

**ECOLOGICAL STUDIES ON THE PURPLE SCALE INSECT, *LEPIDOSAPHES BECKII*
(HEMIPTERA: DIASPIDIDAE) ON NAVEL ORANGE TREES AT EL-BEHAIRA
GOVERNORATE, EGYPT IN 2009 AND 2010 SEASONS**

***KHALIL A. A. DRAZ, **GAMIL B. EL-SAADANY, *MOHAMED A. MANSOUR, ***ABDEL-FATTAH G. HASHEM
and *ADNAN A. E. DARWISH**

*Faculty of Agriculture, Damanhour,

**Faculty of Agriculture, Ain Shams University

***Plant protection research institute, Agriculture research center, Dokki, Cairo, Egypt

ABSTRACT

Field studies were carried out on the purple scale *Lepidosaphes (Cornuaspis) beckii* (Newman) at El- Behaira Governorate throughout two successive years extended from February 2009 to February 2011. Three peaks of overlapping generations were recorded per year. In the 1st year three peaks of infestation were recorded in May 1st, September 4th and November 13th. While in 2nd year of investigation, these peaks were recorded during April 30th, mid October and November 26th. The highest rate of population densities were recorded at March, April, decreased up to August then raised up again in September, October and November. The insect distributes on the whole navel orange tree with special preference to the southern and western cardinal sides. The population of *L. beckii* prefers the middle stratum of navel orange where considerable density of insect population usually occurs. The relationships between the population density of inspected insect stages and prevailing weather factors -degree of temperature and relative humidity- were studied and statistically analyzed through both the

years of study. Positive strong correlations were detected between daily minimum and daily mean of temperature and total counts of insect population.

INTRODUCTION

Scale insects and mealy bugs are serious insect pests, attack the citrus trees and cause a severely considerable damage under the prevailing agroecosystems in Egypt. These insects are sucking pest of plant sap and secrete large amount of the honey dew which encourage the growth of sooty mold fungi, that consequently reduce the photosynthesis and respiration of plant leaves (Radwan, 2003). Which sequentially reflect on the main infestation symptoms are yellowing, drying and falling of infested leaves, reduction and weakness of vegetative growth and finally reduction of fruit production (quality and quantity). Usually, occurrence of the severe infestation lead to the death of the whole trees. The hard scale insect has long thread like mouthparts (stylets) six to eight times longer than its body tall. Most species of armored scale overwinter as eggs beneath the female cover in spring egg hatch into tiny mobile crawlers which migrate to new feeding sites. Recently the purple scale insect *L. beckii* becomes one of the most seriously dangerous insect pests of citrus trees.

It is a polyphagous species that has been recorded on numerous hosts belonging to 45 genera, pertaining to 11 families including citrus. It attacks leaves and fruits (Davison and Miller, 1990).

The purple scale *Lepidosaphes beckii* has four annual generations and tends to accumulate in the shadowy zones of citrus trees (Habib *et al.* 1971). All stages of the purple scale are present in the orchards all around the year, giving of sequent overlapping generations; however, the highest densities were recorded during the early season (Fadamiro *et al.*, 2008).

The present work was conducted on navel orange trees at El-Behaira Governorate from February 6th 2009 until February, 18th 2011, for determining the distribution of the insect stages on the cardinal direction and different strata of navel orange trees, the population dynamical fluctuation to assess the proper and adequate timing of control procedures. Besides the statistical estimation of the relationships between the prevailing whether hygro-thermic conditions and the assigned population peaks of insect throughout the growing year.

MATERIALS AND METHODS

Field experiments were conducted in fruit orchard of 5 feddans, on 12-years-old of navel orange trees, at Nobaria district (85 km south Alexandria city). The study was carried out in one feddan only of this orchard which kept free of any insecticides application throughout the period of the performed study.

In order to determine the fluctuating changes in the relative abundance of *L. beckii* population, samples of sixty leaves of navel orange trees were picked every two weeks (14 day) started from February 6th 2009 until February 18th 2011 (two years). Leaves were kept in 12 labeled poly ethylene bags; each bag represented a particular cardinal direction and / or a specific stratum of the tree; then transported to the laboratory and carefully inspected by means of stereoscopic binocular microscope. For accurate and through inspection, the purple scale individuals in the sample leaves were divided into nymphs and adult females, then the different purple scale stages were precisely counted and recorded.

The population of *L. beckii* nymphs was estimated monthly to point out the number of annual generations of *L. beckii* represented by her numbers of revealed peaks of scale insect all over the year. The monthly variation rate (MVR) in population density was calculated according to the following formula (Abdel-Fattah *et al*, 1978):

$$\text{MVR} = \frac{\text{Average count given at a month}}{\text{Average count given at a preceding month}}$$

The distribution pattern of this insect has been also studied in the four cardinal directions of the tree (North, South, East and West); the rate of infestation at three strata per tree, i.e., vertical heights above the soil surface of growing navel orange tree (1.5 m, 2.5 and greater than 2.5 meters).

The considered and dominating meteorological factors during the investigation were the maximum, minimum, mean temperature and the daily average of relative humidity. The data of such factors were supplied by the meteorological organization, Cairo, Egypt. To clarify the role of selected environmental factors in regulating the population density of this insect. The fluctuating values of the environmental factors were used for calculating the simple correlation and regression. The statistical analysis of the present results was achieved according to the methods of Steal and Torrie (1960).

RESULTS AND DISCUSSION

Population density and seasonal abundance of *L. beckii*:

The fortnightly counts of Nymphal instars and adult female per 60 leaves of navel orange through two successive years started from February 2009 till February 2011 are tabulated in Table (1) and Fig. (1&2).

These data show that the estimated fluctuating densities of the purple scale population indicated three peaks of infestation. These peaks occurred in May 1st, September 4th and November 13th throughout the first year with averages values of 472, 645 and 640 individuals, respectively. In the consecutive growing season 2010/11, the three peaks were recorded on April 30th (980 individuals), mid October (1290 individuals) and November 26th (1215 individuals). The obviously depressive numbers in the first year were occurred during

July 24th and January 22nd indicating 240 and 222 individuals respectively and in the second season was in February, 5th with 278 individuals (Table 1& Fig. 2).

Number of annual generation:

Data presented in Tables 2&3 indicated that the purple scale *L. beckii* has three annual generations, and these results were ensured throughout the two years of study of the insect population under field condition at El-Bhaira Governorate. During the first year of investigation, the percentage of nymph population recorded 82.64 %, 72.32 % and 73.7 % of total population through May, September and November, respectively. Almost similar trend has been obtained in the 2nd year (2010/ 2011), where three annual generations existed. Nymphs population peaked in May (72.89 %), November (76.13 %) and December (73.89 %). Fadamiro *et al.* (2008) stated that all stages of the purple scale were present in the orchards year-round, indicative of overlapping generations; however, the highest densities were recorded during the early season. Aly, Nadia (2011), stated that the purple scale have three generation per year on mango fruit trees.

The monthly counts of different stages of *L. beckii* in addition to the calculated monthly variation of its population through the two successive years of investigation are tabulated in Tables (2&3) and illustrated histogramatcally in Figures (3&4). Results concerning the Monthly variation rate (MVR) of population density of purple scale insects clearly show that the favorable periods for its development and population increase were at March and September 2009, where (MVR) values averaged 1.6 and 1.53, respectively. In the second year the highest values of (MVR) were 1.66, 1.77 and 1.32 in March, April and September, respectively. Rodrigo *et al.* (2004) in Spain, recorded three periods of intense crawler migration were detected annually for *L. beckii*. Abundance of crawlers increased throughout the year and they moved outwards in the tree canopy.

The role of main cardinal directions on the distribution of *L. beckii* on navel orange trees:

Data presented in Table (4) emphasize that population distribution pattern considerably differ from one direction to another. During the first year 2009/10 (Table 4a) leaves on located branches at southern direction harbored the maximum average numbers of insects 29.7 % of the total population while the lowest average numbers of population (20.4%) was counted in the eastern direction. In the second year 2010/11

(Table 4b), the highest rate of infestation was recorded at the southern direction also, but the lowest rate was at the northern and eastern directions. The preference of this scale insect to the existing leaves on the southern and western branches of the tree due to the direction blowing winds from the northern to the southern carrying the newly hatched crawlers and enabling them to settle on the leaves of those directions.

Table (2): Monthly counts of the different stages of *Lepidosaphes beckii* on navel orange trees through the first year (2009/2010):

Months	Average no. of scales / sample				M. V. R.
	Total	Adult	Nymph	% Nymph	
Feb.	150	60.5	89.5	59.67	-
Mar.	240	90	150	62.5	1.6
Apr.	339.5	98.5	241	70.9	1.4
May	411	71.33	339.67	82.64	1.2
Jun.	327.5	70	257.5	78.6	0.8
Jul.	254	96.5	157.5	62	0.78
Aug.	366	110.5	255.5	69.8	1.44
Sep.	560	155	405	72.32	1.53
Oct.	507.67	182	325.67	64.14	0.9
Nov.	620	163	457	73.7	1.22
Dec.	422.5	137.5	285	67.45	0.68
Jan.	238.5	87.5	151	63.3	0.56

Table (3): Monthly counts of the different stages of *Lepidosaphes beckii* on navel orange trees through the second year (2010/2011):

Months	Average no. of scales / sample				M. V. R.
	Total	Adult	Nymph	% Nymph	
Feb.	292.5	122.5	170	58.11	1.22

Mar.	486	226.5	259.5	53.39	1.66
Apr.	864	327	537	62.15	1.77
May	819	222	597	72.89	0.95
Jun.	778.5	242.5	536	68.85	0.95
Jul.	747.5	267	480.5	64.28	0.96
Aug.	787.5	341.5	446	56.63	1.05
Sep.	1039.5	360.5	679	65.31	1.32
Oct.	1216.67	367.67	849	69.78	1.17
Nov.	1150	274.5	875.5	76.13	0.94
Dec.	975	254.5	720.5	73.89	0.84
Jan.	567	211	356	62.78	0.58
Feb.	464.5	204	260.5	56.08	0.81

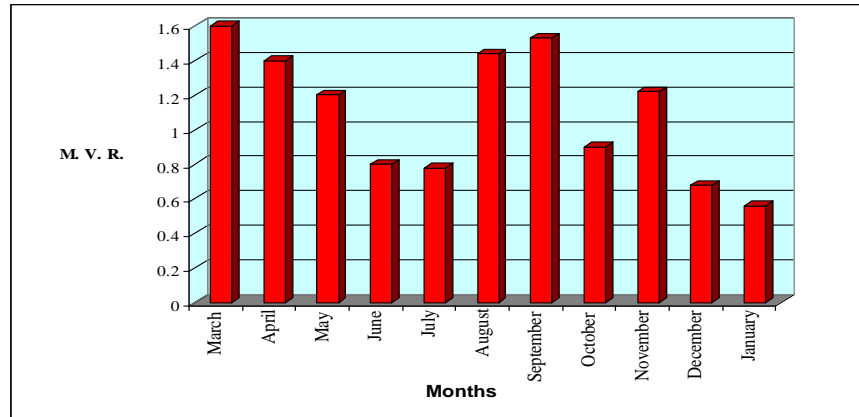


Fig (3): Monthly variation rate (MVR) of *L. beckii* in the 1st season (2009/10).

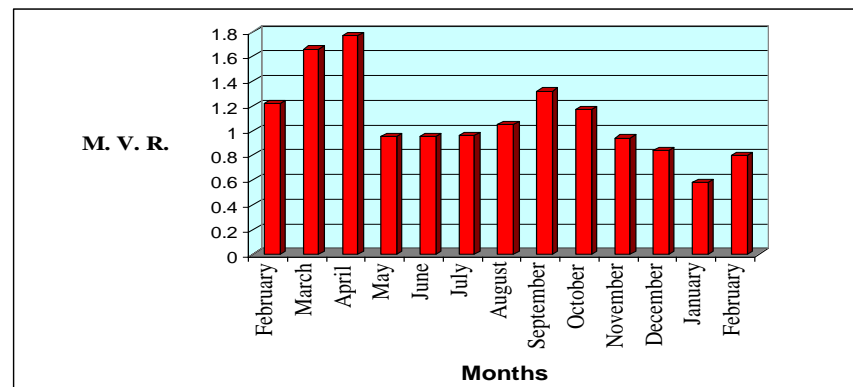


Fig (4): Monthly variation rate (MVR) of *L. beckii* in the 2nd season (2010/11).

The distribution of *L. beckii* population at the vertical heights (strata) of the navel orange tree:

Data in Table (5 a&b) reveal that the distribution pattern of *L. beckii* markedly varies according to the level of navel orange trees strata and prevailing weather conditions.

Middle stratum of navel orange tree always harbored the highest population density of the insect, where about 41.84 % of the total population was estimated in the first year and 40.42 in the second year. The upper stratum showed the lowest population density (19.09 % & 23.44 %), while the less highest population density 39.05% and/or 36.13% was recorded in the lower strata in the first and second year, respectively. Data indicated the preference of this insect to the middle stratum of navel orange trees as preferable site of feeding and multiplication.

Analysis of obtained data revealed substantial and significant difference between the different levels of tree strata. From the aforementioned, results, it could be deduce that the population of *L. beckii* prefers the middle stratum of navel orange where considerable higher population density of developing nymphs and/or adults usually occurs.

Effect of prevailing hygro-thermic condition on the population density of the insect:

The measured relationships between the population density of *L. beckii* and the main weather factors Table i.e., daily temperature and daily relative humidity (6 a&b) proved that the population variability of the insect is markedly influenced by the daily temperatural parameters than relative humidity.

Effect of daily maximum temperature: as shown in Table (6b) considerable positive correlations values were noticed between the maximum temperature and the population density of *L. beckii*; indicating the less effective role of the maximum Temperature on the activity of the insect. In the first year these relationships were not significant vice versa in the 2nd year these values were highly significant with the total population and the population of adult-female insects and significant with the population of nymphs.

Effect of daily mean temperature: as shown in Table (6b) considerable positive correlations values were noticed between the mean temperature and the population density of *L. beckii*. These results indicate that the activity of the insect population positively correlated with mean temperature. In the 1st year these values were highly significant relationships with the total population, the population of nymphs and the population of adult female. For the 2nd growing year these values were strong highly significant with the total population, the population of adult female and with the population of nymphs.

Effect of minimum temperature: as shown in Table (6b) considerable positive correlations values were noticed between the minimum temperature and the population density of *L. beckii*; indicating the high effective role of the minimum temperature on the activity of the insect for both the two years, these relationships were highly significant with the total population, the population of adult female and with the population of nymphs. These results indicate that the decreasing in temperature would increase the density of insect population. Aly, Nadia (2011), stated that that maximum and minimum temperatures was significant on the population of *L. beckii* and its parasitoid, *A. lepidosaphes* while percent of relative humidity it is non significant.

Table (4): Average number of *L. beckii* located on navel orange trees at different directions at El-Bhaira governorate during:

A) The first year:

Directions	Probability		Average number of individuals		
	1 %	5 %	% of the total population	Range	Mean \pm SD
East	bcd	cd	20.39	28 - 136	76.8 \pm 30.8
North	bc	bc	22.47	34 - 146	84.65 \pm 32.7

South	a	a	29.71	37 - 197	111.92 ± 43.17
West	ab	ab	27.41	31 - 182	103.23 ± 39.1

F cal = 5.05

F value at 1 % probability = 3.98

F value at 5 % probability = 2.7

L. S. D. at 1 % probability = 26.83

L. S. D. at 5 % probability = 20.2

B) The second year:

Directions	Probability		Average number of individuals		
	1 %	5 %	% of the total population	Range	Mean ± SD
East	abc	bc	22.49	62 - 297	180.39 ± 67.13
North	abcd	bcd	22.39	59 - 288	179.6 ± 65
South	a	a	28.36	78 - 365	227.5 ± 79.27
West	ab	ab	26.74	79 - 342	214.5 ± 70.8

F cal = 3.28

F value at 1 % probability = 3.98

F value at 5 % probability = 2.7

L. S. D. at 1 % probability = 49.76

L. S. D. at 5 % probability = 37.46

**Table (5): Average numbers of *L. beckii* located in different strata of navel orange trees during:
A) The first year:**

Strata	Probability		Average number of individuals		
	1%	5 %	% of the total population	Range	Mean \pm SD
Upper	c	c	19.09	24 - 168	71.22 \pm 35.25
Middle	a	a	41.84	65 - 390	156.07 \pm 71.71
Low	ab	ab	39.05	38 - 284	145.6 \pm 66

F cal = 16.14
F value at 5 % probability = 3.11
L. S. D. at 5 % probability = 32.4

F value at 1 % probability = 4.88
L. S. D. at 1 % probability = 42.22

B) The second year:

Strata	Probability		Average number of individuals		
	1 %	5 %	% of the total population	Range	Mean \pm SD
Upper	c	c	23.44	48 - 334	192.5 \pm 77.6
Middle	a	a	40.42	101 - 575	332 \pm 115.1
Low	ab	ab	36.13	113 - 536	296.77 \pm 118.3

F cal = 12.8
F value at 5 % probability = 3.11
L. S. D. at 5 % probability = 57

F value at 1 % probability = 4.88
L. S. D. at 1 % probability = 75.67

Table (6): The calculated simple correlation coefficient (r value) between means of *L. beckii* stages on Navel orange trees and daily degrees of temperature and relative humidity at El-Behaira Governorate during 2009/10 and 2010/11 year.

A) Relative humidity:

Stages	Max. R.H.		Mean R.H.		Min. R.H.	
	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11
Total population	0.31 NS	0.303 NS	0.316 NS	0.254 NS	0.267 NS	0.185 NS
Adults -Female	0.184 NS	0.395 *	0.349 NS	0.383 *	0.405 *	0.32 NS
Nymphs	0.326 NS	0.243 NS	0.272 NS	0.187 NS	0.184 NS	0.123 NS

B) Temperature:

Stages	Max. Temp.		Mean Temp.		Min. Temp.	
	2009/10	2010/11	2009/10	2010/11	2009/10	2010/11
Total population	0.366 NS	0.5 **	0.547 **	0.666 **	0.684 **	0.775 **
Adults -Female	0.24 NS	0.519 **	0.489 **	0.616 **	0.731 **	0.647 **
Nymphs	0.375 NS	0.446 *	0.5 **	0.611 **	0.587 **	0.736 **

REFERENCES

- Abdel-Fattah, U. L.; El-Minshawy, and E. Darwish (1978).** The seasonal abundance of two scale insects *Lepidosaphes beckii* (New.) and *Aonidiella aurantii* (Mark.) infesting citrus trees in Egypt. Pro. 4th Conf. pest. Control, NRC. Cairo(1).
- Aly, Nadia (2011).** population dynamics of the purple scale *Lepidosaphes beckii* (Hemiptera: Diaspididae) and its parasitoid *aphytis lepidosaphes* (Hymenoptera: Aphelinidae) as a new threat pest on mango trees in Egypt. Egypt. Acad. J. biolog. Sci., 4(1).
- Davidson. G. H. and Miller, D. R. (1990).** In: Armored scale insects (Ed. Roosen, D.) pp. 603-632. world crop pests Vol. 4B. Elsevier, Amsterdam, Pays-Bas.
- Fadamiro, H.Y.; Xiao, Y. ; Hargroder, T. ; Nesbitt, M. ; Umeh, V. and Childers, C. C. (2008).** Seasonal Occurrence of Key Arthropod Pests and Associated Natural Enemies in Alabama Satsuma Citrus. Environmental Entomology 37(2):555-567.
- Hafez, M. B; El-Mishawy A. M. and Donia, A.R. (1987):** Population fluctuation on parasites of *Lepidosaphes beckii* Newm. and *Ceroplastes floridensis* Comst. Anzeiger fur Schädlingkunde, 60 (1): 6-9.
- Habib, A., Salama, H. S. and Amin, A. H. (1971).** Population Studies on Scale Insects Infesting Citrus Trees in Egypt. Zeitschrift für Angewandte Entomologie, 69: 318–330. doi: 10.1111/j.1439-0418.1971.tb03215.x
- Radwan S. (2003).** Toxicological studies on some scale insects infested mango and guava trees. Ph. D. Thesis, Fac. Agric., Cairo Univ. 1-221.
- Rodrigo, E.; Garcia-Mari, F. (1994).** Study of the abundance and distribution of some scale insects on citrus. Boletín de Sanidad Vegetal, Plagas. 1994. 20: 1, 151-164. 35 ref.

Steel, J. F. and J. H. Torrie (1960): Principles and Procedures of statistics. McCraw-Hill, New York.

الملخص العربي

التغيرات العددية لحشرة الموالح القشرية الأرجوانية المحارية *Lepidosaphes beckii* علي أشجار البرتقال أبو سره في محافظة البحيرة، جمهورية مصر العربية.

خليل عبدالله دراز* ، جميل برهان الدين السعدني** ، محمد عبدالقادر منصور* ، عبدالفتاح جاد هاشم*** ، عدنان عبدالفتاح السيد درويش*

* كلية الزراعة جامعة دمنهور

** كلية الزراعة جامعة عين شمس

*** معهد بحوث وقاية النبات- مركز البحوث الزراعية- الدقي – الجيزة

تعتبر حشرة الموالح القشرية الأرجوانية المحارية *Lepidosaphes beckii* من أخطر الآفات الحشرية التي تصيب أشجار الموالح. تناول هذا البحث بعض الدراسات البيئية الحقلية علي هذه الحشرة في محافظة البحيرة خلال موسمي 2009 و 2010 وذلك علي أشجار البرتقال أبو سره. ثلاث قمم في العام تم ملاحظتها لتعداد هذه الحشرة، في العام الأول سجلت هذه القمم في اشهر مايو و اكتوبر ونوفمبر. في العام الثاني من الدراسة سجلت هذه القمم في اشهر ابريل و اكتوبر ونوفمبر ومن ذلك اتضح ان لهذه الحشرة ثلاث أجيال في العام علي اشجار البرتقال أبو سره. كانت الفترات المناسبه والمفضله لنمو مجموع الحشرة هي اشهر مارس و ابريل وسبتمبر. وكانت هذه الحشرة موجودة علي اشجار البرتقال أبو سره في جميع الاتجاهات مع تفضيل كلا من الاتجاهين الغربي والجنوبي وكان اقل اتجاهات الشجرة الرئيسية من حيث تواجد هذه الحشرة هو الإتجاه الشرقي. ايضا اتضح من الدراسة تفضيل الحشرة للطبقة الوسطي من الشجرة وأقل تعداد للحشرة تم ملاحظته في الطبقة العليا من الشجرة. كذلك تم دراسة العلاقة بين كثافة تعداد اطوار الحشرة المختلفة و تأثير بعض العوامل الجوية مثل الحرارة والرطوبة النسبية وتم تحليل العلاقة احصائيا خلال موسمي الدراسة ووجد ان كثافة تعداد الحشرة يتأثر بالتغير في درجات الحرارة وخاصة درجة الحرارة الدنيا والمتوسطة عن تأثرها بالتغير في الرطوبة النسبية.

Table (1): Fortnightly numbers of different developing stages of *Lepidosaphes beckii* on navel orange trees during the two successive years, at El-Behaira governorate:

1 st season				2 nd season			
Investigation date	Total population	Adult-female	Nymphs	Investigation date	Total population	Adult-female	Nymphs
06/02/2009	130	49	81	05/02/2010	278	112	166
20/02/2009	170	72	98	19/02/2010	307	133	174
06/03/2009	210	82	128	05/03/2010	450	220	230
20/03/2009	270	98	172	19/03/2010	522	233	289
03/04/2009	322	98	224	02/04/2010	715	315	400
17/04/2009	357	99	258	16/04/2010	897	359	538
01/05/2009	472	93	379	30/04/2010	980	307	673
15/05/2009	412	64	348	14/05/2010	768	219	549
29/05/2009	349	57	292	28/05/2010	870	225	645
12/06/2009	339	64	275	11/06/2010	852	265	587
26/06/2009	316	76	240	25/06/2010	705	220	485
10/07/2009	268	90	178	09/07/2010	753	242	511
24/07/2009	240	103	137	23/07/2010	742	292	450
07/08/2009	260	87	173	06/08/2010	765	321	444
21/08/2009	472	134	338	20/08/2010	810	362	448
04/09/2009	645	196	449	03/09/2010	957	350	607
18/09/2009	475	114	361	17/09/2010	1122	371	751
02/10/2009	460	151	309	01/10/2010	1230	320	910
				15/10/2010	1290	387	903

16/10/2009	497	202	295
30/10/2009	566	193	373
13/11/2009	640	181	459
27/11/2009	600	145	455
11/12/2009	465	142	323
25/12/2009	380	133	247
08/01/2010	255	92	163
22/01/2010	222	83	139

29/10/2010	1130	396	734
12/11/2010	1085	288	797
26/11/2010	1215	261	954
10/12/2010	1005	244	761
24/12/2010	945	265	680
07/01/2011	622	212	410
21/01/2011	512	210	302
04/02/2011	444	187	257
18/02/2011	485	221	264

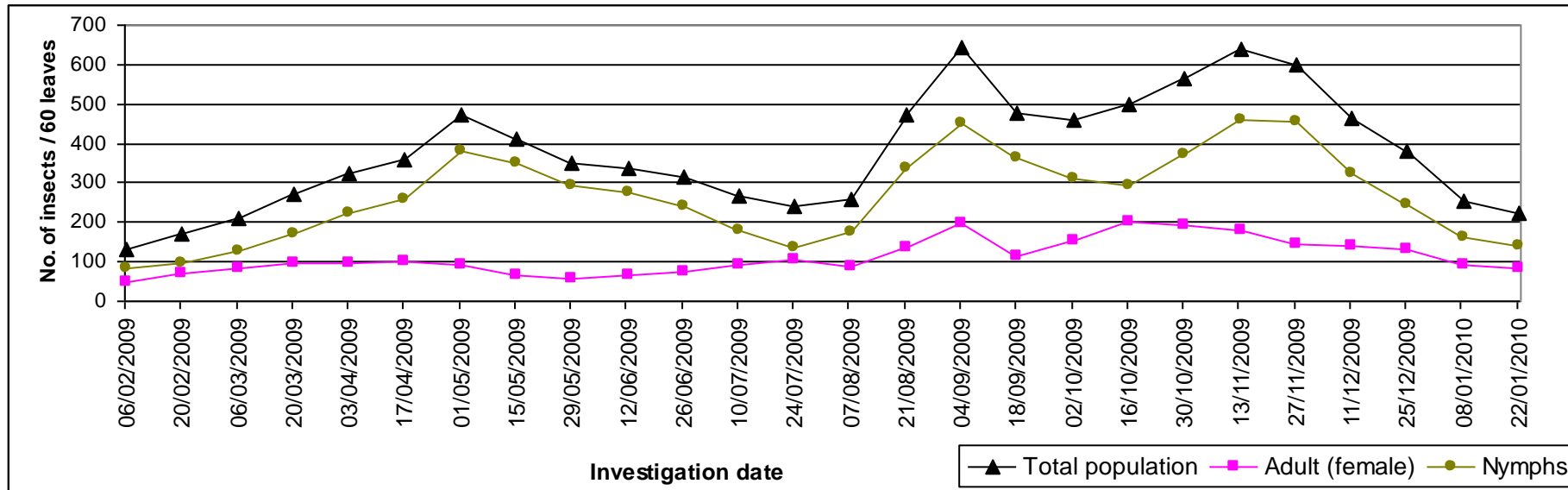


Fig. (1): Seasonal fluctuation of the different development stages of *Lepidosaphes beckii* on Navel orange trees at Nobaria district, El-Beheira Governorate, during the first season, 2009/10.

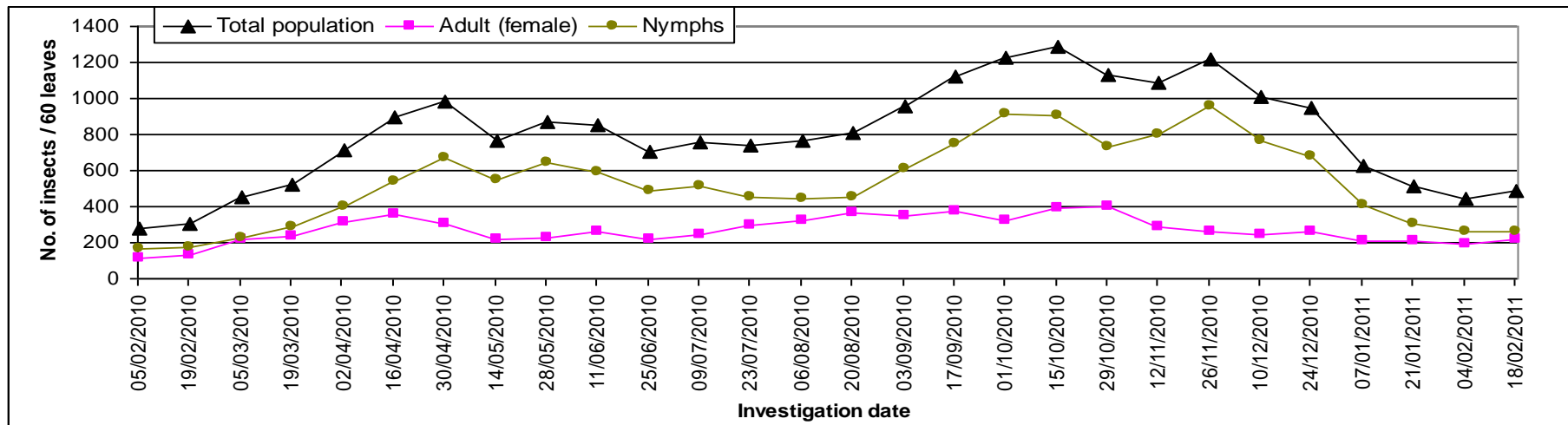


Fig. (2): Seasonal fluctuation of the different development stages of *Lepidosaphes beckii* on Navel orange trees at Nobaria district, El-Beheira Governorate, during the second season, 2010/11.

