J. Plant Protection and Pathology, Mansoura Univ., Vol. 1 (6): 377 - 384, 2010

INFLUENCE OF HOST PLANT SPECIES ON THE POPULATION DYNAMICS OF *Quadraspidiotus perniciosus* COMSTOCK

Abd El-Kareim, A. I.*; E. A. Elwan and Naglaa M. Yousef****

*** Economic Entomology Dept., Fac. of Agriculture, Mansoura University**

**** Plant Protection Res. Inst., Agric. Res. Center, Ministry of Agriculture**

ABSTRACT

The population dynamics of *Quadraspidiotus perniciosus* Comstock was studied on three host plants (apple, plum and pear). It proved that host plant was an important factor. Changes in the developmental period from settling crawlers to newly adult female ranged 28.4 – 34.8 days on apple , 32.6 – 43.9 days on pear and 30.1 – 39.7 days on plum trees.

The construction of life table for *Q. perniciosus* indicated that the total mortality from settling crawlers to the reproducing stage was considerably fluctuating between host plants and generations. On twigs of apple, plum and pear, it ranged 73.1 – 87.8, 81.5 – 87.6 and 86.0 – 96.4%, respectively. This value was extremely high (87.8, 87.6 and 96.4%) in the 4th generation (winter generation) on apple, plum and pear, respectively.

Analysis of the stage specific mortality of life table indicated that mortality of 2nd instar female is the Key-stage specific mortality, which can induce population changes in comparison with other specific stage mortalities.

INTRODUCTION

]

San Jose scale (SJS), *Quadraspidiotus perniciosus* Comstock is one of the most serious diaspidid pests in European and several countries of the world (e.g., Aleksidze, 1995; Jahn and polesny, 1999; Bayoumy 2010). SJS is apparently native to northem China and has spread widely in all temperate regions. It is highly polyphagous and is recorded from hosts belonging to at least 240 genera in 81 plant families, but favours the Rosaceae including apple, pear, peach, plum, currants and some woody ornamental plants (Miller and Davidson, 1990; CABI, 2009).

The pest has been recorded for the first time infesting plum trees in Egypt without its specific parasitoids (Bayoumy, 2004). It sucks plant cell contents and injects toxins, resulting in loss of vigor and productivity of the tree at low levels of infestation (Zalom *et al*., 2001). High infestation result in limb death and may kill the tree within 1- 3 years (Zalom *et al*., 2001; Bessin, 2004).

Knowledge concerning the quantitative changes in the pest population and prognosis basis of these changes are necessary for integrated pest management. Through those knowledge, changes in control practices could be predicted.

The present work aims to evaluate the influence of host plant on the population dynamics of *Q. perniciosus* and determine the key-stage specific mortality which may cause changes in the insect population.

MATERIALS AND METHODS

Life table studies for *Q. perniciosus* were carried out in apple, *Malus domestica* (Boek); pulm, *Prunus salicina* (Lindi) and pear, *Pyrus communis* L. orchards located at the Experimental Farm, Faculty of Agriculture, Mansoura University during 2007 – 2008 seasons.

Insect sources: Crawlers of SJS were colleted from apple trees orchard located at the previously mentioned experimental farm.

Three twigs of each host plant (one twig / tree) were selected and marked on the trees. The marked twigs were artificially infested with crawlers of *Q. perniciosus*. Each infected twigs was caged with cylinder screen cage. The total number of settled crawlers and date of infestation were recorded (Table, 1). Infested twigs were continuously observed every three days in the field to record the developmental period of each stage.

Table (1): Number of *Quadraspidiotus perniciosus* Comstock **crawlers settled on apple, plum and pear twigs and dates of infestation and termination of the experiments.**

Generation	No. of settled crawlers			Date of	
	Apple	Plum	Pear	infestation	termination
Spring	450	510	460	15/4/2007	25/6/2007
Summer	505	475	485	6/6/2007	10/8/2007
Autumn	470	480	500	17/9/2007	11/12/2007
Winter	505	455	510	9/12/2007	2/3/2008

When *Q. perniciosus* females gives birth, infested twigs were collected and examined in the laboratory by using a binocular microscope. The numbers of living and dead insects were recorded for each stage or instar. The mortality of all stages was expressed logarithmically in terms of killing power or k-value, which is the difference between the logarithm of the initial and final populations.

To assess the relative contribution of various stage–specific mortality to the total generation mortality, the following K- values were calculated.

k_1: mortality of first nymph.

k_2 : mortality of second nymph female.

k_3 : mortality of adult female stage.

K : Total generation mortality.

Key factor analysis: Two methods were employed to determine the key-stage specific mortality; (a) visual inspection of k-values over several successive generations (Varley *et al.*, 1973), (b) or the largest coefficient for the relation "k" on "K" (Podolar and Rogers 1975).

RESULTS

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

As shown in Table (2), the duration of each development stage varied according to host plant species in each generation. However, changes in the developmental period from settling crawlers to adult female ranged

from 28.4 to 34.8 days on apple trees and from 32.6 to 43.9 days on pear trees. While, *Q. perniciosus* on plum trees recorded a moderate duration of development (32.6 – 39.7 days).

Table (2): Life table of *Quadraspidiotus perniciosus* Comstock immature satages reared on apple (A), plum (B) and pear (C) trees under field conditions in spring, summer, autumn and winter generations during 2007 and 2008.

Stage	X			lx			dx		
	A	B	C	A	B	C	A	B	C
Spring generation									
1st nymph	14.3±2.5	20.6±0.9	23.4±1.0	450	510	460	22.7	20.2	7.2
2nd nymph				**348**	**407**	**427**	**38.5**	**67.2**	**81.2**
Female	**16.8±1.4**	**19.6±2.2**	**21.6±1.8**	182	262	280	38.5	67.2	81.1
Male	**10.6±1.7**	**12.5±1.2**	**12.5±1.0**	166	145	147	38.5	67.2	81.2
Adult female	----	----	----	112	86	53	24.1	20.9	24.5
Reproducing stage				85	68	40			
Summer generation									
1st nymph	14.5±2.1	15.6±4.6	18.5±1.8	505	475	485	30.1	29.1	19.0
2nd nymph				**393**	**337**	**393**	**29.2**	**64.6**	**82.2**
Female	**14.7±1.7**	**14.6±1.4**	**14.1±1.4**	258	216	258	29.2	64.4	81.1
Male	**10.2±1.4**	**11.0±1.5**	**10.8±2.0**	135	121	135	29.1	64.8	81.2
Adult female	----	----	----	131	77	45	7.6	9.4	15.6
Reproducing stage				121	70	38			
Autumn generation									
1st nymph	17.3±4.2	17.4±4.6	22.9±11.0	470	480	500	40.4	32.3	28.6
2nd nymph				**280**	**325**	**357**	**24.6**	**53.5**	**68.3**
Female	**13.4±1.6**	**15.2±1.6**	**13.4±3.7**	147	208	234	25.1	53.3	68.3
Male	**9.8±1.3**	**11.1±1.3**	**11.3±1.5**	133	117	123	24.1	53.8	68.3
Adult female	----	----	----	110	97	74	11.8	14.4	15.0
Reproducing stage				97	83	63			
Winter generation									
1st nymph	17.3±1.1	19.5±1.7	20.3±2.8	505	455	510	31.1	11.7	15.5
2nd nymph				**348**	**402**	**431**	**60.5**	**78.4**	**89.4**
Female	**17.5±3.4**	**20.2±1.3**	**23.6±1.0**	182	258	283	60.4	78.3	89.4
Male	**12.2±1.0**	**19.5±1.6**	**14.8±1.7**	166	144	148	60.6	78.4	89.3
Adult female	----	----	----	72	56	30	23.9	28.6	46.7
Reproducing stage				55	40	16			

Where X refers to the stage duration, lx : Initial population and dx : is the percentage of dead individuals.

On the other hand, *Q. perniciosus* showed different durations of development for the different generations (spring, summer, autumn and winter generations). The shortest development period of female immature stages was recorded in summer generations (29.2, 30.2 and 32.6 days on apple, plum and pear, respectively). While, the longest duration of development was observed during winter generation, being 34.8, 39.7 and 43.9 days on apple, plum and pear trees, respectively.

The analysis of the factors contributing to stage-specific mortality of female indicated that the determining key-stage specific mortality on the basis of visual correlation (Figure, 1) or regression coefficient of k-values was k_2 (Table, 3).

With respect to the influence of host plant on the developmental period of the 2nd instar male, data obtained in Table (2) showed that the shortest duration of the 2nd instar nymph of male ranged between 9.8±1.3 to ±12.2±1.0 days when the nymph reared on apple, followed by 11.0±1.5 to 13.5±1.6 days on plum. The duration of 2nd instar male when reared on pear trees was relatively long (ranged between 10.8±2.0 to 14.8±1.7 days).

Influence of host plant on population dynamics of *Q. perniciosus*:

The construction of life table for *Q. perniciosus* indicated that total mortality from settling crawlers to the reproducing stage was considerably fluctuating between host plants in all tested generations. On twigs of apple, plum and pear trees, it ranges73.1 – 87.8, 81.5 – 78.6 and 86.0 – 96.4%, respectively. The highest mortality percentages were recorded during winter generation on apple (87.8%), plum (87.6%) and pear (96.4%).

As shown in Figure (1), there was a considerable variation among host plant and generations in the contribution of each stage specific mortality to the total generation mortality (K). However, changes of k_2 values were more correlated with the changes of K-value of the total generation mortality in all tested host plants. Also, regression analysis (Table, 3) reveals that the regression of k_2 values on K showed the highest slope (b= 1.96, 0.96 and 0.76 for apple, plum and pear, respectively), while the slope values of k_1 and k_3 on K were (-0.74, -0.24 and -0.12) and (-0.22, 0.28 and 0.36) in apple, plum and pear orchards, respectively. So, k_2 appeared to be the key–stage mortality which could induce population changes of *Q. perniciosus* population.

Table (3): Regression coefficient values of k-values on K for the four generations on the different host plants (apple, plum and pear).

Key factor	Regression coefficient value		
	Apple	Plum	Pear
k_1	-0.74	-0.24	-0.12
k_2	1.96	0.96	0.76
k_3	-0.22	0.28	0.36

DISCUSSION

Apple trees recorded the highest percentage of juvenile survivorship and the shortest developmental period of San Jose Scale, *Quadraspidiotus perniciosus* Comstock in comparison with plum and pear trees. These results agree with Kozar (1976), who mentioned that *Q. perniciosus* infestation was significantly varied on the different host plants species and varieties as well as the all main parts of trees. On contrary, sour cherry varieties failed to show differences in the susceptibility of *Q. perniciosus* (Jenser and Sheta, 1972).

According to Abd El-Kareim (1988), the biology of insects is strongly influenced by the host tissue content. The more favourable host plant had comparatively faster maturation and higher percentage of juvenile

survivorship. 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.

Analysis of life table of *Q. perniciosus* indicated that mortality in the 2nd instar female of *Q. perniciosus* could induce population changes of the pest. Literature data showed 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.

Generally, it could be concluded that apple trees proved to be the more favourable host plant for *Q. perniciosus* in comparison with plum or pear trees. On the other hand, key factor analysis indicated that 2nd instar female is the main key-stage mortality which can induce population changes.

So, on the basis of the endoparasitoid, *Encarsia citrina* proved to be the main cause of mortality acting on the 2nd instar female of diaspidid species (Abd El-Kareim, 1992 and 2002). The parasitoid is a cosmopolitan species that occurred earlier in Egypt (Priesner and Hosny, 1940) may become well established. Consequently, the mass production and release of *E. citrina* could be easily practiced to control *Q. perniciosus* as newly introduced pest to Egypt.

REFERENCES

Abd EL-Kareim, A.I. (1988). The biology of red pear and oleander scale and possible control methods by Juvenoids and precocenes. Ph. D. Thesis, Hung. Acad., Budapest. 122pp.

Abd EL-Kareim, A.I. (1992):Life table studies on the purple scale insect, *lepidosaphes beckii* New (Homoptera : Diaspididae). Com In. Sci. Dev. Res., 40: 195 – 206.

Abd EL-Kareim, A.I. (2002): The potential of some natural enemies as bio-agents against certain diaspid species. 9th Inter. Conf. 1–6 September , 2002 Aleppo Univ., Syria.

Aleksidze, G. (1995). Armored scale insects (Diaspididae), pests of fruit orchards and their control in the Republic of Georgia. In: Ascher, K.R.S., Ben-Dov, Y. (Eds), Proceedings of the VII International Symposium of Scale Insect Studies, held in Bet Dagan, Israel, June 12-17, 1994. Israel J. Entomol., 29, 187-190.

Bayoumy, M.H.M. (2004). Evaluation of certain parasitoids for biological control of some armored scale insects. M. Sc. Thesis, Fac. Agric., Mansoura Univ., Mansoura, 179 pp.

Bessin, R. (2004). San Jose scale, Entomolgy fact sheet, Univ. of Kentucky, Fac. of Agric. http://www.uky. edu/Ag/Entomology/entfacts/fruit/ef 204.htm.

CABI Crop protection compendium (2009). *Quadraspidiotus perniciosus.* Datasheet. http:// www. Cabi. Org/ compendia/cpc.

Carroll, D. P. and R. F., Luck. (1984). Bionomies of California red scale, *Aohidiella aurantii* (Maskell) (Homoptera : Diaspididae), on orange fruits, leares and wood in california's san Joaquin valley. Environ. Entomol., 13, 847 – 853.

Jahn, S. and F. Polesny (1999). Population dynamics of San Jose scale and San Jose scale parasitoids in three different sites in Austria. Bulletin OILB/SROP. International Organization for Biological and Integrated Control of Noxious Animals and Plants (OIBC/OILB), West Palaearctic Regional Section (WPRS/SROP), Dijon, France. 22 (7): 201-202.

Jenser, G. and I. B., Sheta (1972). Importance of male control in preventing damage done by the san Jose scale (*Quadraspidiotus perniciosus*) Comstock. Acta Agronom. Acad. Sci. Hung., 21: 119 – 124.

Kozar, F. (1976). Colonization sites of scale insects (Homoptera : Coccidea) on different plant species and varieties. Symp. Biol. Hung., 16: 125 – 127.

Miller, D.R. and J.A. Davidson (1990). A list of the armored scale insect pests. Armored Scale Insects: Their Biology, Natural Enemies, and Control (Ed. by Rosen, D.), pp. 299–306. Elsevier, Amsterdam.

Paraskakis, M.; Neuenschwander, P. and S., Michelakis (1980). *Saiissetia oleae* (Oliv.) (Homoptera., Coccidae) and its parasites on olive trees in crete, Gerece. Z. Ang. Ent., 90, 450 – 464.

Podolar, H. and D. Rogers (1975). A new method for the identification of key factors from life table data. J. Anim.Ecol., 44:85- 114.

Priesner, H. and M. Hosny (1940). Notes on parasites and predators of Coccidae and Aleuroididae in Egypt. Bull. Soc. Fouad I Entom., 24: 58-70.

Pucci, C.; Domimici, M.; prosperi G. and A., forcina (1986): Population dynamics of *Saissetia oleae* (oliv,) (Homoptera, Coccidae) on the olive tree. J. Appl. Ent., 1o2, 476 -483.

Schneider, B., Podoler, H. and D., Rosen (1987): population dynamics of the florida wax scale, *Ceroplastes floridensis* (Homoptera : Coccidae) on citrus in Israel. Acta Oecologia/ Oecologia Applicota, 8: 217 – 228.

Uematsu, H. (1979). Studies on life table for an armored scale insect, *Aonidiella taxus* leonardi (Homoptera: Diaspididae). Sci.Bull. Fac. Agr., Kyushu Univ., 33, 79 – 86.

Varley, C.G.; Gradwell, G.R. and M. P. Hassell (1973). Insect population ecology, an analytical approach. Blackweels, Oxford, pp 212.

Zalom, F.G.; Van Steernwyk, P.; Bentley, W.J.; Coviello, R.L.; Rice, R.E.; Heindricks, L.; Pickel, C.; and M.W. Freeman (2001). Insects and mites. In: Almond Pest management guidelines,. Oakland, CA: Univ. Calif. Div. Agric. Natural Resources, 1-29.

تأثير العائل النباتي على ديناميكية التعداد لحشرة سان جوزيه القشرية

عبد الستار إبراهيم عبد الكريم* ، السيد عبد الحميد علوان و نجلاء محمد يوسف****

*** قسم الحشرات الاقتصادية – كلية الزراعة – جامعة المنصورة.**

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

تم إجراء هذه الدراسة بالمزرعة البحثية بكلية الزراعة جامعة المنصورة خلال أربعة أجيال متتالية لحشرة سان جوزيه القشرية بهدف معرفة تأثير اختلاف العائل النباتي (التفاح ،البرقوق و الكمثرى) على ديناميكية تعداد حشرة سان جوزيه القشرية . وقد تم عمل جداول الحياة لدراسة تأثير العائل النباتي على فترات نمو الأطوار الغير كاملة تحت الظروف الحقلية هذا بالإضافة إلى تقدير نسب الموت المختلفة لأطوار النمو المختلفة وتأثير ذلك على ديناميكية التعداد.

وقد أوضحت الدراسة أن أشجار التفاح كانت أكثر العوائل ملائمة لنمو الحشرة بالمقارنة بكل من أشجار البرقوق والكمثرى كما وجد أن نسبة الموت الكلية في تعداد الحشرة منذ بداية الطور الثابت Settling crawlers حتى وصولها للحشرة الكاملة بلغت (73.1 – 87.8) و 81.5 – 87.6)و (86 – 96.4) على كل من التفاح والبرقوق و الكمثرى على التوالي. وقد أبدى العمر الثاني للإناث أعلى نسبة موت على جميع العوائل وخاصة في جيل الشتاء.

قام بتحكيم البحث

أ.د / ليلى عبد الستار البطران — كلية الزراعة – جامعة المنصورة

أ.د / أحمد سمير هنداوى — مركز البحوث الزراعية

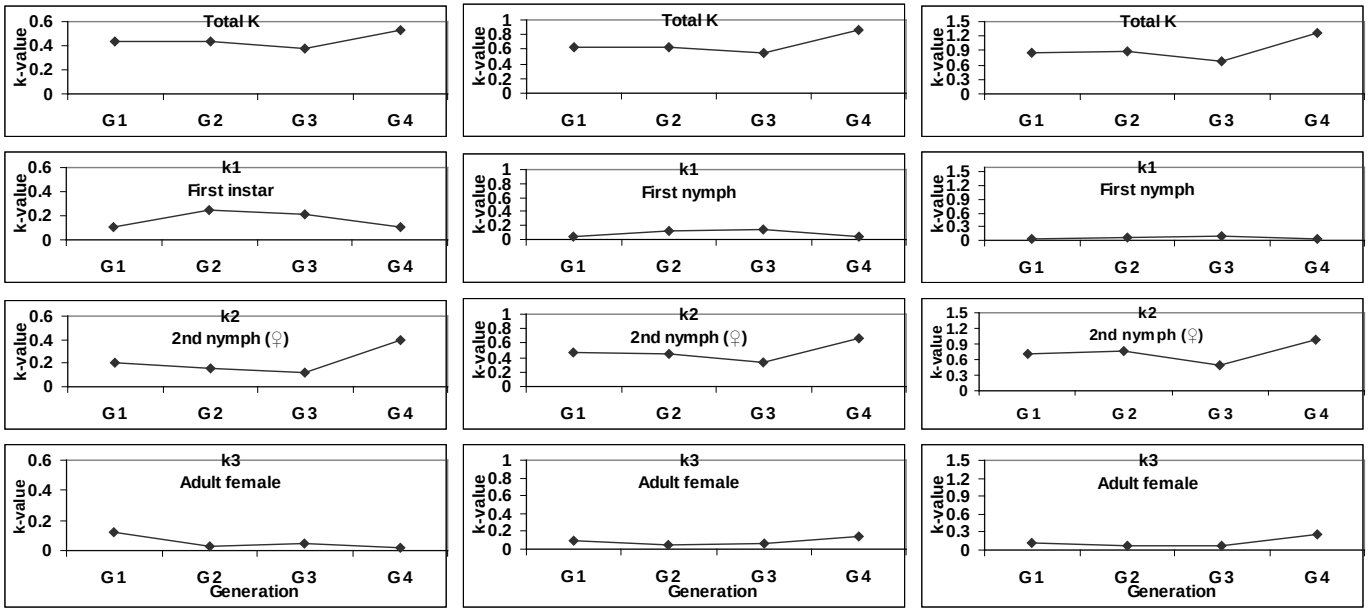

Figure (1): Graphical key factor analysis for *Q. perniciosus* on different host plants (apple, plum and pear trees) over four generations.