J. Plant Protection and Pathology, Mansoura Univ., Vol. 1 (6): 385 - 391, 2010

LIFE AND FERTILITY TABLES OF SAN JOSE SCALE, *Quadraspidiotus perniciosus* COMSTOCK ON DIFFERENT HOST PLANTS

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ABSTRACT

Investigations of life and fertility tables of San Jose Scale (SJS), *Quadraspidiotus perniciosus* Comstock were conducted to study some of its biological aspects on different host plants (apple, plum and pear).

The stage duration, mortality percentage, the net reproductive rate and the intrinsic rate of natural increase were examined. The developmental periods were significantly affected by host plant. The mean duration of the first instar nymph on apple, plum and pear seedlings were 15.8±1.0, 17.5±0.9 and 18.2±0.9 days, respectively. The 2nd instar female lasted by 18.4±1.5, 19.5±1.8 and 21.7±1.2 days; while the 2nd instar male lased 12.2±0.6, 13.4±0.5 and 14.1±0.7 days, respectively. The duration of prepupal and pupal stages reared on apple, plum and pear seedlings lasted 7.5±0.9, 6.3±1.2 and 6.5±0.8 days, respectively.

The stage specific mortality of life table data indicated that the death factors operated mainly during first and second instar nymph. The fertility of *Q. perniciosus* females was relatively high on pear followed by plum and apple.

The net reproductive rate was 21.7, 29.5 and 30.9 females/ female on apple, plum and pear, respectively. The intrinsic rate of increase (r_m) was 0.043, 0.049 and 0.051 females/ female/ day, respectively. In the same order, the time of generation was 71.7, 69.4 and 67.7 days, respectively.

INTRODUCTION

Armored scale insects (Homoptera: Diaspididae) are one of the most important groups of agriculture pests. Many species are highly destructive to fruit tree and ornamental plants (Rosen, 1986 and Miller & Kosztarab, 1979). Diaspididae are world-wide economically important pests of woody plant in field and greenhouse (Burger and Uhlenberg 1990).

San Jose Scale (SJS) *Quadraspidiotus perniciosus* Comstock is one of the most serious diaspidid pests in European and Several Countries of the world (Aleksidze, 1995; Jahn and Polesny, 1999; Bayuomy 2010). SJS is apparently native to noethern China and has spread widely in all temperate regions. It is highly polyphagous, but favors the Rosaceae including apple, pear, peach, plum, currants and some woody ornamental plants (Miller and Davidson , 1990).

It sucks plant cell contents and injects toxins, resulting in loss of vigor and productivity of the tree (Zalom *et al.*, 2001). High infestations result in limb death and may kill the tree (Zalom *et al.*, 2001).

For the success of crop management control program, it is essential to know in detail several informations concerning the biology of the pest. This information can be obtained by constructing life-table technique providing the

different mortality factors act in sequence on the successive developmental stages. The intrinsic rate of natural increase (r_m) is of value as mean of describing the potential growth of population under given climatic and food conditions, it is an important parameter in inductive strategic and management models for insect pest populations (Southwood, 1978 and Abou-Hatab, 1999).

Therefore, the present work aims to know some biological information for *Q. perniciosus* by constructing life tables concerning survival and fertility to estimate the net reproductive rate, the mean generation time and the intrinsic rate of natural increase.

MATERIALS AND METHODS

San Jose Scale (SJS), *Quadraspidiotus perniciosus* Comstock was obtained in the crawler stage from apple orchard of the Experimental Farm of the Faculty of Agriculture, Mansoura University.

An initial population of *Q. perniciosus* was started as 1500 crawlers were placed into three shrubs (500 crawlers/ three shrubs)of each host plant (apple, plum and pear) in the laboratory (25.0±2.7ºC and 63.0±3.2% R.H.). The daily numbers of dead individuals of each stage were recorded and the duration of each stage was calculated.

To construct age–specific fertility table, a sample of 20 females from *Q. perniciosus* / host plant were selected and enclosed by glue (tangle trap) within 1 cm diameter circle, to enable counts of the number of produced progeny / female / day on each host plant. The females were daily observed until their death and the daily number of crawlers laid per female was recorded. The experiment was conducted from the first of February to the end of April 2010 in the laboratory and the average temperature and relative humidity were recorded three times daily.

To estimate the stage-specific survival (l_X) and the intrinsic rate of natural increase (r_m), life and age-specific fecundity tables were constructed as follow:

Life table was constructed with the following columns:

x : The pivotal age for the age class in days.

l_x : The number of survivals at the beginning of age class x.

D_x : The number of deaths during the age interval x.

q_x : The mortality rate per age interval as the rate per thousand.

Age specific fertility table was constructed with the following columns:

x : Actual female age (time from crawlers).

m_X : The number of living females born per female in each age.

L_X : Represented the fraction surviving of females of an initial population of one.

The parameters, net reproductive rate (Ro), mean generation time (T) and the intrinsic rate of increase (r_m) were calculated according to Southwood (1978) as follow :

$$Ro = \Sigma L_X m_X$$

$$T = \Sigma x (L_X m_X) / Ro$$

$$r_m = \ln (Ro) / T$$

RESULTS

Influence of host plant on the duration of the developmental stages:

The duration of each developmental stage on the different tested host plants are presented in Table 1.

The age specific survival (Table, 1) and age-specific fertility (Table, 2)were studied for *Q. perniciosus* reared on three host plant seedlings (apple, plum pear) under laboratory conditions bassed on an initial cohort of 500 crawlers.

The obtained data in Table (1) indicated that the duration of each developmental stage affected by host plant species. The mean durations of the first instar nymph on apple, plum and pear were 15.8±1.0, 17.3±0.9 and 18.2±0.9 days, respectively. The 2nd instar male lasted by 12.2±0.6, 13.4±0.5 and 14.1±0.7 days; while the pupal stages lasted by 8.5±0.9, 6.3±1.2 and 6.5±0.8 days on apple, plum and pear, respectively. The 2nd instar female lasted 18.4±1.5, 19.5±1.8 and 21.7±1.2 days on apple, plum and pear seedling, respectively.

Means of 34.2 ± 2.7, 36.5 ± 2.9 and 40.0 ± 2.5days were recorded for the development of the whole female nymphal instars on apple, plum and pear seedling, respectively.

Statistical analysis showed that, the longest time for the development of male and female immature stages was recorded on pear shrubs and the shortest period was noticed on apple shrubs. It is clear that, the duration of the different nymphal instars were nearly similarly affected by host plant.

Table (1): Duration of the immature stages (in days) of San Jose Scale, *Quadraspidiotus perniciosus* Comstock reared on apple (A), plum (B) and pear (C) seedlings under laboratory conditions.

stage	Apple	Plum	Pear	L.S.D.(P= 5%)
1st nymph	15.8±1.0	17.3±0.9	18.2±0.9	2.1
2nd nymph				
Female	18.4±1.5	19.5±1.8	21.7±1.2	1.6
Male	12.2±0.6	13.4±0.5	14.1±0.7	1.3
Pupal stage	6.5±0.9	6.3±1.2	6.5±0.8	1.4
Total immature stages				
Female	34.2 ± 2.7 a	36.5 ± 2.9 a	40.0 ± 2.5 b	1.6
Male	34.5 ± 2.2 a	37.0 ± 3.3 b	38.8 ± 1.8 b	2.2

Values labeled with the same letter in a row are not significantly different at the level 5% ,respectively.

Influence of host plant on stage-specific mortality of *Q. perniciosus*:

Mortality among (q_x) first instar nymphs was much higher than in other instars (Table,2). The lowest mortality rate among the first instar nymph

occurred on pear. It was 28.4, 22.6 and 20.4% on apple, plum and pear seedlings, respectively. The highest 2nd female nymph mortality of 14.0% was recorded on apple followed by 12.2% on plum; while the lest (7.1%) occurred on pear seedlings. On the contrary, the 2nd male mortality was relatively high on pear (21.0%) followed by 20.4% on plum and (18.8%) on apple. The pupal mortality was relatively high (21.0%) on both apple and pear followed by 17.6% on plum. With respect to SJS adult female, 18.8, 16.0 and 12.2% died just after emergence (reared on apple, pear and plum, respectively).

Table (2): Partial Life table for *Quadraspidiotus perniciosus* Comstock immature stages reared on different host plants (apple (A), plum (B) and pear (C) shrubs) under laboratory conditions (25.0±2.7ºC and 63.0±3.2% R.H.).

Stage	lx			dx			q_x		
	A	B	C	A	B	C	A	B	C
1st nymph	**500**	**500**	**500**	**142**	**113**	**102**	**0.284**	**0.226**	**0.204**
2nd nymph	**358**	**387**	**398**						
Female	188	201	193	28	20	24	0.149	0.110	0.124
Male	170	186	205	32	38	43	0.188	0.204	0.210
Pupal stages	**138**	**148**	**162**	**29**	**26**	**34**	**0.210**	**0.176**	**0.210**
Emergence males	**109**	**122**	**128**						
N-Adult ♀	**160**	**181**	**169**	**30**	**22**	**27**	**0.188**	**0.122**	**0.160**
Reproducing stage	**130**	**159**	**142**						

N-Adult ♀ : refers to the number of newly emerged adult females.

Influence of host plant on some biological parameters (Ro r_m, and T) of *Q. perniciosus*:

The age-specific fertility table is presented in Table (3) for each host plant. From Table (3), the net reproductive rate (Ro), the intrinsic rate of natural increase (r_m) and generation time (T) of *Q. perniciosus* were calculated.

The Ro and r_m values indicate the relative preferences of pear followed by plum and apple; Ro vales were 30.86, 29.49 and 21.40 females/ female, respectively. In the same order, the r_m values were 0.051, 0.049 and 0.043 females / female/ day, respectively.

Based on the data in Table 3, the duration of one generation of *Q. perniciosus* lasted about 66.71, 69.42 and 71.7 days on pear, plum and apple, respectively.

Table (3): Fertility table and the net reproductive rate for *Q. perniciosus* reared on apple, plum and pear seedlings under laboratory conditions (25.0±2.7ºC and 63.0±3.2% R.H.)..

Apple				Plum				Pear			
X	L_x	m_x	L_xm_x	X	L_x	m_x	L_xm_x	X	L_x	m_x	L_xm_x
57	0.618	0.0000	0.000	57	0.721	0.0000	0.000	57	0.744	2.3260	1.731
58	0.618	0.0000	0.000	58	0.721	0.0000	0.000	58	0.744	1.1140	0.829
59	0.618	0.0000	0.000	59	0.721	0.0000	0.000	59	0.744	4.4550	3.314
60	0.618	1.4145	0.874	60	0.721	2.7320	1.970	60	0.744	1.3430	0.999
61	0.618	2.1215	1.311	61	0.721	2.4105	1.738	61	0.695	1.7360	1.206
62	0.618	2.1475	1.327	62	0.721	3.2145	2.318	62	0.695	2.4570	1.708
63	0.618	1.1525	0.712	63	0.721	3.0535	2.206	63	0.695	2.4570	1.708
64	0.603	1.1785	0.711	64	0.677	1.7680	1.197	64	0.622	2.6860	1.671
65	0.603	0.7855	0.474	65	0.677	1.7355	0.498	65	0.622	4.1930	2.608
66	0.603	1.1000	0.663	66	0.677	1.3180	0.892	66	0.622	3.5380	2.201
67	0.557	1.2570	0.700	67	0.634	1.5105	0.958	67	0.518	1.5395	0.797
68	0.557	0.6810	0.379	68	0.634	1.8000	1.141	68	0.518	1.7360	0.899
69	0.557	2.2000	1.225	69	0.634	3.7285	2.364	69	0.518	1.5395	0.797
70	0.534	2.2260	1.189	70	0.584	1.4145	0.826	70	0.518	2.2795	1.181
71	0.534	1.1000	0.587	71	0.584	1.9930	1.164	71	0.518	2.1620	1.120
72	0.534	2.2785	1.217	72	0.584	3.6000	2.102	72	0.463	2.1950	1.016
73	0.534	3.5355	1.920	73	0.584	2.0250	1.183	73	0.463	2.1620	1.001
74	0.534	1.2570	0.671	74	0.584	3.0855	1.802	74	0.463	0.9175	0.425
75	0.512	1.3620	0.697	75	0.559	1.8965	1.060	75	0.427	0.5225	1.077
76	0.512	1.3355	0.684	76	0.559	1.9285	1.078	76	0.427	2.2605	0.965
77	0.512	1.5975	0.818	77	0.559	1.6395	0.916	77	0.427	2.2275	0.951
78	0.496	1.1260	0.558	78	0.522	1.6070	0.839	78	0.427	1.5070	0.643
79	0.496	1.3355	0.662	79	0.522	2.2180	1.158	79	0.427	1.8345	0.783
80	0.496	2.5665	1.273	80	0.522	2.3785	1.242	80	0.396	2.2930	0.908
81	0.496	2.5405	1.260	81	0.286	2.2820	0.653	81	0.396	0.8190	0.324
82	0.496	1.1260	0.559	82	0.282	0.6430	0.181	82	0.396	0.0000	0.000
83	0.496	0.9950	0.494	83	0.282	0.0000	0.000	83	0.396	0.0000	0.000
84	0.466	1.0475	0.488	84	0.282	0.0000	0.000	84	0.284	0.0000	0.000
85	0.466	0.6285	0.293	85	0.282	00.000	0.000	85	0.284	0.0000	0.000
86	0.466	0.0000	0.000	86	0.282	0.0000	0.000	86	0.284	0.0000	0.000

DISCUSSION

From the foregoing results, it is clear that, the durations (in days) of the immature stages of *Q. perniciosus* was affected significantly by the different host plants. The shortest nymphal duration was recorded on apple shrubs, while the longest duration was recorded on pear shrubs. The previous results supported the data of Carroll & Luck (1984); Abd EL-Kareim (1988) and Abou Hatab (1999), who found that the biology of diaspidid species is strongly influenced by the host tissue contents. The more favorable host plant had comparatively faster maturation and higher percentage of juvenile survivorship.

Analysis of life table of *Q. perniciosus* indicated that mortality in the 1st instar nymph of *Q. perniciosus* could induce population changes of the pest. Literature data revealed that the mortality in the younger stages of scale insect, *Saisettia oleae* Olivier (Pucci *et al.*, 1986) and *Ceroplastes floridensis* Comstock (Schneider *et al.*, 1987) was considerably higher. Also,

total mortality of the diaspid species, *Aonidiella taxus* Leonardi and *A. aurantii* was considerably fluctuating between host plants (Uematsu, 1979 and Carroll and Luck, 1984). Paraskakis *et al*.,(1980) added that population changes of *Saissetia oleae* Oliviere were attributed to the changing condition of host plants.

The present results about the net reproductive rat (Ro) and the intrinsic rate of increase (r m) for *Q. perniciosus* on all tested host plants (apple, plum and pear) under laboratory conditions (25.0 ± 2.7 ºC & 63.0 ± 3.2 RH) are in general disagree with those of Baumoy (2010) , hr reported generally relatively high net reproductive rate and intrinsic rate of natural increase for *Q. perniciosus* when reared on other host plant (sweet potato tubers) and under deferent laboratory conditions (19.0 ± 4.0 ºC and 60.0 ± 10 RH).

It could generally concluded from the obtained data and the available Literature data, that host plant and temperature are important factors for development and multiplication of this pest. This information may be useful to predict how fast the population of this pest could develop and give an idea on its population size on the different host plant.

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جداول الحياة والخصوبة لحشرة سان جوزيه القشرية على عوائل نباتية مختلفة.

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**معهد بحوث وقاية النباتات – مركز البحوث الزراعية – الدقي – الجيزة.

أجريت بعض الدراسات على جداول الحياة والخصوبة لحشرة سان جوزيه القشرية تحت الظروف المعملية حيث تم تربية الحشرة على عوائل نباتية وهى شتلات (التفاح – البرقوق – الكمثرى). وتم تقدير فترات النمو للأعمار المختلفة ونسب الموت والحياة خلال الأطوار المختلفة ثم قدر متوسط صافى معدل خصوبة الإناث (Ro) ومعدل التزايد الحقيقي (rm) ومتوسط مدة الجيل (T) .

وقد أوضحت الدراسة أن متوسط فترة نمو الحورية الأول على شتلات التفاح ، البرقوق و الكمثرى هي 15.8 ±1.0 ، 17.5 ± 0.9 ، 18.2 يوم بالترتيب. واستغرقت فترة النمو للعمر الثاني للأنثى 18.4 ± 1.5 ، 19.5 ± 1.8 ، 21.7 ± 1.2 يوم بينما للذكر استغرق 12.2 ± 0.6، 13.4 ± 0.5 21.7 ± 1.2 يوم بالترتيب. واستمر طوري ما قبل العذراء والعذراء التى ربيت على شتلات التفاح، البرقوق، الكمثرى لمدة 7.5 ± 0.9، 6.3 ± 1.2، 6.5 ± 0.8 يوم بالترتيب. وقد أبدى العمر الأول أعلى نسب موت فى جداول الحياة وكانت أعلى نسبة خصوبة للإناث على الكمثرى يلية البرقوق ثم التفاح. كانت قيم متوسط صافى معدل الخصوبة (Ro) 21.7، 29.5 و 30.9 على التفاح، البرقوق والكمثرى على التوالي . ومعدل التزايد الحقيقى (r_m) بلغ 0.043، 0.049و 0.051 انثى / انثى / يوم على التوالي وبنفس الطريقة كان متوسط مدة الجيل (T) هى 71.7، 69.4 و 66.7 يوم على التوالي .

قام بتحكيم البحث

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J. Plant Protection and Pathology, Mansoura Univ., Vol. 1 (6): 385 - 391, 2010