Pakistan Journal of Biological Sciences 10 (18): 3220-3223, 2007
ISSN 1028-8880

Developmental Time and Fecundity of White Peach Scale, *Pseudaulacaspis pentagona* (Targioni-Tozzetti) (Homoptera: Diaspididae), on Potato, Kiwi and Mulberry Hosts in Iran

Habib Abbasipour
Department of Plant Protection, Faculty of Agricultural Sciences,
Shahed University, Tehran, Iran

Abstract: The white peach scale (WPS), *Pseudaulacaspis pentagona* (Targioni-Tozzetti) (Homoptera: Diaspididae), is a world wide polyphagous scale insect. It is widely distributed in north of Iran, near the Caspian Sea areas, where it is the main pest of mulberry and kiwi trees. The development and fecundity of *P. pentagona* were examined at different temperatures and on different hosts in the laboratory. The longevity of WPS decreased with a rise in temperature. At 25°C the largest number of crawlers (76.1 crawlers/female) was observed. The development time of WPS was generally longer on kiwi than mulberry or potato; fecundity was higher on potato than on other hosts, potato tubers and kiwi trees.

Key words: *Pseudaulacaspis pentagona*, white peach scale, diaspididae, biology, temperature effects, host effects

INTRODUCTION

The white peach scale (WPS), *Pseudaulacaspis pentagona* (Targioni-Tozzetti), is a highly destructive and polyphagous scale insect pests of Rosaceae trees family including peach, apricot, cherry, sour cherry, mulberry, tea and kiwi all over the world (Ball, 1980; Erkilic and Uygun, 1997; Hanks and Denno, 1993; Kozarzevkaja, 1988; Mizuta, 2003; Van Duyn and Murphey, 1971). It is widely distributed in north of Iran, near the Caspian Sea areas, where it is the main pest of mulberry and kiwi trees (Afshar Mohamadian and Elhaghi Timori, 1999; Esmaili, 1983). In recent years, with increasing planted areas of kiwi trees in north of Iran, this pest is transferred to shoots and trunks of kiwi trees and made an irreparable damage to yield (Mohamadi and Abdi Seneh Kohi, 1993). In the northeastern of Iran, near the Caspian sea the infestation rate varied significantly among different geographical areas from 60% in the coastal area to only 20% in the mountain area. *P. pentagona* completed two generations in the mountain area (June/July and September/October) and three generations per year in the coastal area (April, June/July and October/November).

In this study, the development and fecundity of *P. pentagona* were examined under laboratory conditions.

MATERIALS AND METHODS

Longevity and fecundity of *P. pentagona* at different temperatures on potato tubers: This study was conducted in entomology laboratory of faculty of Agriculture, Shahed University during 2004-2006. As the laboratory host we used potato tubers, on which 5-6 cm diameter circles were drawn with special glue (Tangle Trap). Approximately 50 male and 50 female *P. pentagona* eggs, which can be distinguished by differences in color, females being reddish-pink and males yellowish-white (Kozarzevkaja, 1988; Seuge, 1972), were transferred into this area. The number of crawlers within this area and the development time of different stages were recorded daily. Adults were allowed to copulate, after which all males were removed. Females were enclosed again by special glue, within a 1.5-2 cm diameter circle, to enable counts of the number of crawlers per female. Experiments were conducted in climate controlled chambers at 15, 20, 25 and 30°C, with 60% relative humidity (r.h.) and 16:8 L:D light regime, using 35 females per treatment.

Longevity and fecundity of *P. pentagona on* different hosts: Potato tubers, mulberry and 2 year old kiwi trees (cv. Hayward) were used as hosts in experiment conducted at 25°C, 60% r.h. and 16:8 L:D light regime, with 35 females per treatment. For potato, the same experimental procedure was followed as in the temperature experiments. On mulberry and kiwi trees, an area of 1.5×2.5 cm was marked on the trunk.

Statistical analyses were done to compare longevity and fecundity data and the data obtained from these experiments were used to construct fecundity tables according to Andrewartha and Birch (1970) and Southwood (1976).

RESULTS

Longevity and fecundity of *P. pentagona* at different temperatures on potato tubers: Settling percentage of crawlers ranged between 50.5 and 57.5% at temperatures from 20 to 30°C; at 15°C, only 26% of the crawlers settled.

The duration of immature stages decreased as the temperature rose, with significant differences for all temperatures tested. The length of the preoviposition period decreased from 36.1 days at 15° to 16.5 days at 30°C. No significant differences were observed for the oviposition and postoviposition periods between 25° and 30°C, but they were significantly shorter at these temperatures than at 15° and 20°C (Table 1).

P. pentagona produced the largest number of crawlers at 25° (76.1 crawlers/female). With significantly fewer crawlers at 15° (18.9 crawlers/female) and 30°C (11.8 crawlers/female) (Table 1).

Logarithmic regression analysis was used to determine the relationships between different temperatures and the longevity of different development stages (Fig. 1). According to the positive regression coefficient between development stages and temperatures (r = 0.990), development time decreased as temperatures increased. The development threshold of *P. pentagona* was 9.8°C for the sum of first and second female instars' development period.

The life tables, survival curves and age-specific fecundity rates of *P. pentagona* are given in Fig. 2. Mortality during the first nymphal stage was high at all temperatures tested. At 15°C only 30% of the females started to lay eggs, whereas at 20, 25 and 30°C approximately 50% of the females reproduced. Overall longevity of *P. pentagona* was strongly affected by high temperatures, being 60 days at 30°, in contrast to 200 days at 15°C. The number of female crawlers per female produced over the life span (R_o = 16.13) was highest at 25°C, at which temperature also the highest intrinsic rate of increase (r_m = 0.059) was obtained. The shortest mean generation time (T_o = 41.93) was found at 30°C, which increased with decreasing temperatures.

Longevity and fecundity of *P. pentagona* on different hosts: The settling percentage of crawlers was found to be 60.5% on young kiwi trees, 50.5% on potato and 32.5% on mulberry.

The development time of *P. pentagona* was generally longer on kiwi trees than on the two other hosts tested. However, these effects were of minor importance, although statistically significant. The highest fecundity

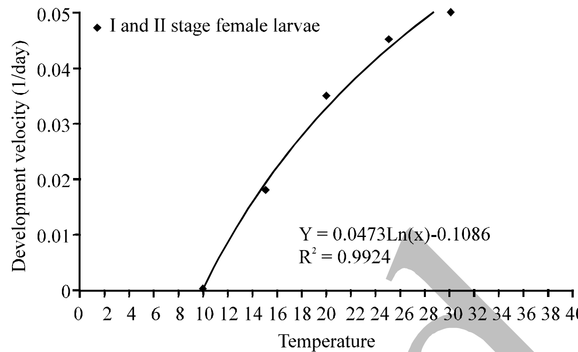

Fig. 1: Development velocity of first and second stage female larvae of *Pseudaulacaspis pentagona* at constant temperatures (°C)

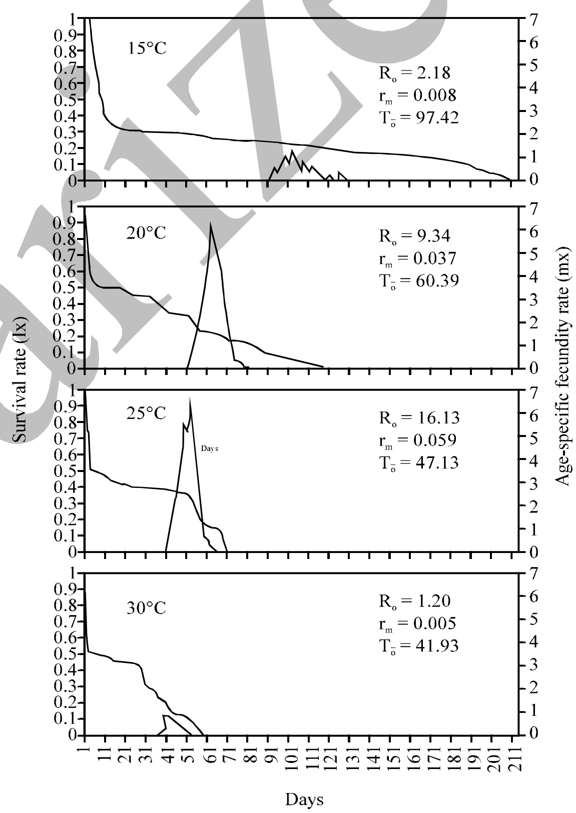

Fig. 2: Survival curve (I_x) and age-specific fecundity rate (m_x) of *Pseudaulacaspis pentagona* at different constant temperatures

was observed on potato, with 76.1 crawlers/female. On kiwi tree and mulberry only 45.9 and 29.5 crawlers/female, respectively, were produced (Table 2).

As calculated from the fecundity tables, the highest r_m values were for potato and kiwi, whereas this value was less than half for mulberry. No significant differences in

Table 1: Mean development time of various stages of *Pseudaulacaspis pentagona* on three different hosts

	Development time (days)								
	Male			Female		Duration of different periods (days)			Fecundity
Host	1st instar	2nd instar	Pupae	1st instar	2nd instar	Preoviposition	Oviposition	Postoviposition	(number of crawlers/female)
15	20.9a*	32.3a	23.2a	21.5a	33.4a	36.1a	26.5a	39.4a	18.9c
20	11.3b	17.9b	11.5c	11.8b	18.3b	27.0b	22.7b	29.7b	56.6b
25	9.4c	13.7c	10.2d	9.5c	13.6c	20.8c	13.3c	10.1c	76.1a
30	7.4d	12.5c	13.9b	7.3d	13.1c	16.5d	13.5c	9.1c	11.8c

* Within columns, means followed by the same letter do not differ significantly (p = 0.05) by the DMRT test

Table 2: Mean development time of various stages of *Pseudaulacaspis pentagona* on three different hosts at four constant temperatures

	Development time (days)								
	Male			Female		Duration of different periods (days)			Fecundity
Temperature (°C)	1st instar	2nd instar	Pupae	1st instar	2nd instar	Preoviposition	Oviposition	Postoviposition	(No. of crawlers/ female)
Kiwi	9.7a*	14.8a	13.9a	9.6a	16.4a	21.9a	13.8a	29.5a	45.9b
Potato	9.4a	13.7b	10.2c	9.5a	13.6c	20.8b	13.3a	10.1b	76.1a
Mulberry	8.7b	14.4ab	13.4b	8.7b	15.7b	18.7c	13.2a	9.8b	29.5c

* Within columns, means followed by the same letter do not differ significantly (p = 0.05) by the DMRT test

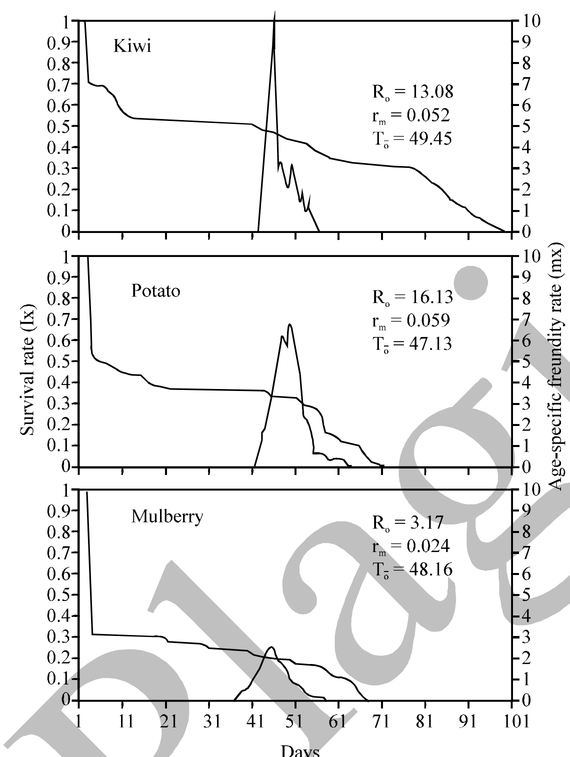

Fig. 3: Survival curve (I_x) and age-specific fecundity rate (m_x) of *Pseudaulacaspis pentagona* on three different hosts

generation time among the three hosts tested were observed, between 47.1 days on potato and 49.9 days on kiwi (Table 2).

Figure 3 shows that the mortality during the development period was high on mulberry (70%) and potato (50%). Total longevity was affected by host, lasting approximately 65 days on mulberry and potato, but 110 days on kiwi. The number of female crawlers per female produced during her life span (R_o=16.13) was high on potato. The intrinsic rates (r_m) were higher on potato (0.059) and kiwi (0.052) than on mulberry (0.024). The mean generation times were similar on the different hosts: between 49.4 and 47.1 days.

DISCUSSION

The development time of *P. pentagona* became shorter with increasing temperatures, which supports the results reported earlier by Azim (1963), Ball (1980) and Takada (2004). The highest fecundity rate was observed at 25°C, as already recorded by Oda (1963) and Park and Kim (1990). The development threshold was calculated as 9.8°C for larval stages, in agreement with the results obtained by Park and Kim (1990). However, these workers arrived at the threshold (10.3°C) by linear regression; on a logarithmic scale the results are more realistic, because the development stages become shorter as temperatures increase, especially above 25°C. The temperature effects on development velocity between 15 and 20°C did not parallel those at 25-30°C (Fig. 1).

The temperature-dependent life table results showed that net reproduction rates (R_o) and intrinsic rates of increase (r_m) were highest at 20 and 25°C. The lowest (R_o) value and shortest generation time (T_o) were at 30°C. At the lowest temperature tested (15°C) the R_o value was low, but generation time was longer than at the other temperatures, which means *P. pentagona* is able to pass the winter months alive, but with almost no reproductive activity.

According to field studies which we conducted in the north region of Iran, overwintering *P. pentagona* females started to produce crawlers about mid-April, when the daily mean temperatures were approximately 15-20°C. The second population peak was usually observed in July, at an average daily mean temperature of 25°C. The first and second generations usually had the highest fecundity. *P. pentagona* continued to produce crawlers, albeit at declining rates, throughout the rest of the year. In the mountain area the first population peak is delayed until June, because of the slower increase in daily mean temperature.

Those field observations are strongly supported by the present laboratory experiments at comparable temperature regimes. Life table results also proved that the reproduction rate was closely correlated with changes in temperature. There were differences between generation time observed in the field and the results obtained in the laboratory. Under field conditions the life span of the first generation lasted 71.6 days (average temperature 20-25°C) and that of the second to fourth generations varied between 61.2 and 66.3 days (average temperature 25-30°C) (Erkilic and Uygun, 1997). In the laboratory, however, generation time was much shorted at comparable temperatures. This may be because under field conditions some other factors, beside temperature, are involved in determining the life span of *P. pentagona*.

Different hosts have had only a slight effect on development time of *P. pentagona*, but strongly affected the longevity and fecundity. These differences may be because *P. pentagona* is adapted to living on the wooden parts of plants, as confirmed by the study of Hanks and Denno (1993). These authors found differences in settling percentage by *Morus alba* L., *Catalpa speciosa* Warder and *Juglans nigra* L. on different host species, but no differences in survival rate.

In conclusion, our studies have shown that temperature changes affect net reproduction rate, intrinsic rate and generation time under constant temperature conditions and that the host affects net reproduction rate and intrinsic rate.

ACKNOWLEDGMENT

This research was financed by University of Shahed.

REFERENCES

Afshar Mohamadian, M. and R.E. Timori, 1999. Kiwi, Culture and Breeding and Food Value, Publishing Company of Meli Bank of Iran, pp: 5-6.

Andrewartha, H.G. and L.C. Birch, 1970. The Distribution and Abundance of Animals. Univ. of Chicago Press, Chicago, IL, USA.

Azim, A., 1963. Systematic and biological studies on the genus *Aphytis* Howard (Hymenoptera: Aphelinidae) of Japan. J. Fac. Agric. Kyushu Univ., 12: 291-321.

Ball, J.C., 1980. Development and fecundity of the white peach scale at two constant temperatures. Fla. Entomol., 63: 189-194.

Erkilic, L. and N. Uygun, 1997. Development time and Fecundity of the White Peach Scale, *Pseudalacaspis pentagona*, in Turkey. Phytoparasitica, 25: 9-16.

Esmaili, M., 1983. Fruit Pests of Iran, Tehran Sepahr Publishing, pp: 550.

Hanks, L. and R.F. Denno, 1993. The white peach scale, *Pseudaulacaspis pentagona* (Targioni-Tozzetti) (Hom.:Diaspididae): Life history in Maryland, host plants and natural enemies. Proc. Entomol. Soc. Wash., 95: 79-98.

Kozarzevkaja, E.F., 1988. Characteristics of reproduction of the mulberry scale *Pseudaulacaspis pentagona* (Targ.-Tozz.) (Hymoptera, Coccidea). Entomolog. Obozr., 67: 257-265.

Mizuta, T., 2003. Differences in development and reproduction of the Mulberry Scale, *Pseudaulacaspis pentagona* Targioni (Hemiptera: Diaspididae), on resistant and susceptible varieties of tea plant. Jap. J. Applied Entomol. Zool., 47: 91-95.

Mohamadi, J. and M. Abdi Seneh Kohi, 1993. Kiwi and its culture, Farhang Gameh Publishing, pp: 13-15.

Oda, T., 1963. Studies on the dispersion of the mulberry scale, *Pseudaulacaspis pentagona*. Jpn. J. Ecol., 13: 41-46.

Park, J.D. and K.C. Kim, 1990. Effects of temperatures on development and distribution of mulberry scale, *Pseudaulacaspis pentagona*, within tree. Korean J. Applied Entomol., 29: 238-243.

Seuge, L., 1972. Sex determination of *Pseudaulacaspis pentagona* (Coccidae: Diaspinae) reared on potato tubers and their sprouts cultured artificially influence the physiological age of the plant material. C.R. Seances Soc. Biol., 166: (In French).

Southwood, T.R.E., 1976. Ecological Methods. Chapman and Hall Ltd., London, UK.

Takada, M., 2004. Effects of temperature on oviposition in overwintering females and hatch in first-generation larvae of *Pseudaulacaspis pentagona* (Hemiptera: Diaspididae). Applied Entomol. Zool., 39: 15-26.

Van Duyn, J. and M. Murphey, 1971. Life history and control of white peach scale, *Pseudaulacaspis pentagona* (Homoptera: Coccoidea). Fla. Entomol., 54: 91-93.