Journal of Entomology

ISSN 1812-5670

Academic Journals Inc.

www.academicjournals.com

Journal of Entomology 6 (2): 96-101, 2009
ISSN 1812-5670

Life Cycle Parameters of *Empoasca decipiens* Paoli (Hom.: Cicadellidae) on Four Potato Cultivars (*Solanum tuberosum* L.) in Iran

S.A.A. Fathi, G. Nouri-Ganbalani and H. Rafiee-Dastjerdi
Department of Plant Protection, University of Mohaghegh Ardabili, Ardabil, Iran

Abstract: *Empoasca decipiens* Paoli (Hom.: Cicadellidae) has been causing damage in potato fields of Ardabil region in Iran. There has been an increasing interest in controlling of *E. decipiens* using resistant cultivars. The resistance of four commonly planted cultivars including Diamant, Agria, Casmos and Omidbakhsh to *E. decipiens* was compared using some life cycle parameters of this pest in greenhouse at 24±1°C, 50±5% RH and 16:8 h (L:D) photoperiod. Incubation period, development time of 1st, 2nd and 3rd instar larvae were not significantly different on the cultivars studied. Fourth and 5th instar larvae development time and female and male life span of *E. decipiens* decreased among the cultivars in the order of Diamant >Casmos >Omidbakhsh >Agria. The percentage of larval survival of *E. decipiens* on Diamant and Casmos were significantly lower than on Omidbakhsh and Agria. Sex ratio of *E. decipiens* on four cultivars was not significantly different. High correlation coefficients were observed between the density of simple and glandular trichomes with the percentage of larval survival, larval development time, female and male life span of *E. decipiens*. These results indicated that among the cultivars that were investigated, Diamant and Casmos were resistant and Omidbakhsh was tolerant to *E. decipiens* damage. The results of this study also confirmed that the density of glandular trichomes may have more affects on the life cycle of *E. decipiens* than the density of simple trichomes by restricting larvae and adult feeding. These results are useful in an integrated management program of *E. decipiens* in potato fields.

Key words: *Empoasca decipiens,* life span, potato cultivars, resistance, trichome

INTRODUCTION

Empoasca decipiens Paoli (Hom.: Cicadellidae) has been recorded on a wide variety of crops including cultivated and non-cultivated plants (Gunthart, 1971; Nielson *et al*., 1990; Schmidt and Rupp, 1997). *E. decipiens* is an economic pest of soybeans in Iowa and also potato and cotton fields in Turkey (Pedigo *et al*., 1986; Atlihan *et al*., 2003; Demirel and Yildirim, 2008). Biological parameters of *Empoasca* sp. has been studied under the field and greenhouse conditions on various plants (Habib *et al*., 1972; Radcliffe and Johnson, 1994; Medeiros *et al*., 2005; Naseri *et al*., 2007). These studies have revealed that the host plant trichomes has an important effects on the life cycle parameters of *Empoasca* sp. Raupach *et al*. (2002) also reported that temperature and host plants affected the life cycle parameters of *E. decipiens* .

In Ardabil plain at Northwest of Iran, more than 25000 ha of irrigated land is allocated for potato production and more than 20% of the annual potato production of the country is produced. Colorado potato beetle, *Leptinotarsa decemlineata* (Say), onion thrips, *Thrips tabaci* Lind., two-spotted spider mite, *Tetranychus urticae* Koch, green peach aphid, *Myzus persicae* (Sulz.) and *Empoasca decipiens* are injurious pests in Ardabil (Nouri-Ganbalani, 1989; Fathi and Nouri-Ganbalani, 2009). *E. decipiens* has been causing damage in potato fields of Ardabil region in Iran. Leafhoppers are capable of becoming resistant to insecticides. Management strategies aimed at reducing or preventing

Corresponding Author: S.A.A. Fathi, Department of Plant Protection, University of Mohaghegh Ardabili, Ardabil, Iran

resistance will help conserve existing products for ongoing use (Charles, 2005). There has been an increasing interest in controlling leafhoppers using resistant cultivars (Medeiras *et al*., 2004, 2005). In this study, four potato cultivars were evaluated for their resistance to the *E. decipiens* by evaluating some life cycle parameters of this pest, such as incubation period, larval development time, larval survival, female and male life span and adult longevity in a greenhouse experiment.

MATERIALS AND METHODS

This study was conducted in greenhouse. Tubers of Diamant, Agria, Casmos and Omidbakhsh cultivars were obtained from Agriculture Research Station of Ardabil and planted in plastic pots (two tubers per pot) in a greenhouse at 24±1°C, 50±5% RH and a photoperiod of 16:8 h (L:D) during June 2008. At stem elongation stage of potato the number of simple and glandular trichomes in 1 cm^{-2} of the lower leaf surface of 10 randomly selected leaves from each potato cultivar were counted using micrometer under stereomicroscope (80 X) (Fig. 1). Leafhopper larvae prefer the lower leaf surface of the plant for feeding (DeLong, 1971). The lower leaf surface of potato is very pubescent, affecting the mobility of herbivores (Raupach *et al*., 2002).

E. decipiens was collected by sweep net from unsprayed potato fields (cv. Agria) in the Ardabil plain during July 2007. This pest were reared in the same greenhouse on alfalfa (cv. Hamadan) planted in plastic pots which were placed inside a Plexiglas cage, 10 l size and the top of the cages were covered with fine mesh silk screen. Newly emerged adults of *E. decipiens* were collected from the colony and used in the experiment.

The life cycle parameters of *E. decipiens* were studied on a 4th leaf, from the top of plant, in four potato cultivars separately at stem elongation growth stage of potato in greenhouse. In these experiments, a pair of one day old adult of *E. decipiens* (after being temporarily anesthetized at -4°C for 5 min), were transferred with a fine hair brush inside a transparent cylindrical plastic cage (10 cm diameter and 25 cm high with fine mesh silk screen that was stacked around the upper part of the cage). The cage was tightened from silk screen portion around the petiole of a 4th leaf in each experimental plant using a silk string. The insects were kept inside the cage (with one potato leaf) for

Fig. 1: Simple and glandular trichomes in the lower leaf surface of potato

three days in order to feed and mate. Since, one day old eggs were needed to conduct the experiments, the cage (with the same one adult pair) was removed from the previous leaf and fastened from silk screen portion around the petiole of a new 4th leaf in order to obtain one day old eggs for 24 h. After 24 h, the insects were removed from the cage. Then, the date of the egg hatch and the number of 1st instar larvae emerged was recorded daily in each cage. The status of the larvae (death or completion of their development to the adult stage and their gender) was recorded in each cage. Also longevity of male and female in each cage was recorded until their death. Each treatment was replicated 25 times.

Data Analysis

The data was log transformed to meet the assumptions of normality and homogeneity of variances. The data of the life cycle parameters of *E. decipiens* on four potato cultivars were analyzed by one-way ANOVA and the differences were compared by Student-Newman-Keals test (PROC ANOVA, SAS). Also pearson correlation coefficients between the number of simple and glandular trichomes on the lower leaf surface in four potato cultivar with life cycle parameters of *E. decipiens* were calculated by the correlation analysis (PROC CORR, SAS, 1999).

RESULTS AND DISCUSSION

According to data in Table 1, incubation period, development time of 1st, 2nd and 3rd instar larvae of *E. decipiens* were not significantly different on the four potato cultivars studied. Fourth instar larvae development time was higher on Diamant and lower on Agria, while no significant difference was observed between Casmos and Omidbakhsh. Fifth instar larvae development time was higher on Diamant and lower on Agria and Omidbakhsh, while it was intermediate on Casmos. Total larval development time of *E. decipiens* was significantly higher on Diamant and Casmos in comparison to Agria and Omidbakhsh (Table 1).

Female and male longevity were not significantly different on four potato cultivars (Table 1). However, female life span was higher on Diamant and Cosmos and lower on Agria, while it was intermediate on Omidbakhsh. Male life span was highest and lowest on Diamant and Agria respectively, while it was intermediate on Cosmos and Omidbakhsh (Table 1).

The percentage of larval survival of *E. decipiens* on Diamant and Casmos were significantly lower than Omidbakhsh and Agria. Sex ratio of *E. decipiens* was not significantly different among four cultivars (Table 2).

The highest number of simple trichomes was observed on Diamant, Agria, Casmos and Omidbakhsh, respectively. The highest number of glandular trichomes was observed on Casmos, Diamant, Agria and Omidbakhsh, respectively. The highest number of leaf per plant was observed on Omidbakhsh, Diamant, Casmos and Agria, respectively. The highest yield was observed on Omidbakhsh, Diamant, Agria and Casmos, respectively (Table 3).

The correlation analysis indicated significant positive correlation coefficients between density of simple and glandular trichomes on the lower leaf surface of four cultivars with larval development time and female and male life span of *E. decipiens*. The significant negative correlation coefficients were observed between density of simple and glandular trichomes on the lower leaf side of four cultivars with the percentage of larval survival (Table 4). Correlation coefficients between density of glandular trichomes with the percentage of larval survival, larval development time, female and male life span were higher than correlation coefficients between density of simple trichomes with the percentage of larval survival, larval development time, female and male life span separately (Table 4). These results indicated that density of glandular trichomes on the lower leaf side of four cultivars probably had

Table 1: Mean comparison of life cycle parameters of *E. decipiens* in greenhouse condition

Life cycle parameters	Diamant	Casmos	Omidbakhsh	Agria
Incubation period	11.20±0.82a	10.94±0.83a	11.25±1.08a	10.83±0.74a
1st larvae development time	3.78±0.74a	3.93±0.52a	3.44±0.58a	3.27±0.56a
2nd larvae development time	3.70±0.58a	3.80±0.44a	3.36±0.65a	3.17±0.51a
3rd larvae development time	3.89±0.55a	3.87±0.45a	3.50±0.60a	3.42±0.64a
4th larvae development time	5.00±0.71a	4.62±0.36ab	4.10±0.62ab	4.00±0.52b
5th larvae development time	6.89±1.03a	6.00±0.75ab	5.10±0.85b	5.17±0.66b
Larval development time	23.33±1.87a	22.25±1.40a	19.30±1.50b	19.17±1.95b
Female longevity	10.00±1.58a	10.35±0.91a	10.80±1.36a	11.00±0.63a
Female life span	44.60±2.32a	45.25±2.96a	41.60±0.95ab	40.50±1.94b
Male longevity	9.25±1.21a	9.50±0.91a	9.75±1.57a	9.80±0.59a
Male life span	44.75±2.45a	43.00±1.29ab	41.25±1.25bc	39.80±1.26c

Different letters indicate significant differences within rows at p=0.05

Table 2: The percentage (±SE) of larval survival and sex ratio of *E. decipiens* on four potato cultivars

Cultivars	The percentage of larval survival	Sex ratio (% of female)
Diamant	52.90±4.94b	55.90±5.72a
Casmos	50.00±7.53b	52.60±5.00a
Omidbakhsh	62.50±7.10a	55.40±3.68a
Agria	66.67±5.98a	54.55±4.31a

Table 3: The mean number of simple and glandular trichomes on lower surface of four potato cultivars and the mean number of leaf and yield/plant (±SE)

Cultivars	The mean number of simple trichomes cm^{-2}	The mean number of glandular trichomes cm^{-2}	The mean number of leaf/plant	The mean yield/plant
Diamant	24.7±1.97	6.2±1.51	14.2±1.44	711±87.07
Casmos	15.6±1.53	7.2±2.30	12.3±0.88	651±74.49
Omidbakhsh	10.0±1.37	4.1±1.41	15.7±0.82	750±90.33
Agria	17.0±2.16	4.4±1.12	12.1±1.02	688±79.52

Table 4: Pearson correlation coefficients between mean number of simple and glandular trichomes and life cycle parameters of *E. decipiens*

Life cycle parameters	The mean number of simple trichomes cm^{-2} (Prob>r)	The mean number of glandular trichomes cm^{-2} (Prob>r)
The percentage of larval survival	-0.60 (0.40)	-0.86 (0.10)
Incubation period	0.07 (0.93)	0.09 (0.90)
Larval development time	0.73 (0.26)	0.88 (0.10)
Female life span	0.45 (0.55)	0.95 (0.05)
Male life span	0.59 (0.40)	0.77 (0.23)

The numbers inside the parenthesis showed the p-value for each correlation coefficient

higher effect on life cycle of *E. decipiens* than the density of simple trichomes. Correlation coefficient between the density of simple and glandular trichomes with incubation period was very low (Table 4). This result revealed that the density of simple and glandular trichomes had no effect in incubation period of *E. decipiens*.

Potato cultivars which were investigated in this study were significantly different on their effects on the life cycle parameters of *E. decipiens*. There was a high negative correlation between trichome (simple and glandular) density on the lower leaf surface of the cultivars with larval survival. Also in the more pubescent cultivars larval development time was significantly longer compared to the less pubescent cultivars. Meanwhile, the adult life span was longer in less pubescent cultivars. It appeared that the high densities of trichome affect the mobility of *E. decipiens* and impair its feeding activities, hence decreases the survival rate and increases the larval development time. Leafhopper larvae generally prefer the lower surface of the leaves for feeding (DeLong, 1971), but when the trichome densities of lower leaf surface is very high, they prefer to feed on the upper leaf surface to avoid the deterrent effects of the pubescence. Habib *et al.* (1972) observed a prolonged larval development time

on tomato compared to broad bean. The significantly longer larval development time was also reported on tomato compared to broad bean, sweet pepper and cucumber (Stamp and Yang, 1996), due to more pubescent nature of the tomato leaf surface. The hairy glands on leaves and stems of tomato possibly affect the mobility and feeding activities of *E. decipiens* larvae. Medeiras *et al*. (2005) concluded that survival rates of larvae, males and females of potato leafhopper, *Empoasca fabae* (Harris), on six potato (*Solanum* sp.) genotypes with varied levels of resistance was related to type, density and droplet/head size of glandular trichomes. Survival rate was significantly lower on *Solanum berthaultii* Hawkes accessions, because the dense glandular trichomes of these accessions affect the survival of the leafhopper through restricting its feeding and mobility. Most of the larvae died from starvation and dehydration on glandular genotypes. Also it was reported that trichome densities and trichome types play the most important role in resistance of *Solanum* sp. to the leafhoppers (Avé and Tingey, 1986; Raupach *et al*., 2002). It has been found that the main component of glandular trichomes that affect the leafhoppers is phenolic oxidase. For example, Avé and Tingey (1986) concluded that phenolic oxidase activities in glandular trichomes of *S. berthaultii* influences the survival and feeding behavior of the potato leafhopper. Present findings on four potato cultivars also revealed that the larval development time is significantly longer on more pubescent cultivars compared with glabrous or less pubescent cultivars. We also found that the survival rate of larvae was higher on less pubescent than more pubescent cultivars. Therefore, it can be concluded that pubescent cultivars of potatoes are more resistant to *E. decipiens* and should be included in the IPM program of this pest.

ACKNOWLEDGMENT

The Research Council of Mohaghegh Ardabili University (Iran) is gratefully acknowledged for their financial support of this research with grant number 4191.

REFERENCES

Atlihan, R., E.N. Yardim, M.S. Ozgokce and M.B. Kaydan, 2003. Harmful insects and their natural enemies in potato fields in Van Province. J. Agric. Sci., 9: 291-295.

Avé, D.A. and W.M. Tingey, 1986. Phenolic constituents of glandular trichomes on *Solanum berthaultii* and *S. polyadenium*. Am. J. Potato Res., 63: 473-480.

Charles, J.G., 2005. Leafhopper Insecticide Resistance Management Strategy. In: Pesticide Resistance: Prevention and Management Strategies, Martin, N.A., R.M. Beresford, K.C. Harrington and N.Z. Hastings (Eds.). Plant Protection Society, New Zealand, ISBN: 0-473-10441-5.

DeLong, D.M., 1971. The bionomics of leafhoppers. Ann. Rev. Entomol., 16: 179-210.

Demirel, N. and A.E. Yildirim, 2008. Attraction of various sticky color traps to *Thrips tabaci* Lindeman (Thysanoptera: Thripidae) and *Empoasca decipiens* Paoli (Homoptera: Cicadellidae) in cotton. J. Entomol., 5: 389-394.

Fathi, S.A.A. and G. Nouri-Ganbalani, 2009. Prey preference of *Orius niger* (Wolf.) and *O. minutus* (L.) from *Thrips tabaci* (Lind.) and *Tetranychus urticae* (Koch.). J. Entomol., 6: 42-48.

Gunthart, H., 1971. Beitrag zur Kenntnis der Kleinzikaden (Typhlocybinae, Hom., Auch.) der Schweiz. Mitt. Schweiz. Entomol. Ges., 43: 218-224.

Habib, A., A. Badawi and F. Herakly, 1972. Biological studies on certain species of leafhoppers (Hemiptera: Cicadellidae) in Egypt. Zeitschrift für Angewandte Entomol., 71: 172-178.

Medeiros, A.H., W.M. Tingey and W.S. De Jong, 2004. Mechanisms of resistance to potato leafhopper, *Empoasca fabae* (Harris), in potato. Am. J. Potato Res., 81: 431-441.

Medeiros, A.H., I.J. Delalibera and W.M. Tingey, 2005. Aspects of potato leafhopper (Homoptera: Cicadellidae) biology on *Solanum berthaultii* and other potato genotypes. J. Econ. Entomol., 98: 1704-1709.

Naseri, B., Y. Fathipour and A.A. Talebi, 2007. Comparison of some biological aspects of *Empoasca decipiens* (Hom.: Cicadellidae) on four bean species. J. Entomol. Soc. Iran, 27: 1-13.

Nielsen, G.R., W.O. Lamp and G.W. Stutte, 1990. Potato leafhopper (Homoptera: Cicadellidae) feeding disruption of phloem translocation in alfalfa. J. Econ. Entomol., 83: 807-813.

Nouri-Ganbalani, G., 1989. Biology of the colorado potato beetle, *Leptinotarsa decemlineata* (Say) (Col. Chrysomelidae), in Ardabil, Iran. J. Agric. Sci., 29: 1-9.

Pedigo, L.P., S.H. Hutchins and L.G. Higley, 1986. Economic injury levels in theory and practice. Ann. Rev. Entomol., 31: 341-368.

Radcliffe, E.B. and K.B. Johnson, 1994. Biology and Management of Leafhoppers on Potato. In: Advances in Potato Pest Biology and Management, Zehnder, G.W., M.L. Powelson, R.K. Jansson and K.V. Raman (Eds.). APS Press, Saint Paul, MN, pp: 71-82.

Raupach, K., C. Borgemeister, M. Hommes, H.M. Poehling and M. Sétamou, 2002. Effect of temperature and host plants on the bionomics of *Empoasca decipiens* (Homoptera: Cicadellidae). Crop Protection, 21: 113-119.

Schmidt, U. and J. Rupp, 1997. Zikadenschaeden an G urke auf der Insel Reichenau. Gemüse, 12: 691-692.

Stamp, N.E. and Y. Yang, 1996. Response of insect herbivores to multiple allelochemicals under different thermal regimes. Ecology, 77: 1088-1102.