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INFESTATION LEVEL AND POPULATION DYNAMICS OF APHID ON MUSTARD

E. MANDAL[1], M. R. AMIN[1], H. RAHMAN[1] AND A. M. AKANDA[2]

Abstract

Mustard *(Brassica juncea)* variety BARI Shorisha-11 was cultivated during September 2016 to March 2017 in Gazipur, Bangladesh to find out the population dynamics of aphid and its infestation level on mustard. The aphid *Lipaphis erysimi* (Homoptera: Aphididae) was abundant in the field and caused infestation. The population of aphid in the mustard field showed fluctuation and reached to the peak at 22 December which was 289 per plant. Inflorescence had significantly higher level of infestation compared to individual siliqua and leaf. The daily mean temperature had significant negative, light intensity had insignificant negative and relative humidity had insignificant positive correlation with the abundance of aphid. The multiple linear regression analysis showed that the weather parameters namely temperature, light intensity and relative humidity individually as well as combindly contributed on the abundance of aphid, but the temperature had greater effect than other factors.

Keywords: Abundance, *Brassica juncea,* infestation, *Lipaphis erysimi.*

Introduction

Mustard (*Brassica* spp.) is one of the first domesticated crops which has wide dispersal, and has been grown as herb in Asia, North Africa and Europe for thousands of years (Oplinger *et al.,* 2016). It ranks world's third important oil crop in terms of production and area, and in Bangladesh, it is the first in ranking. Among the three species of brassica, *Brassica napus* and *Brassica campestris* are regarded as rape seed and *Brassica juncea* is regarded as mustard. Mustard oil is one of the healthiest edible oils as it has no trans fat, has low saturated fats, high mono-unsaturated and poly-unsaturated fats like omega-3 (Das *et al.*, 2009).

Many insect pests like aphid, sawfly and leaf hopper damage the crop by feeding on leaves, stems, flowers and fruits causing serious yield loss. Aphid *Lipaphis erysimi* Kalt. (Homoptera: Aphididae) is the most destructive insect pest of mustard (Das, 2002). It is a cosmopolitan insect and found on both the leaf surfaces and in leaf folds of developing heads, on leaf stalks, and on leaf axles. They are found primarily on the growing points of the host plants, including tips, flowers and developing pods and cover the whole plant with high density (Nelson and Rosenheim, 2006). They suck sap from the hosts and infested plants become stunted and distorted. Their infestation causes wilting, yellowing and stunting of

[1]Department of Entomology, [2]Department of Plant Pathology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur 1706, Bangladesh.

plants (Khan *et al.,* 2015). The avoidable yield losses at anywhere due to aphid infestation may be 20 to 50%, and it could be as high as 78% (Prasad and Phadke, 1983). Vekaria and Patel (2000) reported that weather plays an important role on the appearance, multiplication and disappearance of aphid.

Two model studies indicated that temperature was highly linked with the density of aphid or other sucking insects (Zhou *et al.,* 1997; Whittaker and Tribe, 1998). Bale *et al.* (2002) reported that increased temperature could decrease growth of some aphid species depending on their thermal requirements and host specificity. Though aphid has been identified as a major pest of mustard in Bangladesh but information on its infestation and population dynamics in respect of weather factors are very scanty. In this study infestation level of aphid *L. erysimi* on different parts of the mustard (*B. juncea*) plant BARI Shorisha-11, and the population dynamics of aphid in relation to weather factors namely temperature, humidity and rainfall were studied under field condition.

Materials and Method

The study was conducted during September 2016 to January 2017 in the Experimental Field of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur. The study site is located at 25°25′ North latitude and 89°5′ East longitude, which is in the middle of Bangladesh. The study area has subtropical climate having annual mean maximum and minimum temperatures, relative humidity and rainfall of 36.0 and 12.7 ^{o}C, 65.8% and 237.6 cm, respectively. The mustard *Brassica juncea* variety BARI Shorisha11 seeds were collected from Oil Seed Research Center, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. The crop was cultivated following randomized complete block design comprising 4.0 m × 4.0 m plots. The distance between block to block and plot to plot was 60 cm. Mustard seeds were sown on 30 October 2016 in rows. The distance from row to row was 45 cm and plant to plant was 5 cm. Intercultural operations such as irrigation and weeding were done whenever necessary. Fertilizers were applied according to Fertilizer Recommendation Guide (N- 40 kg, P- 12 kg, K- 30 kg, S- 9 kg per hectare). After emergence of seedlings, weekly field inspection was carried out to record the data of aphid abundance. At each inspection, three plants from each plot were randomly selected and the numbers of aphid nymphs and adults per plant were counted. The population of aphid was counted with the help of a magnifying glass (FD75, Ballon Brand, China). The data of the abundance of aphid were recorded from 28 November to 28 December 2016. During inspection, the total number of leaves, inflorescence and silique as well as the number of infested leaves, inflorescence and silique of the plants were counted and percent infestations were calculated. Light intensity in the field during insect collection was measured with a digital light meter (Model 401025, Extech Instruments Corporation, USA). Data were collected weekly and in between 10.0 and 13.00 h at the canopy area of the plots. Mean daily temperature

and relative humidity data were collected from the weather station of BSMRAU. Aphid abundance during the crop growth stages and their infestation levels on leaf, inflorescence and siliqua were analyzed by Chai statistics. The mean infestation level on leaf, inflorescence and siliqua were analyzed by analysis of variance (ANOVA) followed by Tukey HSD posthoc statistics. Correlation coefficients were calculated for aphid abundance with meteorological parameters. All the analyses were performed using IBM SPSS 21.1 software.

Results and Discussion

Aphid population in mustard field showed significant variations ($\chi^2 = 506.1$, df = 5, $p < 0.001$) during the crop growth stages (Fig. 1). The population showed an increasing trend from 20 November and reached the peak on 22 December and again declined on 28 December. The highest mean abundance of aphid per plant was found on 22 December which was 289 per plant.

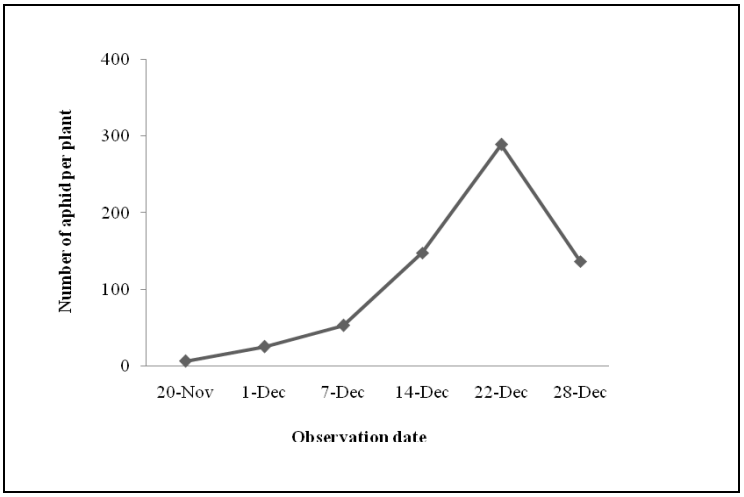

Fig. 1. Population dynamics of aphid in mustard field in Gazipur, Bangladesh during November to December 2016.

The abundance of aphid on mustard crop varies with geographic location and climatic condition of the cropping season. In this study, aphid appearance was first recorded on 20 November but Shahoo (2012) observed the appearance of aphid in the mustard field of West Bengal, India from last week of December and 1st week of January in the year 2009-10 and 2011-12, respectively, but the aphid abundance reached the peak on 6th week of crop cultivation in both the years.

Infestation of aphid on mustard leaf during the growth stages of the crop showed significant difference ($\chi^2 = 13.3$, df = 5, $p < 0.001$, Fig. 2). Aphid started leaf infestation from 20 November and it was highest on 14 December. The inflorescence and siliqua infestation was noticed during 01 December to 28 December and in both cases infestation was highest on 7 December. However,

the inflorescence infestation did not show significant difference ($\chi^2 = 5.0$, df = 4, p = 0.29) but siliqua infestation differed significantly ($\chi^2 = 18.2$, df = 4, p < 0.01). The mean infestation level of leaf, inflorescence and siliqua ranged from 34.1 to 59.3% and the results differed significantly (Fig. 3, $F_{2,13} = 8.4$, p < 0.01). Among the plant parts, inflorescence revealed significantly higher level of infestation compared to leaf and siliqua. In India aphids alone attribute 30-70% losses in rape seed yield in different agro climatic conditions with an average loss of 52.2% (Roy and Baral, 2002). Under favorable circumstances, aphid population increase very rapidly by making dense colonies on all parts of plants. In India, aphid has attained the key pest status in mustard because of its prolific multiplication and severe damage, resulting curling of the leaf, stunting and drying up of the plants (Rana *et al*., 2007). In Pakistan, cabbage aphid and mustard aphid are important pests of *Brassica* (Razaq *et al.,* 2011).

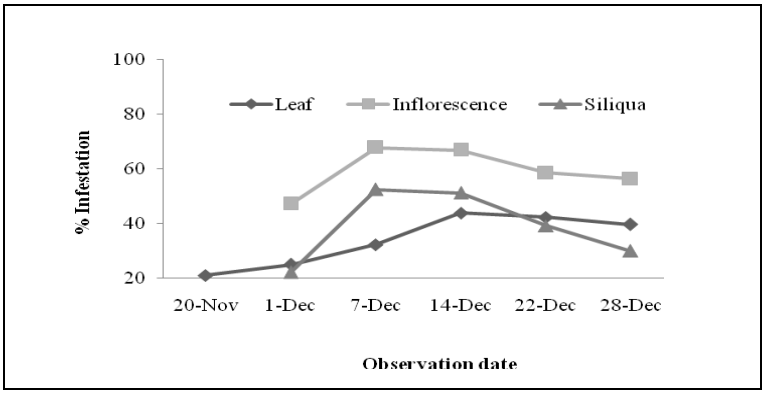

Fig. 2. Infestation level of aphid on different plant parts of mustard during November to December 2016.

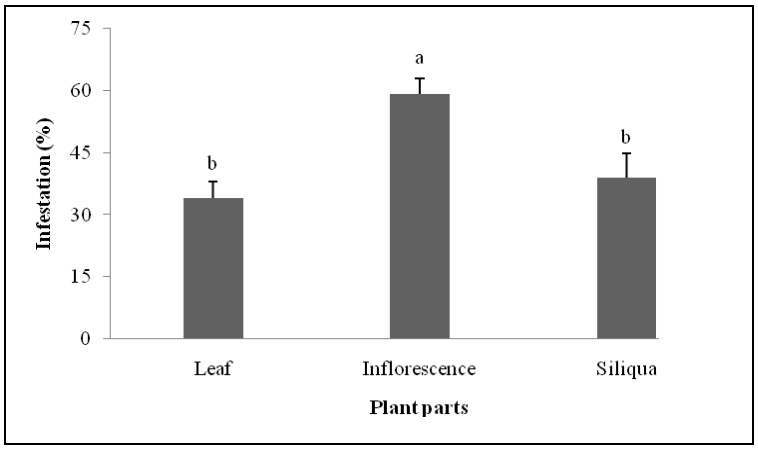

Fig. 3. Mean infestation level of aphid (%mean ± SE) on different plant parts of mustard. Bars with common letter are not significantly different by Tukey HSD posthoc statistic at p≤ 0.05.

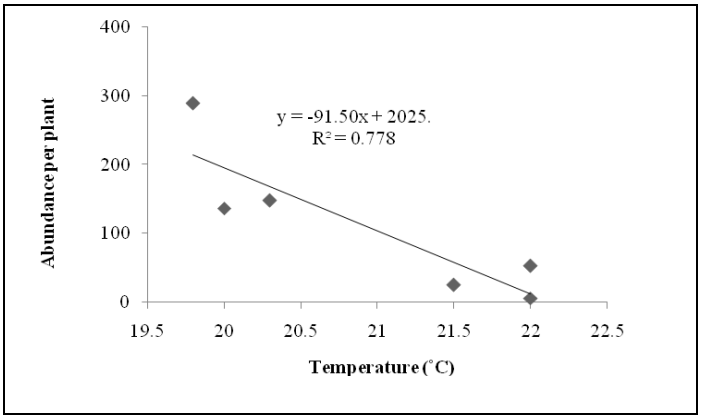

Fig. 4. Relationship between temperature and aphid abundance in mustard field during November to December 2016.

Seasonal variations of the weather factors play a vital role in multiplication, growth, development and distribution of insects, and influence on their population dynamics (Dhaliwal and Arora, 2001). Aphid population build up was regulated by temperature and time and population was relatively short in warm humid climates than in cool climates (Rao *et al.,* 2013). The present study showed that the daily mean temperature had significant negative correlation (Fig. 4: $y = 2025 - 91.503x$, $r = 0.882$, $F_{1, 4} = 14.1$, $p < 0.05$), light intensity had insignificant negative correlation (Fig. 5: $y = 142.12 - 0.065x$, $r = 0.055$, $F_{1, 4} = 0.012$, $p = 0.92$), relative humidity had insignificant positive correlation (Fig. 6: $y = -576.01 + 7.7912x$, $r = 0.473$, $F_{1, 4} = 1.2$, $p = 0.34$) with abundance of aphid. Amin *et al.* (2017) showed that weather parameters had insignificant effect on the population abundance of aphid on cotton plant in Bangladesh. They also reported that the aphid population started to build up at the end of October when the maximum and minimum temperatures decreased, the relative humidity slightly declined, and there was little rainfall.

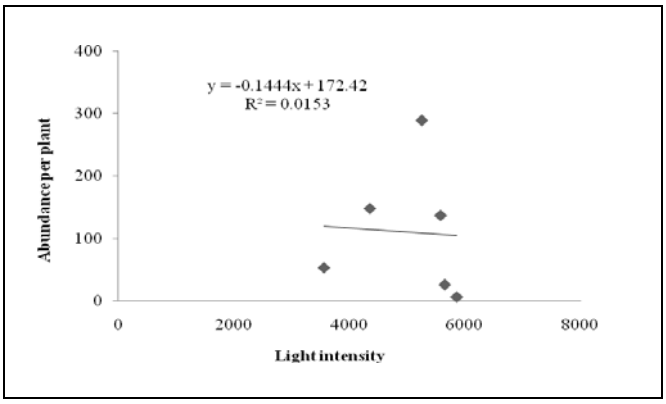

Fig. 5. Relationship between light intensity and aphid abundance in mustard field during November to December 2016.

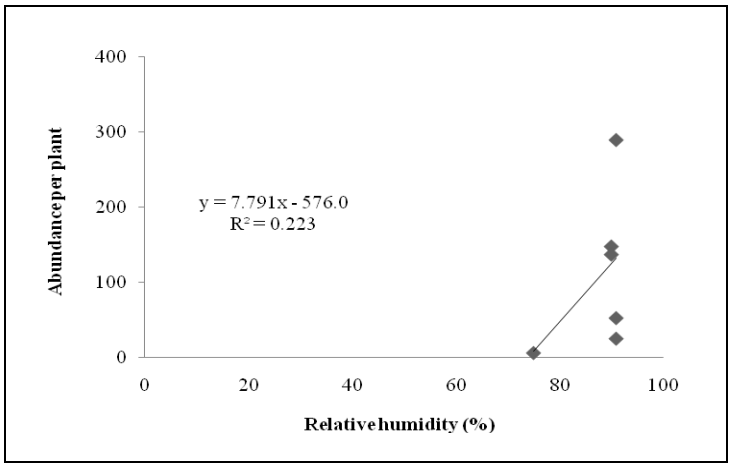

Fig. 6. Relationship between relative humidity and aphid abundance in mustard field during November to December 2016.

Table 1 showed that temperature individually exerted 77.9 % effect on population abundance of aphid on mustard and the effect was significant. The temperature with combination of light intensity provided 81.3% abundance, which was not statistically significant. The individual effect of light intensity demonstrated 3.4% abundance. The combination effect of temperature, light intensity and relative humidity depicted 81.7% abundance and the result was not statistically significant. The individual effect of humidity was 0.4%. The multiple linear regression analysis showed that the three weather parameters together contributed on the abundance of mustard aphid, but the temperature had the greater effect than others.

Table 1. Multiple regression models along with coefficients of determination (R^2) regarding the impact of weather parameters on abundance of aphid in mustard field

Regression equation	R^2	100 R^2	%Role of individual factor	F statistic	
$Y = 2025.07 – 91.50\ X_1$	0.779	77.9	77.9	$F_{1,4}= 14.1$	$P < 0.05$
$Y = 2194.6 – 94.324\ X_1 – 0.219X_2$	0.813	81.3	3.4	$F_{2,3}= 6.5$	$P = 0.08$
$Y = 2473.2 – 99.71X_1 – 0.277X_2 – 1.546X_3$	0.817	81.7	0.4	$F_{3,2}= 2.98$	$P = 0.26$

Y, insect population /plant; X_1, temperature (^oC); X_2, light intensity(lux); X_3, relative humidity (%).

Weather factors greatly influenced the population dynamics of insects. A study by Namni *et al.* (2016) showed that weather parameters contributed 61.7% abundance of hopper on mango plant. Dhaliwal *et al*. (2007) stated that the incidence, growth and multiplication of mustard aphid are largely influenced by meteorological parameters like temperature, relative humidity, rainfall, wind speed and cloudiness.

Ansari *et al.* (2007) observed that the appearance of mustard aphid on *Brassica* germplasm occurred on 11th January at 60 days after sowing and disappeared after 2nd March at 110 days after sowing. Ansari *et al.* (2007) also reported that the peak aphid population was found at a maximum, minimum and average temperature of 23.37°, 6.87° and 15.76°C, respectively and mean relative humidity of 54.75% on 10th February at 90 days after sowing. The present findings showed that the weather factors during November to December remained conducive for the rapid multiplication of aphid. Moreover, the aphid population reached peak level coinciding with the flowering stage of the crop which was similar to those found by Shahoo (2012). However, the present findings provide information on the seasonal abundance of aphid as well as its level of infestation on different parts of mustard plant, which might be helpful to growers to escape the possible time of infestation.

References

Amin, M. R., R. Afrin, M. Z. Alam, M. M. Hossain and Y. J. Kwon. 2017. Effect of leaf trichomes and meteorological parameters on population dynamics of aphid and jassid in cotton. *Bangladesh J. Agril. Res*. **42:** 13-25.

Ansari, M. S., H. Barkat and N. A. Qazi. 2007. Influence of abiotic environment on the population dynamics of mustard aphid, *Lipaphis erysimi* (Kalt.) on *Brassica* germplasm. *J. Biol. Sci.* **7**: 993-996.

Bale, J. S., G. J. Masters, I. D. Hodkinson, C. Awmack, T. M. Bezemer, V. K. Brown, J. Butterfield, A. Buse, J. C. Coulson, J. Farrar, J. E. G. Good, R. Harrington, S. Hartley, T. H. Jones, R. L. Lindroth, M. C. Press, I. Symrnioudis, A. D. Watt and J. B. Whittaker. 2002. Herbivory in global climate change research: direct effects of rising temperature on insect herbivores. *Global Change Biol*. **8:** 1-16.

Das, B. C. 2002. Ecology and diversity of agricultural crop infesting aphids (Homoptera: Aphididae). *Bangladesh J. Aphidol*. **16:** 51-57.

Das, M., D. J. Wiley, X. Chen, K. Shah and F. Verde. 2009. The conserved NDR kinase or b_6 controls polarized cell growth by spatial regulation of the small GTPase Cdc42. *Current Biol.* **19**:1314-1319.

Dhaliwal, G. S. and R. Arora. 2001. Integrated Pest Management Concepts and Approaches. Kalyani Pulishers, New Delhi, India. pp. 27-60.

Dhaliwal, G. S., A. K. Dhawan and R. Singh. 2007. Biodiversity and ecological agriculture: issues and perspectives. *Indian J. Ecol*. **34**: 100-109.

Khan, I. A., M. Ahmad, R. Akbar, S. Hussain, M. Saeed, A. Farid, R. A. Shah, W. Fayaz, B. Shah and M. M. U. Din. 2015. Study on Aphids density and yield components of 12 brassica genotypes under field conditions in Peshawar, Pakistan. *J. Ent. Zool. Stud*. **3**: 11-15.

Namni, S., M. R. Amin, M. R. U. Miah, M. F. Rahman and S. J Suh. 2016. Role of weather parameters on seasonal abundance of insects in a mango-based agroforestry in Bangladesh, with particular reference to mango hopper. *Bangladesh J. Agril. Res*. **42:** 197-205.

Nelson E. H. and J. A. Rosenheim. 2006. Encounters between aphids and their predators: the relative frequencies of disturbance and consumption. *Ent. Exp. Appl*. **118**: 211-219.

Oplinger, E. S., E. A. Oelke, D. H. Putnam, K. A. Kelling, A. R. Kaminsid, T. M. Teynor, J. D. Doll and B. R. Durgan. 2016. Mustard: Alternate Field Crops Manual. Minnesota and Wisconsin Extension Services.

Prasad, S. K. and K. G. Phadke. 1983. Effect of the period of crop exposure to aphid attack on the yield of brown seeded rapeseed. *Indian J. Agril. Sci*. **53:** 1046-1047.

Rana, M. C., S. S. Rana, S. K. Sharma, S. Kumar and G. D. Sharma. 2007. Influence of seed soaking with phosphorus, neem and seaweed extract on the productivity of pea under Lahaul valley conditions of Himachal Pradesh. *Himachal J. Agril. Res.* **33**: 280-281.

Rao, B. B., V. U. M. Rao, L. Nair, Y. G. Prasad, A. P. Ramaraj and C. Chattopadhyay. 2013. Assessing aphid infestation in Indian mustard (*Brassica juncea* L.) under present and future climate scenarios. *Bangladesh J. Agril. Res*. **38:** 373-387.

Razaq, M., A. Mehmod, M. Aslam, M. Ismail, M. Afzal and S. A. Shad. 2011. Losses in yield and yield components caused by aphids to late sown *Brassica napus* L., *Brassica juncea* L. and *Brassica carrinata* A. Braunat Multan, Punjab (Pakistan). *Pak. J. Bot*. **43**: 319-324.

Roy S. K. and K. Baral. 2002. Role of weather parameters on population build up of mustard aphid, *Lipaphis erysimi* (Kaltenbach). *J. Oilseeds Res*. **19**: 86-89.

Shahoo, S. K. 2012. Incidence and management of mustard aphid (*Lipaphis erysimi* Kaltenbach) in West Bengal. *J. Plant Protection Sci*. **4:** 20-26.

Vekaria, M. V. and G. M. Patel. 2000. Screening of promising Brassica and allied genotypes for resistance against mustard aphid, *Lipaphis erysimi* Kalt. (Homoptera: Aphididae). *Appl. Biol. Res*. **4**: 75-77.

Whittaker, J. B. and N. P. Tribe. 1998. Predicting numbers of an insect (Neophilaenus lineatus: Homoptera) in a changing climate. *J. Anim. Ecol*. **67:** 987-991.

Zhou, X., J. N. Perry, I. P. Woiwod, R. Harrington, J. S. Bale and S. J. Clark. 1997. Temperature change and complex dynamics. *Oecologia*. **112:** 543-550.