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Full Length Research Paper

Suitability of an artificial diet for rape aphid, *Brevicoryne brassicae*, using life table parameters

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Experiments based on life tables are suitable for the understanding of the population dynamics of insects. In this work, suitability of an artificial diet was studied through age-specific life tables. Development, survival, reproduction rate and population growth parameters of the rape aphid, *Brevicoryne brassicae* (Hom: Aphididae) were evaluated on leaf discs of *Brassica oleracea,* and a liquid artificial diet enclosed in parafilm sachets under incubator condition. Life parameters of 2 treatments were close to each other. The artificial diet that was used in this study had no significance differences in life table parameters compared with these parameters on leaf of *B. oleracea*. The results obtained in this study indicated that this artificial diet can be useful for rearing and other tests based on artificial diet.

Key words: Life table, artificial diet, *Brevicoryne brassicae*, survival, fecundity.

INTRODUCTION

In large measure, the success of entomology over the past century is founded on our ability to rear insects on artificial diets (Cohen, 2004). Insects that are reared on artificial diets are used in many programs, as agents of biological control and sterile insect technologies (Knipling, 1979), as feed for other animals (Versoi and French, 1992), as bioreactors for production of pharmaceuticals and other recombinant proteins (Hughes and Wood, 1998). Since the first development in 1962 of an artificial diet for rearing an aphid, the green peach aphid, *Myzus persicae*, (Mittler and Dadd, 1962), diets for rearing this and other aphid species have all been chemically defined solutions of sugars, amino acids, vitamins and minerals (Mittler and Koski, 1974). Over the past century of research, only a few diets have been developed that can be clearly considered fully successful. Although success is a subjective term, there are several qualities that can be taken as key requisites for a highly useful diet (Cohen, 2004).

The present study aimed to evaluate the suitability of a general artificial diet on the *Brevicoryne brassicae* through a life table approach, because its parameters are good index for study on insect dynamic.

In this experiment a completely defined synthetic diet which was suitable for rearing of some other aphids was found that with some changes can support continuous culturing of rape aphid. Rape aphid is a specialist on plants in the cruciferae family and prefers feeding on younger plant tissues. This aphid can cause economic damage on this family because it can move to developing floral buds and render the head unmarketable (Sheehan and Shelton, 1989) and for testing of some oral toxic material, such as lectins and enzyme inhibitors, we need to use an artificial diet that can support at least one generation of *B. brassicae*.

MATERIALS AND METHODS

Plants and insects

All *Brassica oleracea* plants were grown in pots under stable greenhouse conditions (23-26°C and L16:D8 photoperiod). The rape aphid from cabbage field of university of Tehran was utilized for all our ex-periments. Aphids were maintained in growth chambers (controlled environments) under optimal conditions for aphid development (20°C, L16:D8 photoperiod and ~70% h).

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Table 1. The comparison of some life time records of *B. brassicae* on leaf and artificial diet (Data are means ± SD).

Treatment	Development time* of different instar nymphs				Total development time	Pre productive time	Productive time	Post productive time	Adult longevity
	First instar	Second instar	Third instar	Fourth instar					
Leaf	3.2 ±0.4	2.2 ± 0.5	3 ± 0.5	3 ± 0.2	38 ± 1.4	12 ± 0.7	15 ± 1.7	9.6 ± 1.1	23.5 ± 0.6
Artificial diet	3 ± 0.2	3 ± 0.15	2.5 ±0.3	3 ± 0.5	37 ± 0.5	12.3 ± 0.4	14.3 ± 0.9	8 ± 1.5	21.2 ± 1.3

*Time = day.
All the data between treatments, in this table were not significantly different (P < 0.05).

Table 2. Demographic analysis of the aphid *B. brassicae* on leaf discs and artificial diet.

Life parameter	Treatment	
	Leaf disks	Artificial diet
rm	0.16	0.15
R0	27.10	26.20
Tc	20.20	21.20
DT	4.20	4.70
λ	1.20	1.15

rm: intrinsic rate of increase, R0: net reproduction rate or gross fecundity, λ: discrete daily growth rate, DT: doubling time, Tc: generation time.

Table 3. Demographic analysis of the aphid *B. brassicae* on leaf discs and an artificial diet with jack-knife method (Meyer et al., 1986 and Sokal and Rohlf, 1981) (Data are means ± SD).

Life parameter	Treatment	
	Leaf disks	Artificial diet
rm	0.16 ± 0.01	0.15 ± 0.01
R0	27.0 ± 1.25	26.43 ± 1.16
Tc	20.71 ± 0.76	21.26 ± 1.1
DT	4.35 ± 0.17	4.5 ± 0.12
λ	1.18 ± 0.01	1.17 ± 0.02

rm: intrinsic rate of increase, R0: net reproduction rate or gross fecundity, λ: discrete daily growth rate, DT: doubling time, Tc: generation time

Artificial diet

Preparing artificial diet was based on A_5 diet that Febvay et al. (1988) described but with some changes in sucrose percentage (20%) and utilizing of sinigrin (Fluka) (0.5%) for feed stimulating. It was mixed with amino acids, minerals, vitamins and some other materials (sigma). For artificial diet, all was sterile condition and solution was sterilized with 0.45 micrometer filter (Sartorius). Diet was enclosed in parafilm sachets and every 3 days was changed with a new one.

Life parameter tests

For study on life parameters on plant, 50 Leaf discs from young plants on agar plates with lids that had net in center (for ventilation) were prepared. 3 to 4/5th instar aphid putted on each leaf and after 12 h, adults and all their nymphs except one (0 - 12 h age) were omitted. Plates were under stable incubator condition (20°C and L16:D8 photoperiod). Every 24 h, aphids status (dead or alive), ecdysis and number of winged adults were checked and recorded until all aphids died. During the reproductive period of resulting adults, newborn aphids were counted and removed from the leaves every day. During life period, unsuitable leaves were changed with new one. For artificial sachets, conditions and records was as described above.

Development time (Table 1) and a complete adult life table were constructed to calculate intrinsic rate of increase, survivorship, net reproduction rate or gross fecundity, instantaneous rate of increase (number of offspring/living female/unit time), discrete daily growth rate, doubling time, generation time (Tables 2 and 3) as follows:

$R_0 = \Sigma l_x m_x$

$T = \Sigma x l_x m_x / \Sigma l_x m_x$

$r_m = (\ln R_0) / T$

$DT = \ln(2) / r_m$

$\Lambda = e^{rm}$ (Ebert, 1999)

Data on development time, longevity and fecundity were analyzed by Excel (2007) and SAS (6.12) programs. Population growth rates were calculated by constructing life tables according to Andrewartha and Birch (1970):

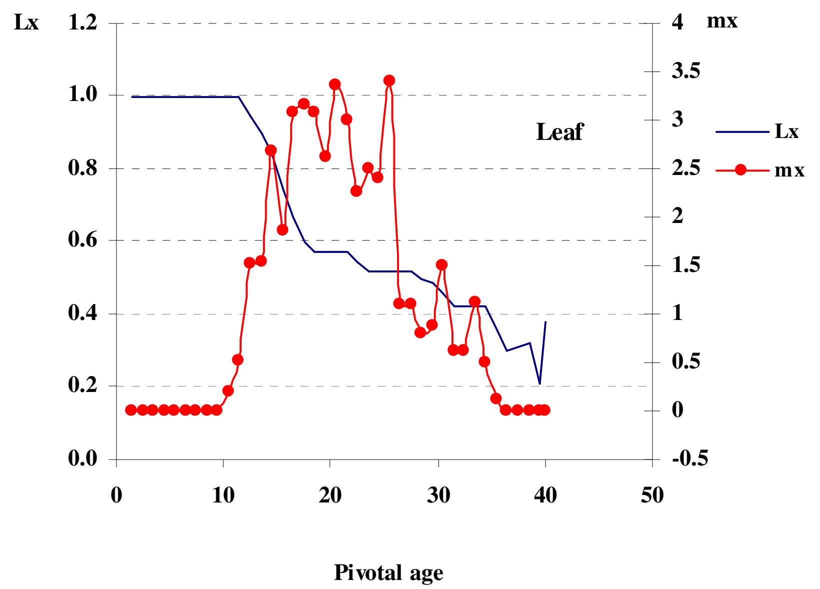
$1 = \Sigma e^{-r_* x} l_{x*} m_x$

The age-specific survival of the rape aphid on leaf discs and artificial diet were fitted in the curve (Figures 1 and 2).

RESULTS AND DISCUSSION

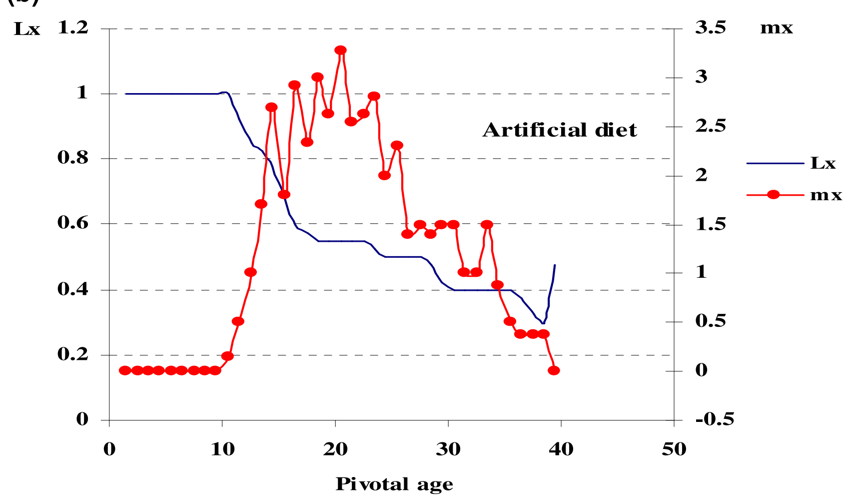
Development times of different instar nymphs of *B. brassicae* on the leaf discs and artificial diet are presented in Table 1. Total development time of *B. brassicae* on both treatments was close to each other. In both leaf discs and artificial diet, nymph-to-adult survival rate of *B. brassicae* nymphs had not significant difference ($P < 0.01$, Tables 2 and 3). Also nymphal survival rate between the leaf discs

(a)



L_x: rate of survivorship, mx: instantaneous rate of increase, pivotal age or x :age.

(b)



L_x: rate of survivorship, mx: instantaneous rate of increase, pivotal age or X: age.

Figure 1. The age-specific survival curve of the *B. brassicae* on leaf discs (a) and artificial diet (b).

and artificial diet was not different ($P < 0.05$). Overall, nymph survivorship was not significantly higher on leaf discs than the artificial diet ($P < 0.05$).

Nymphal-to-adult development time of females was shorter on the leaf discs than on the artificial diet but there was no significant difference between them ($P < 0.05$, Table 1). The intrinsic rate of increase or rm value on leaf and on artificial diet was very close to each other (Tables 2 and 3) and was similar to rm that Francisco (2002) reported for this aphid. Also survivorship, net reproduction rate or gross fecundity, instantaneous rate of increase, discrete daily growth rate, doubling time and generation time (Tables 2 and 3) that are important indexes in life table of an insect, statistically had no differences between the 2 treatments (leaf and artificial diet). None of adult aphids, both on leaves and artificial diet went to winged stage. Most of the mortality of aphids on treatments was in first and second instars and most of nymphs were well settled after third instar.

The host plants have a considerable effect on development, survival and fecundity of the insects. In some tests, for example in bioassay tests for oral components like lectins that are very expensive, were giving insect substances through plant (like systemic pesticides) may result in digestion or transformation to another component by plant, we need a holistic diet that do not change the

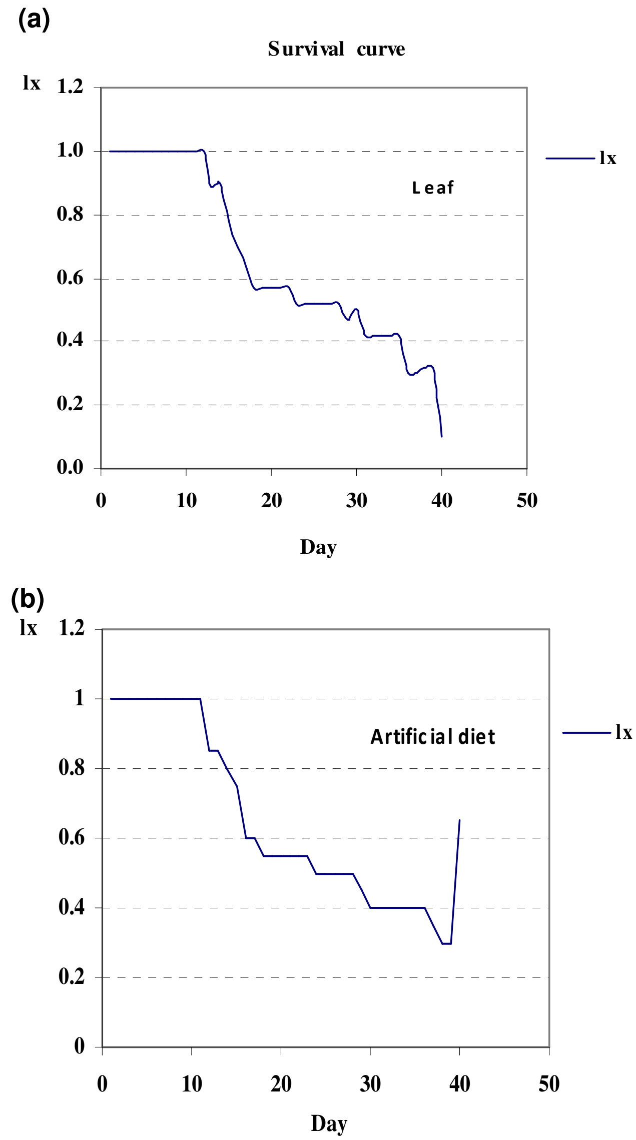


Figure 2. The survival curve (lx) of the *B. brassicae* on leaf discs (a) and artificial diet (b).

structure of our testing material and show just the effect of that. The results in this investigation showed that this artificial diet can support all life stages of *B. brassicae* and this aphid can be established on that. The compareson of results with life table parameters that Francisco (2002) measured in condition of 4 seasons indicates that this investigation was similar to condition of spring or autumn. Aphids are successful insects that feed on plant phloem sap, which is composed of large amounts of sucrose (0.15-0.73 M), some amino acids (15-65 mM), minerals and usually negligible quantities of peptides and proteins (Cristofoletti et al., 2003), and some phloem sap may contain large amounts of proteins (Ziegler, 1975). Then finding the correct mixture of these materials is necessary for synthesis a suitable diet. Each of these components is responsible for a vital action in the insect body. Also some other materials for some insects, like *B. brassicae* that is a specialist insect and only feed on brassicacea plants (Sheehan and Shelton, 1989), is needed; such as sinigrin and sucrose as feeding stimulators.

In this experiment the nymphs on diet had normal ecdysis; also adults had no winged stage that may be due to the poor quality of the feed. For study on a diet of an insect, life parameters are good indexes. The significance differences between life parameters of insect on diet and on a sensitive host plant (*B. oleracea*) were not observed. We hope this study provides useful information for rearing *B. brassicae* in laboratories.

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REFERENCES

Andrewartha HG, Birch LC (1970). The Distribution and Abundance of Animals. University of Chicago Press, Chicago, IL, USA.

Cohen AC (2004). Insect diets: Science and technology. CRC press. p. 324.

Cristofoletti PT, Ribeiro AF, Deraison C, Rahbe Y, Terra WR (2003). Midgut adaptation and digestive enzyme distribution in a phloem feeding insect, the pea aphid *Acyrthosiphon pisum*. J. Insect Physiol. 49: 11-24.

Ebert TA (1999). Plant and animal population. Methods in demography. Academic press, California, p. 312.

Febvay G, Delobel B, Rahbe Y (1988). Influence of the amino acid balance on the improvement of an artificial diet for a biotype of *Acyrthosiphon pisum* (Homoptera: Aphididae). Can. J. Zool. 66: 2449-2453.

Francisco JC (2002). Tabelas de Vida de Fertilidade de *Brevicoryne brassicae* (L.) (Hemiptera: Aphididae) em Condições de Campo. Neotropical Entomol. 31: 419-427.

Hughes PR, Wood HA (1998). Production of pharmaceutical and other recombinant proteins in insect larvae. SIM News, 48: p. 105.

Knipling EF (1979). The basic principles of insect population suppression and management. USDA Agriculture. Handbook, p. 512.

Meyer JS, Ingersoll CG, McDonald LL, Boyce MS (1986). Estimating uncertainty in population growth rates: Jackknife vs. bootstrap techniques. Ecology, 67: 1156-1166.

Mittler TE, Koski P (1974). Meridic artificial diets for rearing aphids. Entomologia Experimentalis et Applicata. 17: 524-525.

Mittler TE, Dadd RH (1962). Artificial feeding and rearing of the aphid, Myzus persicae (Sulzer), on a completely defined synthetic diet. Nature, London, 195: p. 404.

Sheehan W, Shelton AM (1989). The role of experience in plant foraging by the aphid parasitoid *Diaeretiella rapae* (Hymenoptera: Aphidiidae). J. Insect Behav. 2: 743-759.

Sokal RR, Rohlf FJ (1981). Biometry. 2nd ed. Freeman, NY.

Versoi PL, French LK (1992). The establishment of commercial insectaries, in Advances in Insect Rearing for Research and Pest Management. Anderson TE and Leppla NC Eds. Westview Press, New Delhi, pp. 457-463.

Ziegler H (1975). Nature of transported substances. In: Zimmermann H, Milburn JA (Eds.), Encyclopedia of Plant Physiology, New Series, Vol. 1. Springer, Berlin, pp. 59-100.