International Journal of Animal and Livestock Production Research 8 (1), 12-18, 2024
Print ISSN: ISSN 2059-903X
Online ISSN: ISSN 2059-9048
Website: https://www.eajournals.org/
Publication of the European Centre for Research Training and Development -UK

Impact of Temperature on Functional Response of *Rhynocoris Fuscipes* (Hemiptera: Reduviidae) to Different Densities of *Lipaphis Erysimi* (Homoptera: Aphididae), A Sporadic Pest of Mustard, Under Laboratory Condition

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doi: https://doi.org/10.37745/ijahlpr.15/vol8n11218 Published May 05, 2024

Citation: Claver M.A. and Yadav S. (2024) Impact of Temperature on Functional Response of Rhynocoris Fuscipes (Hemiptera: Reduviidae) to Different Densities of Lipaphis Erysimi (Homoptera: Aphididae), A Sporadic Pest of Mustard, Under Laboratory Condition, *International Journal of Animal and Livestock Production Research*, 8 (1), 12-18

ABSTRACT: *Rhynocoris fuscipes in each temperature regimes could prey on L. erysimi and was more predaceous during high temperature regimes. The number of Lipaphis erysimi consumed (y') by R. fuscipes can be expressed in Hollings' disc equation [y'=0.10(10-4.6y)x at 14±º1C and y'=0.06(10-2.3Y) x at 29±1ºC]. The maximum predation rate (k=2.16 at 14±1ºC and k=4.3 at 29±1ºC) were maximum at higher temperature regimes*.

KEY WORDS: Aphid, Lipaphis erysimi, Biocontrol, Rhynocoris fuscipes, Temperature regimes.

INTRODUCTION

Lipaphis erysimi (Homoptera:Aphididae) is small sap-sucking insect pest infesting both aerial and sub-aerial parts of a variety of plants species. It is cosmopolition, at the sometime it is most abundant in temperate climatic areas. It is unique on an account of their peculiar mode of reproduction, development, and polymorphism. It may reproduce either by parthenogenesis, zygogenesis, or pedogenesis. It may either be oviparous or viviparous (Singh and Singh, 2016). The yard-long bean, *Vigna uniquiculata* subspecies *sesquipedalis* L. (Leguminosae) and mustard, *Brassica compestris* (Brassicaceae) are very common and important vegetable and oil seed crops. Both crops are cultivated in parts of Uttar Pradesh, India. The crop yielding is affected due to frequent occurrences of aphid, *Lipaphis erysimi* a ubiquitos group of arthropods (Begum et. al., 1991; Pedigo, 2002), attacking yard-long bean and mustard from seedling to pod maturing stages of plants. *Lipaphis erysimi* causes significant and economic damage to different crops including beans (Attle et. al., 1987) and mustard (Singh and Singh, 1983; Shylesha et. al., 2006).

Sustainable management of *L. erysimi* is a big challenge because of their unusual life cycle, wide spread habitats, and resistance to many pesticides (Bhattacharya, 2019). The reduviid have been recorded as important natural enemies of several pests, particularly lepidopteran and hemipteran insects (Ambrose 1999; Sahayaraj et. al., 2006, 2015), in several agro-ecosystem (Sahayaraj, 2012) and tropical rain forest ecosystems (Biwas; Mitra, 2011). *Rhynocoris fuscipes* is an excellent predator predominantly found in agro-ecosystems, scrub jungles and semi-arid zones boardering agro-ecosystem in India (Ambrose; Claver, 1995). We observed that this predator feeding on *Lipaphis erysimi* under laboratory condition. The relationship between the consumption rate of a predator and the prey density of its prey, often referred to as the functional response is a mainstay in predator-prey theory (Englund et al., 2011). It was recognized early that this relationship is crucial for the dynamics of population and communities (Nicholson 1935; Holling, 1959). However, functional response may be regulated by a range of factors such as host plant the prey (Cedola et al., 2001 and Shah et al., 2013), feeding behavior and history (Castagnoli et al., 1999), prey species (Donnely et al., 2001 and Hoddle, 2003), predator and its phenology (Farhadi et al., 2010 and Sharma et al., 2017) and temperature also (Jalali et al., 2010 and Skirvin et al., 2003). Thus, the specific objective of this study was to compare functional response *of Rhynocoris fuscipes* to *Lipaphis erysimi* under two temperature regimes.

Material and methods: Nymphal colonies of *Rhynocoris fuscipes* were established from fecundity female collected from either Agro-ecosystem or Agro-plantation ecosystem located at Aamghat (Lati.–26.97041, Longi.–83.30451) in Kalayanpur, Campierganj, Gorakhpur. She was maintained in laboratory at a constant temperature of 30±2ºC, relative humidity 65% - 70% under, photophase 13 hours and dark-phase 11 hours in a rectangular transparent plastic container (19L×12W×4H cm). Adult female of *Rhynocoris fuscipes* were fed on head- crushed grasshopper *Heigroglyphus banian*. The pest, *Lipaphis erymisi* collected from agro-ecosystem was used in their study. During functional response experiments, the third instars of predatory reduviid from the mass production containers were first separated and kept in plastic container (Diameter-7.5cm and height-6cm). After this isolation, the instars were starved for 36 hours and the next day; a certain number of (1, 2, 4, 8, and 16) *Lipaphis erysimi* with leaf of host plant (to mimic natural environmental condition and prevent cannibalism among pest) were given to each predator. Another control arena without predator was also maintained for assessing natural mortality. After 24 hours, the number of preys consumed by predator were counted and recorded. The functional response experiment replicated 12 times at two different temperature regimes (14±1ºC and 29±1ºC) under laboratory condition. Hollings' Disc equation (Hollings, 1965) was used to describe the functional response of *R. fuscipes* as follows:

$$Y' = a\,(Tt - by)\,x$$

Where,

X= number of prey offered.

y= total number of prey killed in given period of time.

a= rate of discovery per unit of searching time [(y/x)/Ts]

Ts= time spent by the predator searching for prey each day

b= time the predator spent handling each prey individual (Tt/k)

Tt= total time in days prey were exposed to the predators

k= maximum number of prey killed in a given period of time

Prey consumption ratio (y/x)= the ratio of the number of prey offered (x) and killed or consumed by a predator (y).

RESULT AND DISCUSSION

The nymphal instar of *Rhynocoris fuscipes* were observed for estimating predatory ability to *Lipaphis erysimi*. It was showed a type II functional response curve against *Lipaphis erysimi* at both temperature (14±1ºC and 29±1ºC) regimes. The result indicated that, *R. fuscipes* in each temperature regimes could prey on *Lipaphis erysimi* and was more predaceous during the high temperature (29±1ºC) regimes as compared to low temperature (14±1ºC) regimes (figure1,2). At the same prey density, the predation rate of *R. fuscipes* nymphs increased when temperature increases from 14±1ºC to 29±1ºC. The predation rate of *Orius sauteri* on *Dendrothrips minowai* also increased as temperature increased (Zhang, 2021). The number of *Lipaphis erysimi* consumed (y') by *R. fuscipes* can be expressed in Hollings Disc equation [y'= 0.10 (10 – 4.6 y)x at 14±1ºC and y'= 0.06(10 – 2.30y)x at 29±1ºC]. The functional response of *R. fuscipes* at different temperature regimes were shown in Table 1 and 2. The regression statistics and ANOVA indicated that the temperature had significant impact on functional response of *R. fuscipes* (multiple R= 0.0909, Significant F= 0.032, intercept P value= 0.043 and x variable 1 P value= 0.032 at 14±1ºC and multiple R= 0.994, Significant F= 0.00049, intercept P value = 0.0047 and x variable 1 P value = 0.00049). The rate of discovery 'a' was minimum at higher temperature regimes. Prey attack ratio (y/x), prey attack (y) and maximum predation rate (k= 2. 16 , k= 4.3) were maximum at higher temperature. The functional response of a predator plays a vital role in the population dynamics of predatory systems (Schenk et al., 2010). The functional response of *R. fuscipes* was influenced by temperature. The predation efficiency of *R. fuscipes* were increased at higher temperature (29±1ºC) regimes and decreased at lower temperature (14±1ºC) regimes. Therefore, nymph of *R. fuscipes* can be utilized as biocontrol agents in winter as well as summer crops tickled mustard insect pest like *Lipaphis erysimi.*

Table-1. Functional response of *R. fuscipes* to *L.erysimi* at 14±1ºC

Prey density (x)	Prey attack (y)	Max (k)	Days/y b=Tt/k	Days all y's (by)	Days searching Ts=Tt-by	Attack ratio y/x	Rate of Discovery y/x/Ts=a	Disc equation Y'=a(Tt-by)
1	0.58			2.67	7.33	0.58	0.079	
2	0.91			4.20	5.8	0.45	0.077	
4	1.25	2.16	4.62	5.77	4.23	0.31	0.07	y'=0.10(10-4.6y)x
8	2.0			9.24	0.76	0.25	0.32	
16	2.16			9.97	0.03	0.13	0.0	

Table -2. Functional response of *R. fuscipes* to *L. erysimi* at 29±1ºC

Prey density (x)	Prey attack (y)	Max (k)	Days/y b=Tt/k	Days all y's (by)	Days searching Ts=Tt-by	Attack ratio y/x	Rate of Discovery y/x/Ts=a	Disc equation Y'=a(Tt-by)
1	1			2.3	7.7	1	0.12	
2	1.41			3.24	6.76	0.70	0.10	
4	1.66	4.33	2.30	3.81	6.19	0.41	0.06	y'=0.06(10-2.30y)x
8	2.33			5.35	4.65	0.29	0.06	
16	4.33			9.95	0.05	0.27	0.0	

Fig- 1. Functional response curve of *R. fuscipus to Lipaphis erysimi* at 14±1°C temperature

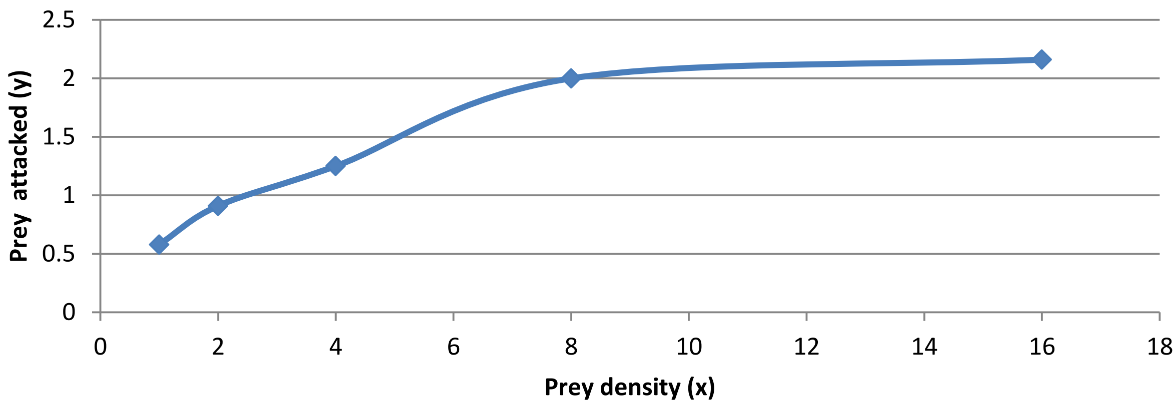
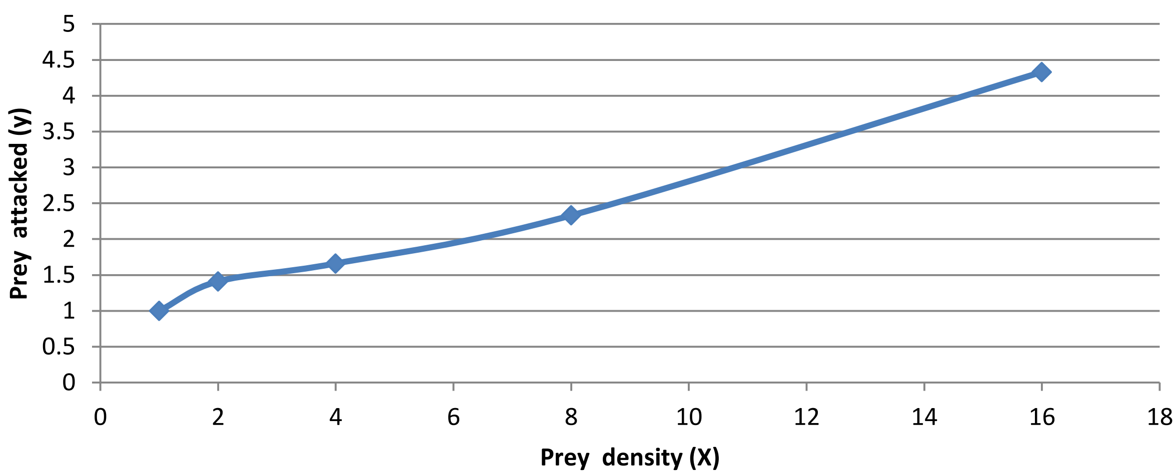


Fig- 2. Functional response curve *of R. fuscipes* to *Lipaphis erysimi* at 29±1°C



Acknowledgements

The authors are thankful to Prof. CO Samuel, Principal and Secretary, St. Andrew's College for providing laboratory facilities and encouragement. The junior author is acknowledged to his Ph.D. advisory committee members Prof. Veen Batra Kushwaha and Prof. Keshav Singh for their great concern and encouragements.

REFERENCE

Ambrose, D. P.; Claver, M. A.; 1995. Functional response of *Rhynocoris fuscipes* Fabricius (Heteroptera: Reduviidae) to *Riptoris clavatus* Thunberg (Heteroptera:Alydidae). J. of Bio. Control.(2):74-77.

Ambrose, D.P.; 1999. Assassin bugs. Science, Enfield.

Attle, A. A.; Eliheneidy, A. H.; E.A. E 1- Kady.; 1987. Studies on the aphid, *Aphis craccivora* in Egypt. Bull.de la societe. Entomol.d' Egypte.(66):319-324.

Bahar, Md. H.; Islam, Md. A.; Mannan Md. A.; and Uddin, Md. J. 2007. Effectiveness of Some Botanical Extracts on Bean Aphids Attacking yard-Long Beans. Journal of Entomolgy 4(2):136-142.

Begum, E. M.; Hussain F.; Talucdar, F. A. 1991. Relative effectiveness of some granular insecticides against mustard aphids, *Lipaphis erymisi* (Katt). Bang. J. Agri. Sci.,18:49:52

Begum, S.; 1995. Insect pest of oilseed crops of Bangladesh. Bangladesh Journal of Zoology (23):153-158.

Bhattacharya, S.; 2019. *Brassic*a-aphid interaction: Challenges and prospects of genetic engineering for integrated aphid management. Physiological and Molecular Plant Pathology 108:101422.doi:10.1016/j. pmpp.101442.

Biwas, G. C.; Das G. P.; 2000. Population dynamics of the mustard aphid, *Lipaphis erysimi* (Kalt.) (Hemiptera:Aphididae) in relation to weather parameters. Bangladesh Journal of Entomology(19):15-22.

Biwas, B.; Mitra, B.; 2011. Check list of Indian assassin bugs (Insecta:Hemiptera:Reduviidae). Zoological Survey of India, New Alipore.

Castagnoli, M.; Simoni, S.; 1999. Effect of long-term feeding history on functional and numerical response of *Neoseiulus californicus* (Acari: Phytoseiidae). Exp. Appl. Acarol.(23):217-234.

Cedola, C.V.; Sånches, N.E.; Liljesthröm, G.G.; 2001. Effect of tomato leaf hairiness on functional and numerical response of *Neoseiulus califarnicus* (Acari:Phytoseiidae). Exp. Appl. Acarol.(25):819-831.

Donnelly, B.E.; Phillips, T.W.; 2001. Functional response of *Xylocoris flavipes* (Hemiptera:Anthacoridae) - effects of prey species and habitat Environ. Entomol.(30):617-624.

Englund, G.; Öh lund, G.; Hein, C.; Diehl, S.; 2011. Temperature dependence of the functional response. Ecology Letters.(9):914-21.

Farhadi, R.; Allahyari, H.; Juliano, S. A.; 2010. Functional response of larval and adult stages of *Hippodamia vuriegata* (Coleoptera:Coccinellidae) to different densities of *Aphis fabae* (Hemiptera:Aphidae). Environ. Entomol.(39):1586-1592.

Ghosh, L.K.; 2000. Contribution to the Indian Aphididae (Homoptera) (D.Sc. thesis). D.D.U. Gorakhpur University, Gorakhpur, India.

Hoddle, M.S.; 2003. The effect of prey species and environmental complexity on the functional response of *Franklinothrips orizabensis*: A test of the fractal foraging model Ecol. Entomol.(28):309-318.

Holling,C.S.; 1959. The components of predation as revealed by study of mammal predation of the European pine sawfly. Can. Ent.(91):293-320.

Jalali, M.A.; Tirry, L.; De Clercq, P.; 2010. Effect of temperature on the functional response of *Adalia bipunctata* to *Myzus persicae.* Biocontrol.(55):261-269.

Jayappa, B.G.; Lingappa, S.; 1988. Screening of cowpea germplasm for resistance of *Aphis craccivora* in India. Tropical Pest Management.(34):62-64.

Nicholoson, A.J.; 1935. The balance of animal populations. Proc. Zool. Soc. 551-598.

Pedigo, L. P.; 2002. Entomology and Pest Management. Princenton and Hall Incorporation, London.

Sahayaraj, K.; 2012. Artificial rearing on the nymphal development time and survival of three reduviid predators of Western Ghat Tamil Nadu. J Biopest(5):218-221.

Sahayaraj, K.; Kumar, V.; Avery, P. B.; 2015. Functional response of *Rhynocoris kumarii* (Heteroptera:Reduviidae) on *Phenacoccus solenopsis* (Hemiptera:Pseudococcidae) in the laboratory. Euro J Entomol.(112):69-74.

Sahayaraj, K.; Raju, G.; 2006. Assessing the intraguiid predation of *Rhynocoris marginatus* (fab.) (Heeteroptera:Reduviidae:Herpactorinae) and *Menochiluss exmaculatus* (fab.) cotton pest *Aphis craccivora*. Hexapoda.(13):62-65.

Schenk, D.; Bacher, S.; 2010. Functional response of a generalist insect predator to one of its prey species in the field. J.Anim.Ecol.(71):524-531.

Shah, M.A.; Khan, A.; 2013. Fundamental response – a function of predator and prey species. Bioscan.(8):751-758.

Sharma, P.; Verma, S.; Chandel, R.; Shah, M.; Govkare, O.; 2017. Functional response Harmonia dimidiate (fab.) to melon aphid, *Aphis gossypii* Glaver under laboratory conditions. Phytoparasitica.(45):373-379.

Shylesha, A.N.; Azad T. N. S.; Pathak, K.A.; Rao, K.R.; Saikia, K.; Surose, S.; Kodandaram, N.H.; Kalaishekar, A.; 2006. Integrated management of insect pests of crops in north eastern hill region. Technical Bulletin No.19.ICARRC for NEH Region, Umiam:50.

Singh, H.; Singh Z.; 1983. New records of insect pests of rapeseed-mustard. Indian Journal of Agricultural Science (53):970.

Singh, R.; Singh, G.; 2016. Aphid and their biocontrol.In: Omkar (ed.), Ecofriendly Pest Management for Food Security. Academic Press ,pp. 63-108.

Skirvin, D. J.; Fenlon, J. S.; 2003. The effect of temperature on the functional response of *Phytoseiulus persimilis* (Acari:Phytoseiidae). Exp. Appl. Acarol.31-37

Srivastava, K. M.; Singh, L.N.1986. A review of the complex of Kharif pulses in U.P. Lens. (28):333-335.

Zhang, Q.; Zhang, R.; Zhang, Q.; Ji, D.; Zhou, X.; Jin, L.; 2021. Functional response and Control potential of *Orius sauteri* (Hemiptera:Anthocoridae) on Tea Thrips (*Dendrothrips minowai Priesner)*. Insects(12):1132.