Journal of Advanced Research in Agriculture Science and Technology
Volume 2, Issue 2 - 2019, Pg. No. 29-35
Peer Reviewed Journal

Research Article

Influence of Leguminous Plants on the Life-Table Statistics of *Aphis Craccivora* Koch (Hemiptera: Aphididae)

Rakhshan[1], Md Equbal Ahmad[2]

[1,2]Aphid Systematics & Biocontrol Laboratory, University Department of Zoology, T.M. Bhagalpur University, Bhagalpur -812007, Bihar.

I N F O

Corresponding Author:
Rakhshan, Aphid Systematics & Biocontrol Laboratory, University Department of Zoology, T.M. Bhagalpur University, Bhagalpur-812007, Bihar.
E-mail Id:
rakhshankalim@gmail.com
Orcid Id:
https://orcid.org/0000-0002-8071-5924
How to cite this article:
Rakhshan, Ahmad ME. Influence of Leguminous Plants on the Life-Table Statistics of *Aphis Craccivora* Koch (Hemiptera: Aphididae). *J Adv Res Agri Sci Tech* 2019; 2(2): 29-35.

Date of Submission: 2019-04-02
Date of Acceptance: 2019-04-28

A B S T R A C T

The effect of four host plants viz., *Phaseolus sinensis, Lablab purpureus, Vigna radiata* and *Vigna mungo* have been studied on the life-table statistics of *Aphis craccivora*. Our data revealed that, the age specific survival rate (lx) and age specific fecundity (mx) were observed higher on *P. sinensis* than *V. mungo.* The estimated values of net reproductive rate (Ro) for *A. craccivora* was significantly higher (100.0±1.3 nymphs/aphids) followed by *L. purpureus, V. mungo* and *V. radiata* (F1=4.99, F2= 13.15; P<0.05). The maximum rate of population growth (rm) was observed on *P. sinensis* (0.438) and minimum on *V. mungo* (0.241) (F1=29.37, F2= 19.79; P<0.05). The weekly multiplication rate (rw) and finite rate of increase (λm) was observed minimum on *V. mungo* (F1=6.92, F2= 4.43; F1=20.71, F2= 14.08, P<0.05). Furthermore, the shorter generation time and impressive fecundity of aphids accelerate the vicious circle causing considerable economical loss. This study, according to growth index and life-table statistics, *P. sinensis* was the suitable host for population growth pattern of *A. craccivora* related to different host plants and its results contribute to better understanding the biology of the species and improve pest management skills.

Keywords: *Aphis Craccivora*, Leguminous plant, l_x, m_x, GT

Introduction

Intrinsic specific variation in plant quality is hypothesized to be a key factor affecting the growth and regulation of population (Painter, 1951; Haukioja, 1980; Rhoades, 1983; White, 1984; Underwood and Rausher, 2000). Genetic variation in plants can have direct and indirect affect on herbivores (Karbon, 1987; Underwood and Rausher, 2002; Fritz and Hochwender, 2005, Rakhshan and Ahmad 2017a). Particular genetic variation among plants, affects the preference and performance of individual herbivores which has lead to the hypothesis that genetic variation in resource quality can influence herbivores population (Karbon, 1992).

Leguminous plants are economically very important due to high nutritional quality and protective effects regard to hypercholesterolemia, cardiovascular diseases and cancers have been also reported (Chau et al., 1998; Castle and Thrasher, 2002). These plants are damaged by several pests including aphids. *Aphis craccivora* (Hemiptera: Aphididae) is a major pest of few leguminous plants.

The life-table statistics and development of aphid have been studied by several workers in India and other countries on

Copyright (c) 2019: Advanced Research Publications

different host plants (Shirvani and Hoseini, 2004; Loarocca et al., 2011; Bernaldi et al., 2012). The influence of host plants on the life-table parameters was also observed on several aphid species (Abhilasha and Singh 2008; Fozia and Nayyar, 2013; Tazerouni et al., 2016 and Rakhshan and Ahmad 2018). Therefore, in the present work, the effect of four economically important leguminous host plants viz., *Lablab purpureus*, *Phaseolus sinensis*, *Vigna radiata* and *Vigna mungo* were studied on the life-table statistics of *A. craccivora* which will be useful to contribute the knowledge of pest management.

Materials and Methods

L. purpureus, *P. sinensis*, *V. radiata* and *V. mungo* were grown in the research field. The fresh specimens of *A. craccivora* were collected from field and cultured on different host plants in research field. Randomly selected apterous females from the stock culture were transferred on to the fresh leaves of each host plants potted in plastic vials (250ml) at room temperature during November, December to February. Offsprings born within 24h were individually confined on the leaf disks in the petridishes. The cotton wool in the petridishes was saturated daily with water and every day aphids were transferred on to fresh leaf. For each set of the experiment, 10 apterous females were utilized. The exuviae were used to determine the moulting time and new born nymphs were removed after counting.

The growth rate of the population can be calculated directly from the vital statistics of the age-specific survival and net fecundity rates which is called as **"intrinsic rate of increase (r_o)"**. The calculation of growth rate under natural condition is known as **"intrinsic rate of natural increase (r_m)"**. The values of r_m under optimum conditions indicates the maximum biological potential of the population and growth in that situation.

Age-specific survival rate, l_x (l_x = proportion of surviving females of the cohort) and net fecundity rate, m_x (m_x= number of nymphs/female progeny per female of age X) were calculated. A close approximation of the intrinsic rate of natural increase (r_m) was made following Andrewartha and Birch (1954) using trial and error substitute of r_m in the Lotka- Euler equation: $\sum l_x m_x \exp(-r_m X) = 1$.

Where, X is the pivotal age (the median developmental time from egg to adult and the age of the adult at oviposition). The net productivity rate (R_o) defined as the mean number of nymphs/ female progeny produced by the female during its life-span, was calculated by the equation: $R_0 = \sum l_x m_x$.

The Generation Time (***GT***) which is equivalent to the mean period of elapsing between the birth of the parents and the birth of the offspring and Doubling Time (***DT***), defined as the time required to double the population size and the finite rate of natural increase (λ_m) were calculated by the formulae: $GT = \ln R_o / r_m$, $DT = \ln 2 / r_m$, $\lambda_m = \exp(r_m)$

$(\lambda_m)^n$ gives the factor of the population by which the population increase in n days, e.g., $(\lambda_m)^7$ expresses the fold number of population increase in a week (usually called as weekly multiplication rate, r_w).

Result and Discussion

The effect of host plants viz., *P. sinensis, L. purpureus, V. mungo* and *V. radiata* on the life-table statistics of *A. craccivora* was studied in the laboratory. The significant variations were observed on the age specific survival rate, age specific fecundity rate, net fecundity rate, generation time, intrinsic rate of increase, Doubling time, finite rate of increase and weekly multiplication rate.

Life-table Parameters

- Age-specific survival rate (l_x)

The age-specific survival rate (l_x) of *A. craccivora* was observed significant (F1=16.66, F2= 138.26; P<0.05) on all host plants in experimental months. The mortality of adult was observed after 22 days on *P. sinensis* followed by 18 days on *L. purpureus*, 16 days on *V. radaita* and 14 days on *V. mungo* during November (Fig. 1a). Similarly, longest age specific survival rate was also observed on *P. sinensis* and shortest on *V. mungo* during December, January and February (Fig. 1b, 1c and 1d).

Age-specific survival rate of aphid was observed more when reared on *P. sinensis* than other host plants. Similarly, Soffan and Aldawood (2014) also observed host plant dependent age specific survival of *A. craccivora.*

- Age specific fecundity rate (m_x)

The age specific number of progeny per day (m_x) of *A. craccivora* for each host plant is illustrated in Fig. 2a, 2b, 2c and 2d. The maximum number of nymphs/ female/ day was recorded on *P. sinensis* (4.87±0.11 nymphs/ female/ day) and minimum on *V. mungo* (3.08±0.14 nymphs/ female/ day) during November. Similarly, minimum age specific fecundity rate was observed on *V. mungo* in different months. This difference is observed significant by analysis of variance test (F1=1.13, F2=5.95; P<0.05) (Table 1).

- Net fecundity rate (R_o)

The highest net fecundity (R_o) was also observed on *P. sinensis* (100.4±1.30 nymphs) and lowest on *V. mungo* (42.75±0.67 nymphs/female). This variation is observed significant by ANOVA (F1=4.99, F2=13.15; P<0.05). Similarly, R_o values were recorded more on *P. sinensis* than *L. purpureus, V. radiata* and *V. mungo* (Table 1) even in December, January and February.

Other researchers have reported that R_o values depend on aphid species, temperature, humidity and host plants (Rahman et al., 2009; Takalloozadeh, 2010; Tazerouni 2016).

- Generation Time (GT)

The generation Time (GT) of *A. craccivora* on the tested food plants was observed 10.49 days on *P. sinensis*, 12.02 days on *L. purpureus*, 13.31 days on *V. radiata* and 15.48 days on *V. mungo* during November. Similarly, minimum generation time of *A. craccivora* was observed on *P. sinensis* in different months (Table 2). The significant variation is observed by ANOVA test (F1=57.15, F2=1.26; P<0.05) (Table 2).

Tazerouni et al., (2016) also studied life-table parameters of *A. gossypii* on two different host plants and found to be host plant dependent generation time of aphid.

- Intrinsic rate of increase(r_m)

The highest intrinsic rate of increase (r_m) of *A. craccivora* was observed on *P. sinensis* with 0.4388 aphids/aphid/day and lowest on *V. mungo* 0.2412 aphids/aphid/day during November. Similarly, maximum intrinsic rate of increase was also observed on *P. sinensis* and minimum on *V. mungo* during December, January and February respectively. The mean difference is calculated statistically significant (F1=29.37, F2=19.79; P<0.005) (Table 2).

The r_m is the most important parameters for describing the growth potential of a population under given climatic and food conditions as these parameters reflects an overall effect on development, fecundity and survival (Southwood and Handerson, 2000).

- Doubling Time (DT)

Doubling Time (DT) is the period during which the populations of an organism double its original size. Since its value is calculated by using the value of r_m, it follows the pattern of the latter. A significant effect of host plant on DT of *A. craccivora* is observed (F1=100.41, F2=79.95, P<0.005). It is shorter on *P. sinensis* (1.58 days) than on *V. mungo* (2.87 days) during November. Similarly, calculated DT of different months (Dececember, January and February) was observed minimum on *P. sinensis* followed by *L. purpureus, V. radiata* and *V. mungo* respectively (Table 2).

- Finite rate of increase (λ_m) and Weekly multiplication rate (r_w)

The finite rate of increase (λ_m) is calculated by taking exponent values of r_m. Any factor over it depicts that the population increase by that period in days. For example, λ_m^7 (r_w), weekly multiplication rate) indicates the factor by which the population increase per week. Since its value is also calculated by using the value of r_m, it follows the pattern of the latter. The r_w of *A. craccivora* significantly varied on different host plants (F1= 6.92, F2= 4.43, P<0.005). It was higher on *P. sinensis* (21.57 days) than on *V. mungo* (5.410 days) during Nov. similarly, it was also observed higher on *P. sinensis* in different months (Table 2).

The rate of growth and reproduction of aphids depend on the quality and quantity of the consumed food and the phloem sap. The minimum growth, survival and fecundity of *A. craccivora* were observed on *V. radiata* and *V. mungo*. This was probably the reason that the feeding process was severely limited. The present result is consistent with earlier observations on the aphid feeding behavior studied by Golawaska et al., (2007). The limiting factors of aphids are allelochemicals, which are supposed to have toxic effect on insect behavior (Agrell et al., 2003).

The negative effect of trichomes on ovipositional preference, eggs laid and number of herbivore were reported by several workers (Eisner et al., 1998; Khan et al., 2000; Pompon et al., 2010 and Znidarcic et al., 2011).

The temperature also exerts important and limiting effects on the biology, distribution and abundance of aphids either by reducing their survival, retarding development/suppressing reproduction (Slosser et al., 1989; Schowalter, 2000). The parameter r_m is inversely proportional to generation time and directly to the logarithm of R_o, which is not affected by time scale because, it is calculated on a per generation basis. Therefore, when m_x and l_x expressed in terms of days, increase in r_m with increasing temperature can be attribute both to an increase in R_o and decline in GT. The generation time decreased due to a reduction in pre reproductive period (Table 2). However, the increase in R_o was compensated by an increase in temperature and r_m declined with increase temperature (Table 1 and 2). GT decreased with increase in temperature (Table 2).

Aphids are poikilotherms, their rate of growth and development is proportional to ambient temperature. At very low temperature, there is no development at all. As temperature increases, development begins to occur and gets faster. At high temperature development rate level off and then drops quickly near the upper limit of survival. Which are in agreement of (Rakhshan and Ahmad 2017 b and Rakhshan et al., 2018).

The *A. craccivora* fed on *P. sinensis* showed shorter pre reproductive and longer reproductive and post reproductive periods. The age-specific survival rate (l_x) and age-specific fecundity (m_x) were observed higher on *P. sinensis* than other host plants. The estimated values of net reproductive rate (R_o) was observed significantly higher (100.0±1.3 nymphs/aphids) on *P. sinensis* than *L. purpureus*, *V. mungo* and *V. radiata*. The maximum rate of population growth (r_m) was observed on *P. sinensis* and minimum on *V. mungo*. Less Generation Time (GT) and Doubling Time (DT) were recorded on *P. sinensis* which shows suitability of host plants. The weekly multiplication rate (r_w) and finite rate of increase (λ_m) were also observed maximum on *P. sinensis*. Thus, Furthermore, the shorter generation time and impressive fecundity of aphids accelerate the vicious circle causing considerable economical loss.

It can be conclude that *P. sinensis* and *L. purpureus* were suitable host for *A. craccivora* during November and February based on fast development and high intrinsic rate of increase. However, further physiological and biochemical investigation on host plants on life-history of *A. craccivora* are required for Biological control programme.

Table 1.Life-table parameters of A. craccivora on various host plants in different months (mean±SE) during 2012-2013

Life-table parameters	Months	Host plants				F- value
		P. sinensis	*L. purpureus*	*V. radiata*	*V. mungo*	
Age specific fecundity rate m_x / day	November	4.87±0.11	2.95±0.09	4.21±0.12	3.08±0.14	F1=1.13 F2=5.95 P<0.05
	December	3.95±0.10	4.21±0.14	4.16±0.18	4.14±0.14	
	January	2.51±0.19	2.50±0.10	2.18±0.18	2.98±0.18	
	February	4.22±0.12	3.25±0.11	3.15±0.15	3.02±0.15	
Net fecundity (R_o)	November	100.0±1.3	48.60±0.6	58.40±0.8	41.87±0.6	F1=4.99 F2=13.15 P<0.05
	December	38.5±1.1	29.70±0.7	28.2±0.8	26.2±0.7	
	January	21.7±0.7	18.4±0.5	15.4±0.6	14.6±0.6	
	Febuary	64.2±1.0	42.60±0.6	38.8±0.7	34.4±0.6	

Table 2.Life-table parameters of A. craccivora on various host plants in different months (mean±SE) during 2012-2013

Life-table parameters	Months	Host plants				F- value
		P. sinensis	*L. purpureus*	*V. radiata*	*V. mungo*	
Generation time (GT)	November	10.49	12.02	13.31	15.48	F1=57.15 F2=1.26 P<0.05
	December	11.05	12.93	13.36	14.51	
	January	11.69	12.58	13.69	14.79	
	February	11.66	12.60	13.59	15.65	
Intrinsic rate of increase(r_m)	November	0.438	0.323	0.305	0.241	F1=29.37 F2=19.79 P<0.05
	December	0.330	0.262	0.249	0.225	
	January	0.263	0.231	0.199	0.181	
	February	0.357	0.297	0.269	0.226	
Doubling time (DT)	November	1.58	2.15	2.27	2.87	F1=100.41 F2=79.95 P<0.05
	December	2.099	2.644	2.77	3.080	
	January	2.630	2.995	3.472	3.825	
	February	1.94	2.33	2.57	3.07	
Weekly multiplication rate (r_w)	November	21.57	9.592	8.486	5.410	F1=6.92 F2=4.43 P<0.05
	December	10.08	6.263	5.75	4.830	
	January	6.324	5.052	4.043	3.555	
	February	12.17	8.03	6.58	4.868	
Finite rate of population growth (λ_m)	November	1.5508	1.381	1.357	1.272	F1=20.71 F2=14.08 P<0.05
	December	1.391	1.299	1.283	1.252	
	January	1.301	1.260	1.220	1.198	
	February	1.429	1.34	1.30	1.25	

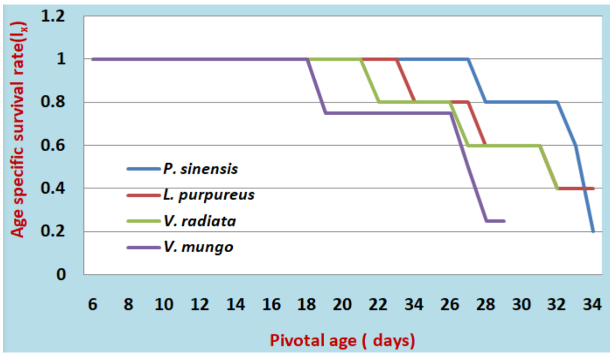

Figure 1(a).Age specific survival rate (lx) of A. craccivora during November (19.96 °C)

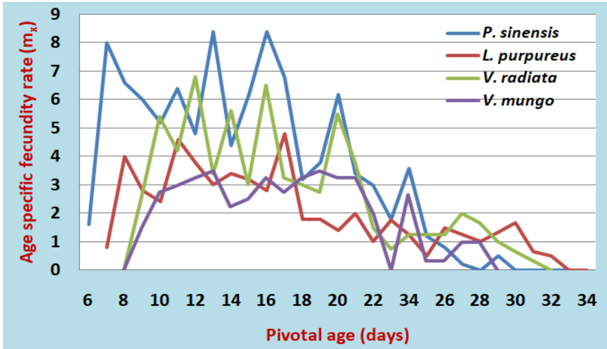

Figure 2(a).Age specific fecundity rate (mx) of A. craccivora during November (19.96°C)

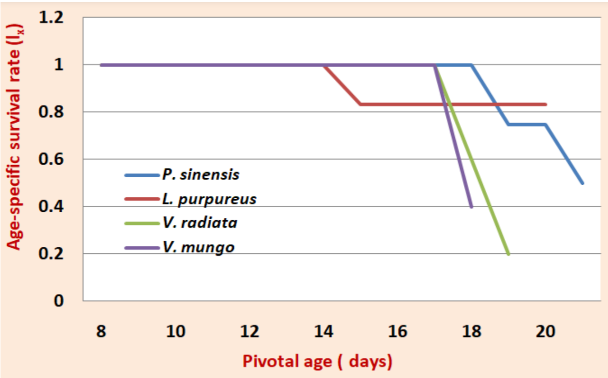

Figure 1(b).Age specific survival rate (lx) of A. craccivora during December (15.43°C)

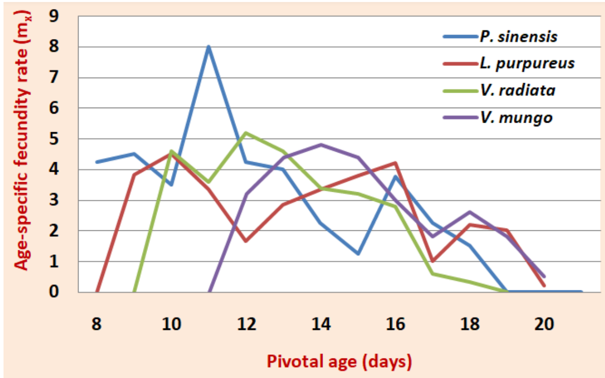

Figure 2(b).Age specific fecundity rate (mx) of A. craccivora during December (15.43°C)

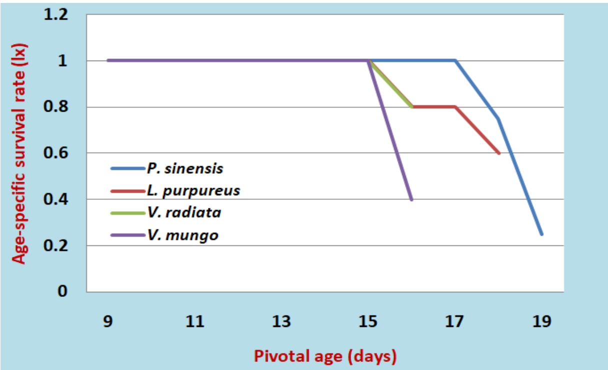

Figure 1(c).Age specific survival rate (lx) of A. craccivora during January (9.24°C)

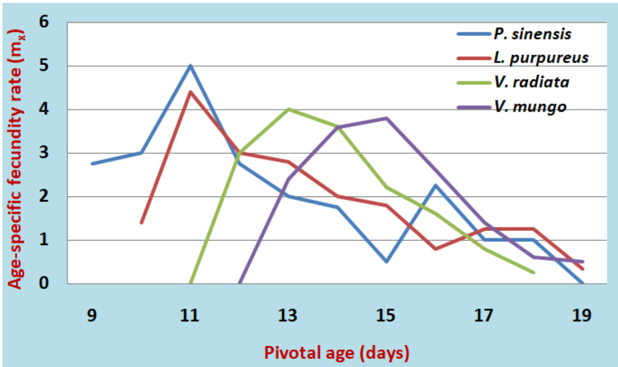

Figure 2(c).Age specific fecundity rate (mx) of A. craccivora during January (9.24°C)

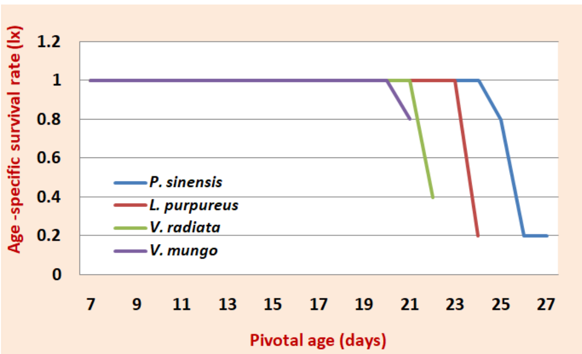

Figure 1(c).Age specific survival rate (lx) of A. craccivora during February (17.92°C)

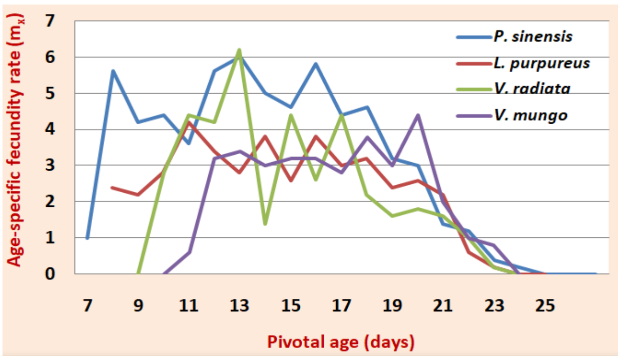

Figure 2(d).Age specific fecundity rate (mx) of A. craccivora during February (17.92°C)

Conclusion

It can be conclude that *P. sinensis* and *L. purpureus* were suitable host for *A. craccivora* during November and February based on fast development and high intrinsic rate of increase. However, further physiological and biochemical investigation on host plants on life-table parameters of *A. craccivora* are required for Biological control programme.

Acknowledgement

Authors are thankful to Head, University Department of Zoology, Tilka Manjhi Bhagalpur University, Bhagalpur for providing facilities. We are also thankful for Innovation in Science Pursuit for Inspired Research (INSPIRE) Fellowship of Department of Science and Technology (DST) Gov. of India, New Delhi.

References

1. Abhilasha S, Singh R. Effect of host plants on the life-table of *Sitobion miscanthi* (TAKAHASHI) (Homoptera: Aphididae). *Journal of Aphidology* 2008; 22(1&2): 1-8.
2. Agrell J, Oleszek W, Stochmal A. Herbivore induced responses in alfalfa (*Medicago sativa*). *J Chem Ecol* 2003; 29: 303/320.
3. Bernardi D, Garcia MS, Botton M et al. Biology and fertility life table of the green aphid *Chaetosiphon fragaefolli* on strawberry cultivars. *J Insect Sci* 2012; 12: 28.
4. Eisner T, Eisner M, Hoebeke ER. When Defense Backfires: Detrimental Effect of a Plant's Protective Trichomes on an Insect Beneficial to the Plant. *P Natl Acad Sci* 1998; 95: 4410-4414.
5. Fozia B, Nayyar AM. Effect of host plants on the biology of cabbage aphid, *Brevicoryne brassicae* (L.) *Journal of Entomological Research* 2013; 37(1): 83-86.
6. Fritz RS, Hochwende. Cascading effects of plant genetic variation on herbivore communities. pp. 177-204 in MDE Fellowers, Holloway GJ, Rolff (eds.), Insect Evolutionary Ecology: Proceedings of the Royal Entomological society's 22nd Symposium. CABI Publishing, Wallingford, Oxan OX10 8DE, UK. 2005.
7. Goławska S. Effect of various host plant on the population growth and development of the pea aphid. *Journal of Plant Protection Research* 2010; 50(2): 224-228. https://doi.org/10.2478/v10045-010-0039-8.
8. Haukioja E. On the role of plant defenses in the fluctuation of herbivore population Oikos. 1980; 35: 202-213.
9. Karban R. Environmental conditions affecting the strength of induced resistance against mites in cotton. *Oecologia* 1987; 73: 414-19.
10. Karbon R. Plant variation : Its effects on populations of herbivores insects. In RS fritz, EL simms editors Plant resistance to herbivores and pathogens: *Ecology Evolution and Genetics.* University of Chicago Press, Chicago.
11. Khan AA, Zaki FA, Khan ZH et al. Biodiversity of predacious ladybird beetles (Coleoptera: Coccinellidae) in Kashmir. *Journal of Biological Control* 2009; 23: 43-47.
12. Loracca A, Fanti P, Molonaro A et al. Aphid performance on *Vicia faba* and two southern Italy *Phaseolus vulgaris* Landraces. *Bulletin of Insectology* 2011; 64(1): 101-106.
13. Painter RH. Insect resistance in crop plants. *Mac Milan*, Newyork. 1951; pp. 520.
14. Pompon J, Quiring D, Giordanengo PH. Role of Host-Plant Selection in Resistance of Wild Solanum Species to Macrosiphum euphorbiae and Myzus persicae. *Entomol Exp Appl* 2010; 137: 73-85.
15. Rahman MM, Sarker PK, Das B et al. Intrinsic Rate of Increase (r_m) of *Aphis gossypii* Glover Infesting Brinjal Plants. *J Biol Sci* 2009; 17: 123-127.
16. Rakhshan, Ahmad E. Changes in morphological traits of *Aphis craccivora* Koch (Hemiptera: Aphididae) in relation to different host plants of family fabaceae. *American Journal of Life Science and Researches.* 2017a; 5(4): 134-142.
17. Rakhshan, Ahmad E. Association of Aphis craccivora Koch infesting Phaseolus sinensis and Lablab purpureus with its predator Cheilomenes sexmaculata (Fabricius) in different seasons. *Journal of Entomology and Zoology Studies* 2017b; 5(4): 1222-1228. http://www.entomoljournal.com/archives/2017/vol5issue4/PartP//5-4-47-777.pdf.
18. Rakhshan, Ahmad E. Effect of fabaceous plants on the biological performance of *Aphis craccivora* koch (Hemiptera: Aphididae). *American Journal of Life Science and Researches* 2018; 6(3): 131-138.
19. Rakhshan, Ahmad E, Kumar S. Seasonal incidence of *Aphis craccivora* Koch on *Vigna mungo* and *V. radiata* with its predator *Cheilomenes sexmaculata* (Fabricius) (Coleoptera: Coccinellidae). *Advances in Agricultural Science* 2018; 6(1): 26-33. https://aaasjournal.org/submission/index.php/aaas/article/view/37.
20. Rhodes DF. Herbivores population dynamics and plant chemistry. In Denno RF, McClure MC, editors variable plants and herbivores in natural and managed ecosystem. Academic Press. San Diego. 1983; 155-220.
21. Schowalter TD. Insect ecology: An Ecosystem Approach. *Academic, San Diego CA* 2000; pp. 483.
22. Shirvani A, Hoseini V. Fertility life-table parameters estimation of *Aphis gossypii* Glover. *Iranian J Agric Sci* 2004; 35: 23-29.
23. Singh R, Tripathi CPM. Effect of temperature on the life-table of Anola Aphid, *Schoutedenia emblica* (Patel and Kulkarni) (Homoptera: Aphididae). *Journal of Aphidology* 2010; 24(1&2): 37-44.
24. Slosseer JE, Pinchak WE, Rummel DR. A review of

known and potential factors affecting the population dynamics affecting the population dynamics of the cotton aphid. *Southwestern Entomol* 1989; 14: 302-313.
25. Soffan A, Aldawood AS. Biology and demographic growth parameters of cowpea aphid (*Aphis craccivora*) on faba bean (*Vicia faba*) cultivars. *Journal of Insect Science* 2014; 14(120).
26. Southwood TRE, Henderson PA. Ecological Methods. 3rd edition. Blackwell, Oxford, United Kingdom. 2000; pp. 592.
27. Takalloozadeh HM. Effect of host plants and various temperatures on population growth parameters of *Aphis gossypii* Glover (Homoptera: Aphididae). Middle East. *J Sci Res* 2010; 6(1): 25-30.
28. Tazerouni Z, Talebi AA, Fathipour Y et al. Bottom-up of two host plants on life-table parameters of *A. gossypii* (Hemiptera: Aphididae). *J Agr Sci Tech* 2010; 18: 179-190.
29. Underwood N, Rausher MD. Comparing the consequences of induced and constitutive plant resistance for herbivore population dynamics. *The American Naturalist* 2002; 160:20-30.
30. Underwood N, Rausher MH. The effects of host plant quality on herbivore population dynamics in a model system. *Ecology* 2000; 81:1565-1576.
31. White TCR. The abundance of invertebrates herbivores in realtion to the availability of nitrogen is stressed food plants. *Oecologia* 1984; 63: 90-105. http://www.jstor.org/stable/4217356.
32. Znidarcic D, Markovic D, Vidrih R et al. Which Biophysical and Biochemical Factors May Contribute to Higher Resistance of Cabbage (*Brassica oleraceae* L. var. Capitata) to Attack of the Most Important Pests. *Acta Agr Slov* 1984; 97(2): 151-158.