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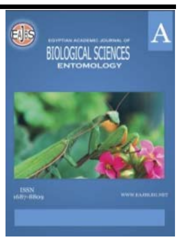

Temperature and Leaf Status Effect Range on The Rates of *Aphis craccivora* Koch in bean

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ABSTRACT

Five degree of temperatures was tested from 10 to 30˚C, *Aphis craccivora,* was reared on two statuses of bean leaves young and old (Nbrasca variety). Aphid insects were developed faster and had a higher mean relative growth rate and higher intrinsic rate of increase on young than on old leaves of bean, respectively. At temperature 25°C, it was more performance for aphid's development and rearing comparing by other degrees. The intrinsic rate of increase is strongly correlated with the mean relative growth rate during development for *Aphis craccivora* reared on both young and old leaves of bean plants from 10 to 25°C.

INTRODUCTION

Aphids are an important group of piercing-sucking insects with worldwide distribution. *Aphis craccivora* Koch is associated with many host plants in the Leguminous and also in many other plant families so that it attacks about 50 crops in 19 different plant families in Egypt (Abdel-Rahman *et al*., 2005) and Abd El-Wareth (2005). Aphids are economically important insects causing severe damage to a number of crop plants. Both nymphs and adults suck plant sap and cause serious damage right from the seedling to pod bearing stage (Ascher *et al.,* 1992). Cowpea aphids inject toxins into the plant while feeding; they most likely reduce mung-bean and yields (Barnby and Klocke (1987). Aphids causing direct damage to the host by sucking the sap from various plant parts, they may lower the yield, quality and marketability of legume crops by transmitting plant viruses especially FBNYV for faba bean which reduce the yield over 95% in middle Egypt during winter 1992, Abd EL-Wareth (2005). All of these reasons led to result in early plant death and the production of an excess of honey dew (Blaney *et al*., 1990). Few investigations have been conducted on the factors that influence its rate of increase. Differences during development and fecundity were occurred in response to change in temperature (Noda, 1960; Gunther *et al*., (1980) and Wellings (1981). However, similar effects may be produced by differences in the age of the host plant (Watt, 1979).

The effects of temperature on the performance of this aphid species during the earlier developmental stages of bean have been very little studied. This investigation aims to quantify these effects and to relate the changes in the rate of increase to the mean relative growth rate of the aphid during development.

MATERIALS AND METHODS

This study was carried out at five constant temperatures of 10, 15, 20, 25 and 30 ± 2 C˚, under Laboratory conditions using air condition at Fayoum Agriculture Research Station, ARC, from May till September 2015. Aphid culture of *Aphis craccivora* Koch was collected from infected bean fields at Fayoum Governorate, Fayoum district. The stock of aphids were established on potted *Phaseolus vulgaris* L. plant (Nbrasca cv.) in insectary at a temperature of 22±2 C˚, 65± 10 % relative humidity and 16 L: 8 D light. To estimate the effect of *A. craccivora* on vegetative growth of bean plants, seeds of bean were planted in plastic pots five replicate/each degree (20cm diameter and 25 tall) filled with fine loam soil at a density of three seeds per pot, under laboratory conditions. Seven days after emergence, seedlings were thinned to a single plant for each pot. Bean plants were watered every two days and fertilized once shortly after emergence with Diammonium phosphate (DPA) (18: 46:0) (Dap company) 8 granules/pot according Saffon (2014). Aphids were introduced into the plants when they reached eight true leaf stages, 14 days after seedling emergence, (Hail and Ja'fer, 2007). Nymphs were clip leaf caged individually on young and mature leaves at a density of two clip leaf cages per plant using cages (Fig. 1) of the type described by Abd El-Wareth (2005) and (Watson and Dixon, 1984), at a density of one aphid per leaf, separated by small plastic cones. The nymphs were checked every day till the final molt recorded. They were weighed using electric sensitive balance, replaced singly on plants at the same developmental stage and temperature at which they had been reared. The time of the onset of reproduction was noted and recorded. The nymphs were counted and removed for a time equal to the pre-reproductive period. The plants were changed as necessary in order to maintain the specified developmental stages.

Fig. 1: clip leaf cages, described by (Watson and Dixon,1984) and designed by Abd EL-Wareth (2005)

RESULTS AND DISCUSSION

A- Development and relative growth rates:

Aphid development rate, defined as formula 1/ D, where D = time in days from birth to adult molt, increased with temperature up to 25C˚ when further increase in temperature became detrimental for aphids rearing (Table 1).Development rate was higher at all temperatures on the young than old leaf from 10 till 30C˚. The highest development rate was cleared at 25C˚ being 0.142 and 0.125 day, while the lowest rate at 10C˚ being 0.052 and 0.050 day on the young and old leaves, respectively as shown in the same table. The mean relative growth (RGR), defined according to Van Emden (1969) formulae as (InA – InB) / D, where In= Natural logarithm , A= adult weight, B= birth weight and D= developmental time, increased from 10 till 25 C˚ and decreased after that on both young and old leaves, as shown in (Table 2). The relationship between temperature and leaves showed that, RGR was higher on the young than on the old leaves. The highest record of RGR was noticed at 25˚C but, the lowest was recorded at 10 C˚ on both young and old leaves, respectively. The aphid's weight was varied by increasing of temperature from 10-25 C˚. The highest weight was recorded at 20˚C being 1.50 and 1.31 gm, but the lowest weight at 30˚C being 0.70 and 0.90 gm on both young and mature leaves, respectively as shown in (Table 3).

Table 1: The developmental rate (days) of wingless aphids on the young and old leaves on bean through five constant temperatures.

Leave status	Temperatures C°				
	10	15	20	25	30
Young	0.052**a**	0.090**b**	0.111**c**	0.142**d**	0.083**e**
	19 days	11 days	9 days	7 days	12 days
Old	0.050**a**	0.070**b**	0.083**c**	0.125**d**	0.071**e**
	20 days	15 days	12 days	8 days	14 days

Mean in a row with different letters are significantly different (P<0.05)

Table 2: Mean relative growth rate (RGR mg/mg/day) of wingless aphids on the young and old leaves on bean through five constant temperatures.

Leave status	Temperatures C°				
	10	15	20	25	30
Young	0.141**a**	0.35**b**	0.450**c**	0.670**d**	0.260**e**
Old	0.110**a**	0.117**b**	0.270**c**	0.460**d**	0.119**e**

Mean in a row with different letters are significantly different (P<0.05)

Table 3: Weight of adult wingless aphids (gm) reared on the young and old leaves on bean through five constant temperatures.

Leave status	Temperatures C°				
	10	15	20	25	30
Young	0.95**a**	1.27**b**	1.50**c**	1.40**d**	0.70**e**
Old	1.10**a**	1.05**b**	1.31**c**	1.23**d**	0.90**e**

Mean in a row with different letters are significantly different (P<0.05)

B- Mortality:

The percentage of nymph's mortality of *A. craccivora* was calculated according this formula: % apparent mortality = DX*100/IX according to (Birch, 1948) where, IX= Number of individuals at beginning and DX= Numbers of dying during the age.

The highest percentage mortality was occurred on the young and old leaves at 30C˚ being 29.6 and 33.3 % on young and old leaves, respectively .On the other hand, the lowest mortality occurred on the young and old leaves at 15 and 25C˚, respectively. Generally, percentage of nymph's mortality of *A. craccivora* fluctuated from 10 till 30 C° decreased and increased dramatically as shown in (Table 4).

Table 4: Percentage (%) of immature individuals mortality of *A. craccivora* on young and old leaves of bean plants at different temperature degrees under laboratory conditions.

Leave status	Temperatures C°				
	10	15	20	25	30
Young	9.50a(21)*	9.1b(33) *	14.3c(42)*	8.2d(49) *	29.6e(54)*
	2**	**3****	**6****	**4****	**16****
Old	12.5a(24)*	10.5b(38)*	12.8c(39)*	11.5d(52)*	33.3e(60)*
	3**	**4****	**5****	**6****	**20****

* Number of replications of aphids ** Number of aphids died

Mean in a row with different letters are significantly different (P<0.05)

C- Reproduction:

The effective lifetime fecundity (MD) of an aphid is achieved in time 2 days from birth, where MD: number of days from the birth of the aphid until production of the first progeny (Wyatt and White, 1977). There were no differences between young and mature leaves as shown in (Table 5). The maximum effective lifetime fecundity on the young leaf occurred at 25˚C but on mature leaf at 20˚C. On the other hand, fecundity was much decreased at 30˚C on both young and mature leaves.

Table 5: Effect of life time fecundity on reproduction (MD) of wingless aphid individuals (*A. craccivora*) reared and kept on the young and old leaves on bean in relation to temperature degrees.

Leave status	Temperatures C°				
	10	15	20	25	30
Young	22**a**	24**b**	37**c**	48**d**	5**e**
Old	25**a**	27**b**	40**c**	32**d**	8**e**

Mean in a row with different letters are significantly different (P<0.05)

D- The intrinsic rate of natural increase:

The intrinsic rate of natural increase (rm) refers to the rate of daily population growth (aphids/ aphid/day) and was calculated from the formula: In rm= 0.738 (log Fe) / Tpr (Asian and Pons, 2001), where Fe= effective fertility = number of nymphs produced during a period equivalent to Tpr and Tpr = pre- reproductive time= number of days from the birth of the aphid until production of the first nymph. The mean intrinsic rate of natural increase was higher on the young leaf than on the mature leaf and increased on young leaf up to 25C˚. The highest (rm) was recorded at 25 C˚ while, the lowest at 30C˚,as shown in (Table 6).

Table 6: Effect of intrinsic rate of natural increase (rm individuals/aphid/day) of wingless aphids (*A. craccivora*) reared and kept on the young and old leaves on bean in relation to temperature degrees.

Leave status	Temperatures C°				
	10	15	20	25	30
Young	0.18**a**	0.29**b**	0.35**c**	0.42**d**	0.07**e**
Old	0.12**a**	0.16**b**	0.26**c**	0.31**d**	0.05**e**

Mean in a row with different letters are significantly different (P<0.05).

Work in field legumes in southeast Australia has shown that *A. craccivora* is highly sensitive to temperature possesses highly potential for migration (Gutierrez *et al*., 1971). Although not in conformity with the results of (Grylls, 1972) who demonstrated the ability of the aphid to multiply locally from November to April, (Gutierrez *et al*., 1971) inferred that *A. craccivora* may not survive mild winters or hot dry summers characteristic of that region, so hosts are colonized during autumn and spring each year from distant favorable regions. (Chambers, 1979) considered growth and development as separate processes that together determine the size attained by an aphid. The weight is greater at low temperatures in several aphid species (Wellings, 1981 and Dixon *et al*., 1982), and increased nutrition has been shown to result in larger aphids (Watt, 1979 and Dixon *et al*., 1982). This is due to different influence of temperature and nutrition on growth and development (Chambers, 1979 and Shamsan, 1999). Although at high temperatures growth is more rapid, this does not result in larger aphids because the development rate is accelerated disproportionately, causing growth to be truncated earlier. Between 10 – 25C˚ the relative growth rate of *A. craccivora* on the young leaf increased from 0.141 to 0.670

(475.2%), while the development rate increased from 0.052 to 0.142 (273.1%).But on the old leaves increased from 0.110 to 0.460 (418.2%), while the development rate increased from0.05 to 0.125 (250.0%), and consequently, aphids were smaller at 10C° than at 25 C°. Increased host plant quality will result in larger aphids if the developmental rate increase is less than that of the growth rate. In *A. craccivora*, this occurred at 15C° when the growth rate was 0.350 on the young leaf and 0.117 on the old leaf (299.1%), while the developmental rate was 0.09 on the young leaf and 0.07 on the old leaf (128.6%) as shown in tables(1&2). These results occurred there were larger aphids on the young than old leaves. At low temperature, the relationship between development and temperature may be not linear (Dixon *et al*., 1982). This was evident in the relationships of aphid growth and development with temperature on the young leaf. The present study also corroborated and agreement with, Dutta *et al.,* (2012) reported the same in the upper canopy of brinjal and the variation in result can by explained by the fact that mites migrate from older to younger leaves when food reserve in older leaves becomes scanty. Walsh(2001), observed the presence of only thylakoid granules, the key photosynthetic engines in plant cell, following feeding.

Reproductive rate is positively correlated with both aphid size and temperature (Dixon and Wratten, 1971; Watt, 1979 and Dixon and Dharma, 1980). Consequently, the intrinsic rate of natural increase (rm) also increases with improved nutrition and at higher temperatures. The intrinsic rate of natural increase (rm) has been used as a criterion of host resistance to aphid attack (Sotherton and van Emden, 1982). When an aphid molts to adult, its embryos are at an advanced state of development, therefore, its reproductive capacity must depend on its experience as a nymph (Dixon, 1987).

REFERENCES

Abdel-Rahman , G.A., M.H. Belal, N.M. Ibrahim and E.A. Ali, 2005. Observations on toxic effects of some desert plant extracts on the cowpea aphid, *Aphis craccivora* Koch. *Egypt J. Agric. Res.,* 83 (2): 609-621.

Abd EL-Wareth, H.M. (2005). IPM for some aphid species transmitted faba bean necrotic yellow virus at Fayoum. *PhD. Thesis, Fac. Agric., Fayoum Univ., 235pp.*

Asin L. and X. Pons (2001). Effect of high temperature on the growth and reproduction of corn aphids(Homoptera: Aphididae) and implications for their population dynamics on the north-eastern lberian peninsula. *Environ. Entomology.* 30(6): 1127-1134.

Ascher K R.S., M. Klein and J. Meinser (1992) . Azatidirachtin, a neem formulation, acts on nymphs of the western flower thirps. *Phytoparasitica,* 20, 305-306.

Barnby M.A. and J. A. Klocke (1987). Effects of azadirachtin on the nutrition and development of the Tobacco Budworm, *Heliothis virescens* (Fabr) . *J. Insect Physiol*, 33, 69-75

Blaney W. M., M.S.J. Simmonds, S.V. Ley, J.C. Anderson and P.L.

Birch, L. C.(1948). The intrinsic rate of natural increase of an insect population. *J. Animal. Eco.,* 17:15-26.

Chambers, R.J. (1979). Simulation modeling of a sycamore aphid population. *PhD. Thesis, Univ. of East Anglia.*

Dixon, A. F. G. (1987). Parthenogenetic reproduction and the rate of increase in aphids. *Pages 269-287 in Aphids, Their Biology, Natural Enemies and Control,* *Vol. 2A(A. K. Minks and P. Harrewijn, eds) . Elsevier, Amsterdam.*

Dixon, A. F. G., R. J. Chambers and T. R. Dharma. (1982). Factors affecting size in aphids with particular reference to the black bean aphid *Aphis fabae*. *Entomolgia. Experimentalis et Applicata*, 32: 123- 128.

Dixon, A. F. G. and T.R. Dharma. 1980. Spreading the risk in developmental mortality; size, fecundity and reproductive rate in the black bean aphid *Aphis fabae*. *Entomolgia. Experimentalis et Applicata*, 28: 301- 312.

Dixon, A. F. G. and S.D. Wratten. 1971. Laboratory studies on aggregation, size and fecundity in the black bean aphid *Aphis fabae* Scop. *Bulletin of Entomological Res.,* 61: 97-111.

Duncan, D.B.(1955). Multipale range and multiple- F test. *Biometrics.*, 11:1-42.

Dutta, N. K., S. N. Alam, M. K. Uddin, M. Mahmudunnabi and M. F. Khatun (2012). Population abundance of red spider mite in different vegetables along with its spatial distribution and chemical control in brinjal, *Solanum melongena L. Bangladesh. J. Agril. Res.,* 37(3): 399404.

Grylls, NE. (1972). Aphid infestation and virus infection of peas and beans on the Central Tablelands of New South Wales. *Australian J. of Experimental Agric. And Animal Husbandry,* 12:667-674.

Gunther, T. B. Freier and T.Wetzel (1980). Untersuchungen uber des Temperature-gims in einen Weizenbestand und sein Einfluss auf die Entwicklung der Getreidlaus (Macrosiphum avenae (Fabr.). *Archiv für Phytopathologia und Pflanzenschutz,* 16: 209-216.

Gutierrez, A. P., D. J. Morgan and D. E. Havenstein (1971). The ecology of *Aphis craccivora* Koch and subterranean clover stunt virus. I. The phonology of aphid populations and the epidemiology of virus in pastures in Southeast Australia. *J. of Appl. Ecol.,* 8: 699- 721.

Hail, K. Shannag and Ja'fer, A. Ababneh (2007). Influence of black bean, Aphis fabae Scopoli on growth rates of faba bean. *World J. of Agric. Sci.,* 3(3):344-349.

Noda, I. (1960). The emergence of winged viviparous female in aphid. VI. Difference in the rate of development between the winged and the un-winged forms. *Jap. J. of Ecology* 10: 97- 102.

Soffan, A. and A. S. Dawood (2014). Biology and demographic growth parameters of cowpea aphid (*Aphis craccivora*) on faba bean (*Vicia faba*) cultivars. *J. of Ins. Sci.,* vol. 14(120): 1536- 2442.

Shamsan, A.D.A.(1999). Studies on some leafminer insects infesting fruit trees in Egypt. *PhD.Thesis, Fac. of Agric., Ain Shams Univ.*256pp.

Sotherton, N.W. and H.F. Van Emden (1982). Laboratory assessment of resistance to the aphids, *Sitobion avenae* and *Metopolophium dirhodum*, in three *Triticum* species and two modern wheat culivars. *Ann. of Appl. Biol*., 101:99-107.

Toogood (1990). Antifeedant effects of *azadirachtin* and structurally related compounds on lepidopterous larvae. *Entomol. Exp. Appl,* 55:149-160.

Van Emden, H.F.(1969). Plant resistance to Myzus persicae induced by a plant regulator and measured by aphid relative growth rate. *Entomologia Experimentalis et Applicata,* 12:125-131.

Watson, S.J. and A. F. G. Dixon (1984). Ear structure and the resistance of cereals to aphids. *Crop Protection*, 3:67-76.

Watt, A.D.(1979). The effect of cereal growth stages on the reproductive activity of *S.avenae* and *M. dirhodium Ann. of Appl. Bio.*, 91:147- 157.

Wellings, P.W.(1981). The effect of temperature on the growth and reproduction of two closely related aphid species on sycamore. *Ecol. Ent.,* 6:209-214.

Wyatt, I.J. and P.F. White (1977). Simple estimation of intrinsic rate for aphids and tetranychid mites. *J. of App. Ecol.*, 14:757-766.

ARABIC SUMMERY

مدي تأثير درجة الحرارة وحالة الأوراق علي معدلات حشرة من اللوبيا في الفاصوليا

حماده محمد عبد الحميد عبد الوارث
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تم تربية من اللوبيا تحت خمسة درجات حرارة مئوية من 10 الي 30 درجة مئوية علي نوعين من أوراق من الفاصوليا وهما الأوراق الصغيرة (الأوراق القمية) والأوراق القديمة (الأوراق القاعدية) للصنف نبراسكا. تتطورت حشرات المن بمعدل أسرع وسجلت أعلي متوسط لمعدل النمو النسبي وأعلي معدل للزيادة الحقيقية(الجوهرية) علي الأوراق القمية والقاعدية علي الفاصوليا بالترتيب. تعتبر درجة الحرارة 25 درجة مئوية هي الأنسب والأفضل لنمو وتطور حشرات المن مقارنة بباقي درجات الحرارة. لوحظ أن معدل الزيادة الحقيقي مرتبط بقوة مع متوسط المعدل النسبي للنمو خلال تطور حشرات من اللوبيا المرباه علي الأوراق القمية والقاعدية لنباتات الفاصوليا من 10 الي 25 درجة مئوية.