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Suitability of Host Plants and Insect Preys to the Zoophytophagous Tomato Bug *Nesidiocoris tenuis* (Reuter) (Heteroptera :Miridae)

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ABSTRACT

The tomato bug *Nesidiocoris tenuis (*Reuter) (Miridae, Heteroptera) is one of the mirid bugs that can feed on plants and preys on different insect pests. It's generally appears with large numbers in greenhouses and open fields of tomato crop in Egypt. It can complete the development of immature stages and survive on solanaceous plants with no choice feed. Tomato plants found to be the suitable host plant with survival rate 42.5%, followed by eggplant and pepper and represented by 21.7 and 10.0 %, respectively. Meanwhile, the duration of the total immature stage found to be the shortest duration when it reared on pepper plants and represented by 7.3 ±0.33days, followed by eggplant and pepper and represented by 8.3±0.3 and 7.7 ±0.3 days, respectively. In addition tomato bug can develop and survive when the immature stage feed on different insects as prey with no choice feed. The survival rate increased by feeding the immature stages insects as prey, the highest survival rate recorded when the tomato bug reared with the tomato borer, *Tuta absoluta* Meyrick. ranged between 80.8%, meanwhile the lowest survival rate record when reared immature stages on the cotton leafworm *Spodoptera littoralis* Bosid., and ranged 63.3%, respectively .On other hand the duration found to be short with 6.33±0.33 days on the cotton whitefly *Bemisia tabaci* Genn., and *T.absoluta* followed by the cotton worm and plant hoppers *Empoasca* spp., and represented by 6.33±0.33 days, respectively. When tomato plants and insects as prey introduced to the immature stages with choice feed, the highest survivals rate were record and ranged 95.8 % on tomato with *B. tabaci* followed by tomato plants with *T.absoluta ,S.littoralis* and *Empoasca* spp. and represented by 92.9 , 90.8 and 89.2 ,respectively.

INTRODUCTION

Nesidiocoris tenuis (Reuter) (Heteroptera : Miridae) is one of the mirid bug which appeared on the Mediterranean regoin including Egypt (UK CAB International, 1971). As a predator ,it used to control various pests attacking solanaceous plants as the cotton whiteflies, tomato borer, thrips, aphids and lepidopteron insect pests (Arno *et al.* 2009; Molla *et al.* 2011; El-Arnauty *et al.*2012; Biondi *et al.* 2016). As insect pest *N. tenuis*feed on plants as a source of water and supplementary nutrients , with egg-laying substrate (entophytic oviposition) (Biondi *et al*. 2016;De Puysseleyr *et al.* 2012).*N. tenuis* is a zoophytophagous species which can feed on certain plants also has been classified as a pest of solanaceous vegetable crops due to feeding damage such as necrotic rings in both leaf and flower petioles, and whitish halos on fruit (El-Dessouki *et al.* 1976; Awadalla ,1980 ; Urbaneja *et al.* (2005); and Arno *et al.*2006).The injury to tomato has been observed to decrease with increased availability of prey (Arno´ *et al.* 2006). Therefor , the present experiments aims to study the suitable host plants and insect preys on durations and survival rates of the nymphal instars of the tomato bug *N. tenuis* under laboratory condition (28±2ºC, 60 ±10% RH and photoperiod of 12:12h (L: D).

MATERIALS AND METHODS

The nymphal stages of *N. tenuis* were collected and transferred from tomato field located in Kafr El Sheikh region to the laboratory of vegetable insect pests, department of Plant Protection Center, Sakha branch .under laboratory conditions, nymphal stages reared on tomato as host plants till develop to adult stages. Adults with one week old inputted on cages of tomato plants with 40 day old to oviposit (5 male:5 female/cage). The first yellow green nymphal stage collected and counted to use in all laboratory studies. The laboratory conditions were 28±2ºC, 60 ±10% RH and photoperiod of12:12h (L: D) for all studies.

Rearing tomato bugs on different host plants (no choice test).

The first yellow green nymphal stage transferred to new cages of tomato, eggplant and pepper cages (10 individuals/cage). Each cage contain one plant with 40 day old with free insect infestations, covered by plastic tube with 30 cm tall and tided with part of clothes by rubber band and replicated ten times per each host plants .The development of the five nymphal stages were classified using morphological characters and morphological information according to Kimi *et al*. (2016) to study the effect of different host plants alone on the biological parameter of the nymphal instars.

Rearing the tomato bugs on different insects as preys only without host plants (no choice test).

A glass tube with a diameter of 5.00cm covered with piece of cloth with rubber band use as preys cadges without host plant. Four insect preys were used to evaluate the effect of different insect preys on the biological parameter of *N. tenuis*. Each glass cage contained 10 individuals newly yellow green nymphal stage and replicated for three times for each insect prey. The insect preys were the cotton whitefly *Bemisia tabaci*, the plant hoppers *Empoasca* Spp., the cotton leafworm *,S. littoralis* and the tomato borer *,T. absoluta*. Each glass cage contained a small tube for water supplied covered with cotton piece. The insect preys introduced to the nymphal instars daily to investigate the effect of different insect prey on the biological parameter of the nymphal stages (no choice test).

Rearing the tomato bug using different insects as preys and tomato plants as host plant together (Choice test).

To evaluate the effect of different insect prey and tomato plants together (Choice feeding) on the biological parameters of *N.tenius*, 12 cages contained tomato plants used for this experiment. Each cage contained 10 individuals of newly yellow green nymphal stage of *N.tenius*. The same four insects were introduced with tomato plants to the tomato bug insect daily until reached the adult stage.

Statistics:

Developmental times and survival rate of nymphal instars to adult stages analyzed by using Duncan's multiple range tests. Difference in rate of development of the immature stages analyzed by one-way ANOVA and were considered significant when $P<0.05$.

RESULTS AND DISCUSSION

Results

Effect of different Solanaceous plants on the development and survival rate of *N. tenuis*(no choice feeding):-

The obtained results arranged in table (1) showed the effect of different host plants on the developmental period and survival rate of *N. tenuis*under laboratory condition. It can be noticed that, the shortest nymphal stages of *N. tenuis* when reared on pepper plants ,represented by 1.3 , 1.0, 1.3, 1.3, 1.3 and 2.0 days for the 1st, 2nd, 3rd, 4th and 5th nymphal instars ,respectively .While the longest nymphal instars were recorded when the tomato bug reared on tomato plants and represented by 1.3 , 2.0 , 1.7, 1.0 and 1.7 days , respectively . The survival rates for the five nymphal instars were the highest on the tomato plants and ranged between 73.3 % and 98.3%. Meanwhile the survival rates were the lowest when reared the tomato bug on pepper plants and ranged between 48.8 and 96. %, respectively.

Table 1. Effect of different solanacous host plants (no choice feeding) on the developmental period and survival rate of tomato bug *N. tenius* under laboratory conditions.

Nymphal instars	Solanaceous host plants					
	Tomato		Egg plant		Pepper	
	Duration	%	Duration	%	Duration	%
1st instar	2.3±0.33 b	73.3	2.3±0.33 a	52.9	1.3±0.33 b	48.8
2nd instar	2.0±0.00a	81.8	2.0±0.00a	74.0	1.0±0.00b	55.6
3rd instar	1.7±0.33a	83.3	1.7±0.33a	88.1	1.3±0.33a	63.1
4th instar	1.0±0.33a	98.3	1.3±0.33a	88.1	1.33±0.33a	61.0
5th instar	1.7±0.33ab	86.6	1.0±0.00b	88.1	2.0±0.00a	96.0
Total immature stage	8.8±0.33a	42.5	8.3±0.33ab	21.7	7.3±0.33b	10.0

Means followed by the different letters in rows are significant different at 5% level of probability (Duncan's multiple range tests)

As a conclusion, the total nymphal stages were the shortest when *N. tenuis* reared on pepper (7.3± 0.33 days), followed by eggplant was (8.3±0.33days) and tomato came in the third category and represented by 8.8 ±0.33 days with significantly differences. On the other hand, the survival rates were the highest when the insect reared on tomato plants followed by eggplant and pepper plants and represented by 42.5, 21.7 and 10.0%, respectively.

Effect of different insect preys on the developmental periods and survival rates of *N. tenuis*(no choice feeding):-

The obtained results arranged in Table (2) showed the effect of different insect preys on the developmental period and survival rate of the tomato bug *N. tenuis* under laboratory condition. It can be noticed that, the shortest nymphal instars for *N. tenuis* when reared on the cotton leaf hoppers *Empoasca Spp.* and the tomato borer *T.absoluta* and represented by 1.0, 1.0, 1.33, 1.0 and 1.67 days for the 1st, 2nd, 3rd, 4th and 5th nymphal instars ,respectively .While the longest nymphal instars were recorded when the tomato bug reared on cotton whitefly *B.tabaci* and the cotton leafworm *S.littoralis* and represented by 1.0 ,1.3 ,1.3,1.3and 2 days for the five nymphal instars ,respectively . The survival rates for the five nymphal instars were the highest in the tomato borer *T. absoluta* and ranged between 85.4 % and 99.5%, meanwhile the survival rates were the lowest when reared the insect on *S. littoralis* and ranged about 63.3% for the five nymphal instars.

As a conclusion, the total immature stage were the shortest when the insect *N. tenuis* reared on *Empoasca Spp.* and *T.absoluta* and represented by (6.0±0.00days) followed by *S.littoralis* and *B.tabaci* (7.0± 0.58days) with significantly differences. On the other hand, the survival rates were the highest when the insect reared with no choice feed on *T.absoluta* by 80.8% followed by the *B.tabaci*, *Empoasca spp.*, and *S.littoralis* and represented by 72.5, 71.5 and 63.3% respectively.

Table 2. Effect of different insect preys (no choice feeding) on the developmental periods and survival rates of tomato bug *N. tenuis* under laboratory conditions.

Nymphal instars	Insect preys(No choice feed)							
	S. littoralis		*B. tabaci*		*Empoasca* Spp.		*T. absoluta*	
	Duration	%	Duration	%	Duration	%	Duration	%
1st instar	1.00±0.0a	82.9	1.00±0.0a	85.4	1.00±0.0a	83.8	1.00±0.0a	85.4
2nd instar	1.33±0.33a	93.5	1.33±0.33a	94.1	1.00±0.0b	94.5	1.00±0.0b	97.1
3rd instar	1.33±0.33a	95.2	1.33±0.33a	95.3	1.33±0.33a	99.5	1.33±0.33a	99.5
4th instar	1.33±0.33a	90.4	1.33±0.33a	96.2	1.00±0.0b	96.3	1.00±0.0b	99.5
5th instar	2.0±0.00a	95.0	2.0±0.00a	98.3	1.67±0.33b	94.5	1.67±0.33b	98.5
Total nymphal stage	7.0±0.58a	63.3	7.0±0.58a	72.5	6.0±0.00b	71.7	6.0±0.00b	80.8

Means followed by the different letters in rows are significant different at 5% level of probability (Duncan's multiple range tests)

Effect of different insect preys with tomato plants together on the developmental periods and survival rate of *N. tenuis* (choice feeding):-

The obtained results arranged in Table (3) showed the effect of different insects as a prey with tomato plants as choice feed on the developmental period and survival rate of *N. tenuis* under laboratory condition. It can be noticed that, the shortest nymphal instars of *N. tenuis* when reared on tomato borer with tomato plants and represented by 1.67, 1.33, 1.0, 1.0 and 1.67 days for the 1st, 2nd, 3rd, 4th and 5th nymphal instars ,respectively .While the longest nymphal instars were recorded when the tomato bug reared on the cotton whitefly and cotton leaf worms and represented by 1.67 ,1.33 ,1.0,1.0and 1.3 days for the five nymphal instars ,respectively . The survival rate for the five nymphal instars were the highest in *T. absoluta* and the *B .tabaci* with tomato plants ranged between 92.9 % and 95.8%. Meanwhile the survival rates were the lowest when reared the insect on *S. littoralis* and *Empoasca* spp., and ranged between 90.8 and 89.2%, respectively .

As a conclusion, the total nymphal stage were the shortest when *N. tenuis* reared on *B.tabaci* and *T.absoluta* with tomato plants (6.0 ± 0.00 days) followed by *Empoasca Spp.* ,and *S. littoralis* and represented by (6.33 ± 0.33 days) with significantly differences. On the other hand, the survival rates were the highest when the insect reared on *B.tabaci* with tomato plants 95.8% followed by *T.absoluta*, *S. littoralis* and *Empoasca* spp., and represented by 92.9 ,90.8 and 89.2% respectively.

Table 3. Effect of different insect preys with tomato plants (choice feeding) on the developmental periods and survival rate of tomato bug *N. tenuis* under laboratory conditions.

Nymphal instars	Insect preys with tomato plants (choice feed)							
	S. littoralis		*B. tabaci*		*Empoasca* spp.		*T. absoluta*	
	Duration	%	Duration	%	Duration	%	Duration	%
1st instar	1.67±0.0a	94.6	1.67±0.00a	99.2	1.33±0.33b	95.0	1.67±0.33a	96.7
2nd instar	1.33±0.33a	99.1	1.33±0.33a	99.2	1.33±0.33a	99.6	1.33±0.33a	98.3
3rd instar	1.00±0.33b	100	1.00±0.00b	98.5	1.00±0.00b	97.8	1.33±0.33a	99.1
4th instar	1.00±0.33a	99.6	1.00±0.00a	99.6	1.00±0.00a	99.5	1.00±0.00a	99.9
5th instar	1.33±0.33a	97.3	1.00±0.00b	99.6	1.33±0.33a	96.8	1.00±0.00b	99.6
Total nymphal stage	6.33±0.33a	90.8	6.0±0.00b	95.8	6.33±0.33a	89.2	6.0±0.00b	92.9

Means followed by the different letters in rows are significant different at 5% level of probability (Duncan's multiple range tests)

Data presented in Table (4) indicated that, the survival rates for the five nymphal instars were the highest when reared on the insect prey *B .tabaci* with tomato plants, represented by 95.8%. Meanwhile the survival rates were the lowest when reared the insect on pepper plants were only 10.0%.results indicated that the survival rates of the immature instars of tomato bug increased with introducing prays with tomato plants than insect preys only and the tomato as a host plant only 95.8 ,80.8 and 42.5% respectively.

As a conclusion, tomato plants are the suitable host plant to the nymphal stage of the insect *N. tenuis* with no choice feed, with significantly differences with other solanaceous host plants. On the other hand, the survival rates were the highest when the insect reared on the insect prey *B.tabaci* with tomato plants by 95.8%. *T. absoluta* were the suitable preys to the immature stage of the insect *N. tenuis* with no choice feed by 80. 8% respectively.

Table 4. the Survivorship percentage of the different nymphal instars of *N. tenuis*with host plant alone, several preys alone and preys with tomato as host plant under laboratory conditions.

Nymphal instars	Feeding type	1St instar	2nd instar	3rd instar	4th instar	5th instar	Total
Host plants alone	Tomato	73.3	81.8	83.3	98.3	86.6	42.5
	Eggplant	52.9	74.0	92.2	88.1	88.1	21.7
	Pepper	48.8	55.6	63.1	61.0	96.0	10.0
Preys alone	*Spodoptera littoralis*	82.9	93.5	95.2	90.4	95.0	63.3
	Bemisia tabaci	85.4	94.1	95.3	96.2	98.3	72.5
	Empoasca Spp.	83.8	94.5	99.5	96.3	94.5	71.7
	Tuta absoluta	85.4	97.1	99.5	99.5	98.5	80.8
Preys with tomato plants	*Spodoptera littoralis*	94.6	99.1	100	99.6	97.3	90.8
	Bemisia tabaci	99.2	99.2	98.5	99.6	99.6	95.8
	Empoasca Spp.	95.0	99.6	97.8	99.5	96.8	89.2
	Tuta absoluta	96.7	98.3	99.1	99.9	99.6	92.9

Discussion

The nymphal instars of the tomato bug *N. tenuis* were able to complete development on tomato, eggplant and pepper, that agreed with Biondi *et al.* (2016); De Puysseleyr *et al.*(2013). These results disagreed with Kazahide *et al.* (2011) and Urbaneja *et al*. (2005). The tomato bug survived longer on tomato than on eggplant and especially sweet pepper which agreed with Urbaneja *et al*. (2005). *N. tenuis* is able to develop without having to feed on the plant as agreed with De Puysseleyr *et al*. (2013) ,and without the availability of prey which is not agreed with (Urbaneja-Bernat *et al*. (2013) and Urbaneja *et al*. (2005). Urbaneja *et al*. (2005) showed that *N. tenuis* was unable to completely develop on sweet pepper, eggplant and tomato without supplemental food. However, tomato proved to be the most suitable plant food, Eggplant was an intermediate plant, and pepper was the least suitable plant host, allowing only 10 % of the nymphs to survive. Furthermore, when prey was also available, the biological parameters of *N. tenuis* varied depending on the host plant from which it fed. This mirid was able to completely develop on sweet pepper, eggplant and tomato host plants when supplemented with preys and developmental time days were shorter than informed by Urbaneja *et al.* (2005).Mirid insect is able to feed on several different pest species (Urbaneja *et al*.(2003), (2005)). Urbaneja *et al*. (2003) determined that the time needed to reach adulthood varied according to the prey species. Developmental time from the first nymphal instar until adulthood was longer than when it fed on the *B. tabaci* and Lepidoptera larvae as good demographic parameters when fed on this factitious prey as agreed with Molla *et al.* (2014). Laboratory studies indicate that the fecundity of omnivorous mirids is greatly reduced in the absence of prey (Perdikis & Lykouressis, (2004); Sanchez *et al*.,(2004)).Also the results of the present study indicate that *N. tenuis* has a marked effect on the abundance of *T. absoluta* as agreed with Ostfeld & Keesing, (2000) and can successfully control *T. absoluta* in tomato crops if it is well established.The duration time of nymphal stages decreases with the 28 ±2. ºC temperature with an average development time of 6.5 days when reared on tomato with preys which less than the developmental with Sánchez *et al.* (2009). The developmental time of the immature instars were averaged 6 to 7.7 days shorter than Sanchez (2008)**.**

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مدى صلاحية العوائل النباتية والفرائس الحشرية لحشرة لبقة الطماطم

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تم اجراء هذه الدراسة المعملية بقسم افات الخضر ,معهد بحوث وقاية النبات بسخا كفر الشيخ وتهدف الدراسة الى تقييم مدى صلاحية العوائل النباتية التابعة للعائلة الباذنجانية مثل الطماطم والفلفل والباذنجان والفرائس الحشرية لنمو وتطور افراد بقة الطماطم .اوضحت النتائج ان الحشرة تستطيع اكمال دورة حياتها على العوائل النباتية التابعة للعائلة الباذنجانية في حالة عدم وجود فرائس حيث بلغت نسبة البقاء حتى الوصول للحشرات الكاملة٤٢.٥% عند التربية على الطماطم, في حين بلغت ٢١.٧ % و١٠% على الباذنجان والفلفل على التوالي. واوضحت الدراسات ان الفترة الزمنية اللازمة للتطور عند التربية على العوائل النباتي كانت قصيرة حيث بلغت ٦.٣٣ ±٠.٣ يوم على الفلفل بينما كانت ٨.٠±٣.٠ يوم على الباذنجان و ٨.٨ ±٠.٣ يوم على الطماطم. عند تربية الحشرات غير الكاملة لبقة الطماطم على الآفات الحشرية كفرائس في غياب العوائل النباتية اوضحت الدراسات ان نسبة البقاء للحشرات ارتفعت حيث بلغت ٨٠.٨% عند تربية الحشرة على صانعة انفاق أوراق الطماطم بينما كانت ٧٢.٥% ,٧١.٧% و٦٣.٣% عند تربية الحشرة على نطاطات الاوراق ,الذبابة البيضاء ودودة ورق القطن على التوالي. بنما انخفضت المدة الازمة للتطور حيث اصبحت ٦.٠ يوم عند تربية الحشرة على صانعة انفاق أوراق الطماطم ونطاطات الاوراق بينما كانت ٧ يوم عند التربية على الذبابة البيضاء ودودة ورق القطن.عند تربية الاطوار الغير كاملة على تربية الحشرة على الانواع المختلفة كفرائس في وجود الطماطم كعائل نباتي ارتفعت نسبة البقاء لتسجل اعلى قيم لها ٩٥.٨% عند التربية على الذبابة البيضاء في حين سجلت ٩٢.٩%,٩٠.٨ % و٨٩.٢% عند التربية مع الطماطم كعائل نباتي ومعه الفرائس صانعة انفاق اوراق الطماطم ,نطاطات الاوراق ودودة ورق القطن على التوالي.