSRI

3.4 Relationship of Mealybugs Infestation with Relative Humidity at BSRI

The relationship of mealybugs infestation with relative humidity positive and linear, could be expressed by the regression y = 1.258x – 90.24. However, the relationship was strong showing high co-efficient of determination (R^2 =0.514). The value of co-efficient of determination indicates that influence of relative humidity on mealybugs was 51%. The regression co-efficient was 1.25%, which means that 1% change in RH only 1.25% change may occur in mealybugs infestation (Fig. 4). So, contribution of other factors to change mealybugs infestation was more than 49%.

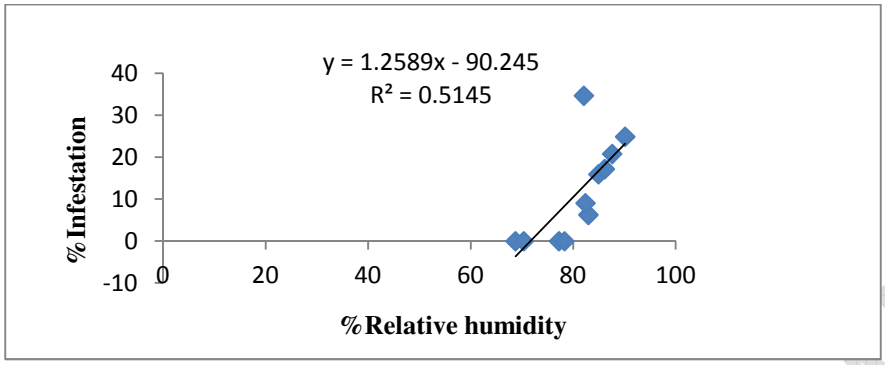

Fig. 4. Relationship between mealybug infestation and relative humidity at Pabna

3.5 Seasonal Abundance of Mealybugs at RSRS, Thakurgaon

The relationship of mealybugs with weather parameters at RSRS, Thakurgaon is shown in Fig. 5. The weather data of maximum and minimum temperature, average monthly rainfall and mean of monthly relative humidity of experimental site were recorded during January to November. From January to April, mealybugs infestation was not observed. The lowest infestation of mealybugs was recorded (7.48%) in May at 28.40^{0}C temperature, 72%RH and 89.00 mm rainfall and the highest (29.30%) in September when the average temperature, relative humidity and rainfall were 29.40^{0}C, 74% and 138.00 mm, respectively.

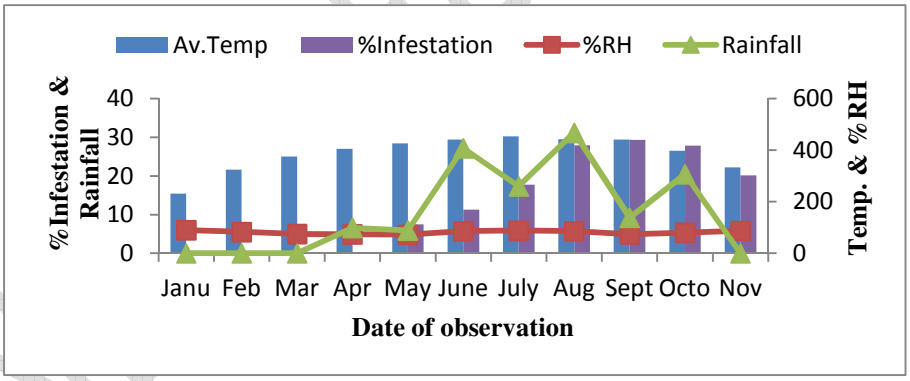

Fig. 5. Mealybugs infestation in relation to weather factors: temperature (^{0}C), relative humidity (%RH) and average rainfall (mm) at RSRS, Thakurgaon

3.6 Relationship of Mealybugs Infestation with Temperature at RSRS

A linear and weakly negative relationship was found of mealybugs infestation with temperature. Their relationship could be expressed by the regression y = 1.374x – 22.69, where y = mealybugs infestation (%) and x = temperature. The relationship was not significant and R^2 value indicates that influence of temperature on the change in mealybugs infestation may be attributed to only 26% (Fig.6).

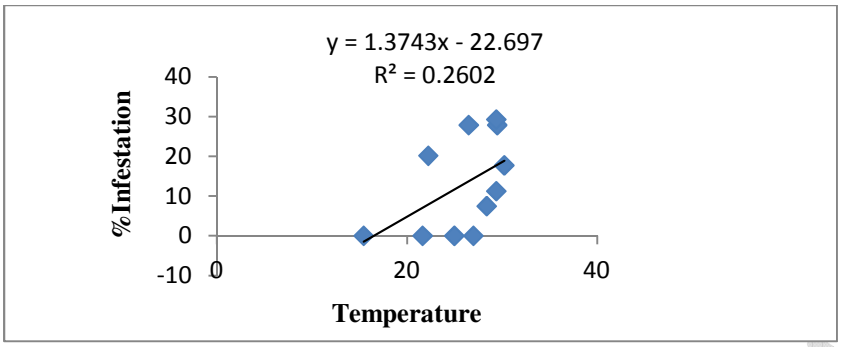

Fig. 6. Relationship between mealybug infestation and temperature at RSRS, Thakurgaon

3.7 Relationship of Mealybugs Infestation with Rainfall at RSRS

The relationship of mealybugs infestation with rainfall was weak inverse which means that increase in rainfall decrease the infestation. The probable cause of this relationship between these two parameters might be due to unfavourable situation for physiological activity which hinders their infestation. Their relationship could be expressed by a regression equation, y = 0.042x + 6.048 (Fig. 7).

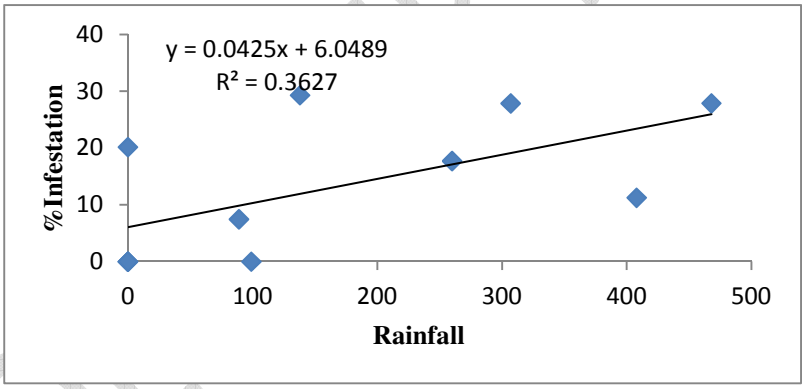

Fig. 7. Relationship between mealybug infestation and rainfall at RSRS

3.8 Relationship of Mealybugs Infestation with Relative Humidity at RSRS

The relationship of mealybugs infestation with relative humidity is positive and linear, could be expressed by the regression y = 0.205x -3.800. However, the relationship was very weak showing insignificant and very low co-efficient of determination (R^2 =0.012). The value of co-efficient of determination indicates that influence of humidity on mealybugs infestation was 1.2% (Fig. 8).

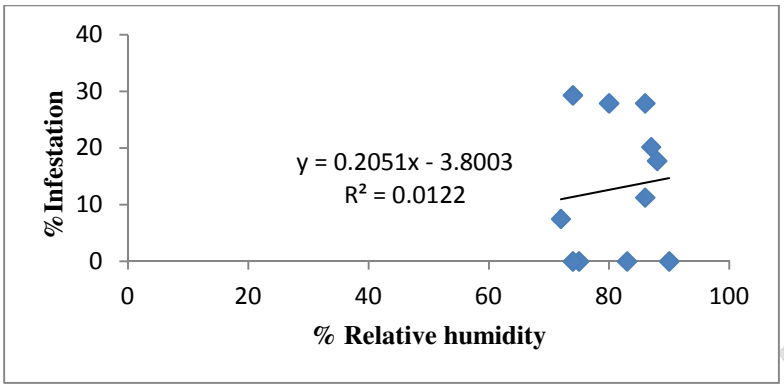

Fig. 8. Relationship between mealybug infestation and relative humidity at RSRS

3.9 Cane Weight Loss

It was observed that substantial yield loss occurs due to attack of mealybugs in tested variety Isd 36. No significant differences were observed in weight loss among 0 to 40% levels of infestation (5.40 - 6.30) but over 50% onward showed remarkable weight loss where infestation of 80% onward gave more than 33% weight loss. The weight loss at 100% infestation level was 36.50% (Table 1). The findings are at par with the findings of Biswas [6] who found that mealybugs caused 20% reduction in yield loss.

Table 1. Loss in weight due to different level of infestation in Isd 36 variety at BSRI

Treatments	Loss in weight due to mealybugs infestations	
	Mean weight (Kg)	Percent loss in weight
0% infestation	6.30 a	-
10% infestation	6.00 a	4.76
20% infestation	5.95 a	5.55
30% infestation	5.62 ab	10.79
40% infestation	5.40 abc	14.28
50% infestation	5.17 abc	17.93
60% infestation	4.95 abc	21.42
70% infestation	4.90 abc	22.22
80% infestation	4.20 bc	33.33
90% infestation	4.05 bc	35.71
100% infestation	4.00 c	36.50
LSD (0.05)	1.59	-

- *Figures accompanied by the same letter are not significantly different at 5% level as per LSD test.*

It reveals from the Table 2 that percent weight losses were 6.57% and 33.55% at 10% and 100% level of infestation in tested variety. Mean loss in cane weight due to the mealybugs varies from 5.05 to 7.10 at 100% to 10% levels of infestation, respectively. The results showed no significant differences were observed in weight loss between healthy canes (7.60) and infested canes of 10%, 20% and 30% where mean weight loss were 7.10, 6.55 and 5.85, respectively. Weight loss was significantly lower at 30 to

100% levels of infestation where percent loss in weight varied from 23.02 to 33.55%. It is observed that higher the levels of mealybugs infestation more the loss in weight in tested variety.

Table 2. Loss in weight due to different level of infestation in lsd 36 variety at RSRS

Treatments	Loss in weight due to mealybugs infestations	
	Mean weight (Kg)	Percent loss in weight
0% infestation	7.60 a	-
10% infestation	7.10 ab	6.57
20% infestation	6.55 abc	13.81
30% infestation	5.85 abc	23.02
40% infestation	5.55 bc	26.97
50% infestation	5.65 bc	25.65
60% infestation	5.75 bc	24.34
70% infestation	5.45 bc	28.28
80% infestation	5.33 bc	29.86
90% infestation	5.20 c	31.57
100% infestation	5.05 c	33.55
LSD (0.05)	1.81	-

** Figures accompanied by the same letter are not significantly different at 5% level.*

3.10 Available Natural Enemies at BSRI and RSRS Experimental Site

From January to March, there were no natural enemies of mealybugs found due to seedling stage of sugarcane. From April to July, there was a sharp increase in natural enemies due to vegetative growth and available host and reached in 30 numbers at BSRI and 38 numbers at RSRS sites (population size in 10 sweeps). They continued to drop gradually from August (Figure 9). Different natural enemies viz., parasitic wasps, ladybird beetles, hover flies, brown lacewings, spider, cryptochaetum were found during the study periods.

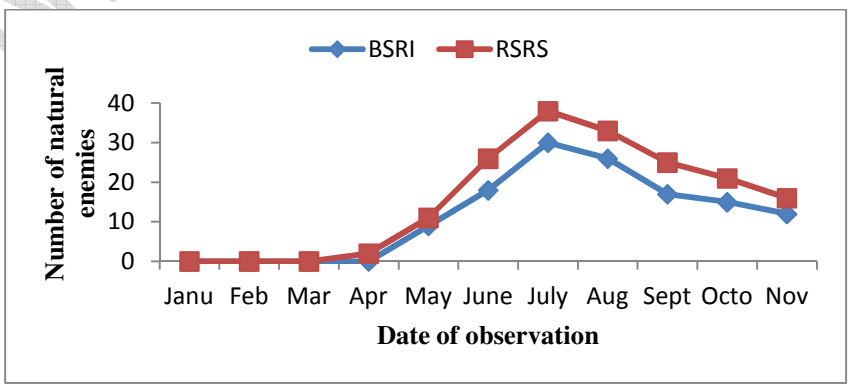

Fig. 9. Monthwise available natural enemies in relation to different weather condition at BSRI and RSRS

4. CONCLUSION

Seasonal influences on the abundance of mealybugs showed higher infestation at RSRS than BSRI. The lowest infestation was recorded at Pabna in May and the highest in November. At Thakurgaon, the lowest infestation was in May and the highest in November and September. Although there were positive relationships between infestation and relative humidity, but inverse relationship was evident with temperature and rainfall.

REFERENCES

[1] David BV, Ananthakrishnan TN. General and Applied Entomology. Tata McGraw-Hill Publishing Company Limited, New Delhi; 2004.

[2] Ebieda AM, Solouma AG, Bassuony AM. Studies on sugarbeet pests by two methods for counting cotton aphid on sugarbeet varieties and their predicted equations. Alex. Sci. Exch. 1993;14:61-75.

[3] Finch S, Collier RH, Phelps K. A review of work done to forecast pest insect attacks in UK horticultural crops. Crop Protection.1996;15(4): 353-357.

[4] Pandey SK, Kant S. Influence of meteorological factors on population build-up of *Chilo auricilius* dudgeon in sugarcane under subtropical conditions. Sug.Tech. 2005;7(4):157-159.

[5] Hu Y, Yuan X, Zhu F, Lei C. Development time and size-related traits in the oriental blowfly, *Chrysomya megacephala* along a latitudinal gradient from China. J. Therm. Biol. 2010;35(7): 366-371.

[6] Biswas MM, Abdullah M, Alam MA, Begum M, Rahman MA, Siddiquee MNA. Bangladeshe Ikkhur Pokamakar Parichiti O Daman Babostapana (in Bangla). Bangladesh Sugarcane Research Institute, Pabna; 2007.

[7] Jahn GC, Beardsley JW, Hernandez HG. A review of the association of ants with mealybug wilt disease of pineapple. Proceedings of the Hawaiian Entomological Society. 2003; 36: 9-28.

[8] Naidu P. IPM in sugarcane. Assignment part of module B. XII. India, 2009.

[9] Prasad D. Insect pest and disease management. Daya publishing house, Delhi; 2008.

[10] Hance T, Van Baaren J, Vernon P, Boivin G. Impact of extreme temperatures on parasitoids in a climate change perspective. Annual Review of Entomology. 2007;52:107–126.

[11] Soil Resource Development Institute. Soil and Land Utilization Guide (Upazila Nirdeshika). Birol Upazila, Dinajpur District, Ministry of Agriculture, Dhaka; 2008.

[12] Matin, MA, Hossain MA, Miah MAS. Tiller dynamics in sugarcane variety Isd 16. Bangladesh J. Sugarcane. 1989;11:1-6.

[13] Bangladesh Agricultural Research Council. Fertilizer Recommendation Guide. Dhaka; 2005.

[14] Watson GW, El-Serwy SA. Aspects of the biology, ecology and parasitism of *Acanthomytilus sacchari* (Hall) (Hemiptera: Diaspididae) on sugarcane in Egypt. Proceedings of the XI international symposium on scale insect studies. Giza, Egypt; 2010.