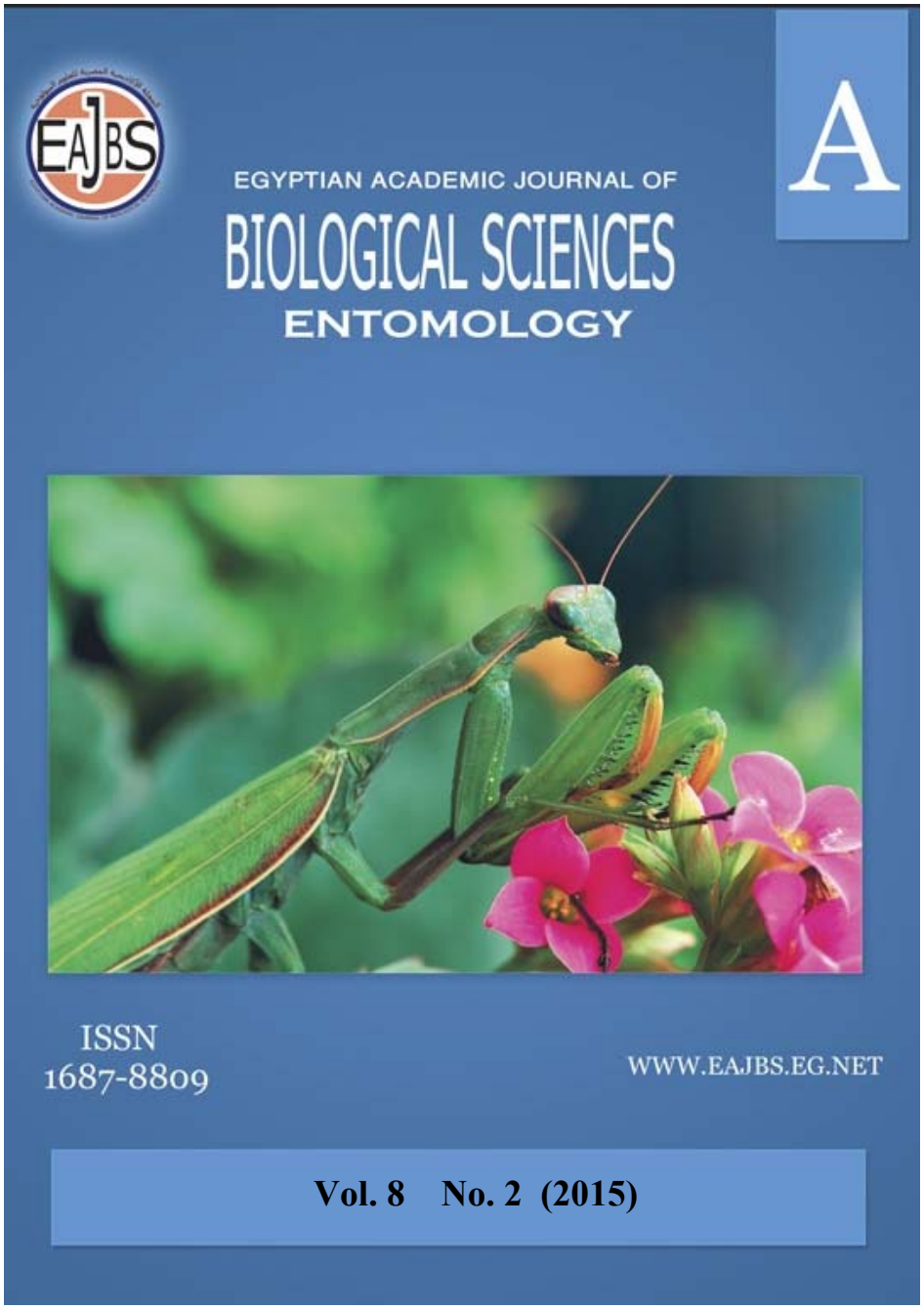

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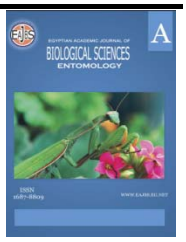

Susceptibility of Certain Fruit Trees to Infestation With the White Peach scale, *Pseudaulacaspis pentagona* (Targioni -Tozzetti), With Some Ecological Aspects

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ABSTRACT

The susceptibility of peach, apricot, and pear trees to attack with the white peach scale, (WPS) *Pseudaulacaspis pentagona* (Targioni-Tozzetti) (Hemiptera, Diaspididae) was evaluated in Nubaria district, El-Beheira Governorate, Egypt from May, 2013 to April, 2015. Results showed that there were no fruit trees of them immune to this pest; the populations of (WPS) were significantly different between the fruit species under study. The susceptibility of peach trees was significantly higher than apricot and pear trees. The total population of *P. pentagona* had four overlapping annual generations on the three types of fruit trees during the two successive years of study. The monthly variations of *P. pentagona* population were calculated. Also distribution patterns of *P. pentagona* on the cardinal directions were studied. The insect distributes on the whole tree with special preference to the eastern cardinal sides in peach and pear trees followed by northern side. But the preference sides in apricot trees were the northern side followed by eastern cardinal side.

INTRODUCTION

White peach scale, *Pseudoaulacaspis pentagona* (Targioni-Tozzetti) (Hemiptera, Diaspididae) is the most serious pest of peach in the East Mediterranean region (Anonymous, 1993). This insect is a polyphagous pest with very wide host plant range, especially on fruit trees and ornamental plants including peach, apricot, plum and apple trees in many parts of the world (Kosztarab and Kozer, 1988). The infestation by this insect is mainly concentrated on the trunks, branches, twigs and may move to fruits. When occurs, injury is caused by different stages of the insect. They suck plant sap and cause wilting of twigs, death of branches, defoliation and considerable yield loss (Pan *et al*., 2003). Female white peach scales deposit all their eggs (≈100–150 total eggs/female) in about a week. Eggs hatch in 3-4 days and the young scales (crawlers) settle on the host plants within two days after hatching (Miller and Davidson, 2005). Crawlers are active up to 24 h and disperse primarily within plants (Hanks and Denno, 1993a), but aerial dispersal among plants does occur and is important in colonization of new hosts (Hanks and Denno, 1993b). *P. pentagona* has three annual generations, in Italy, the first was present approximately from April to July), the second from July to September and the third in September, overwintering as a gravid females (Kreiter *et al*., 1997). In Egypt Atteya (2004) recorded five generations in mid-March, early May, July, mid-August and in October, also Mousssa, *et al*. (2010) stated that white peach scales had five annual generations.

The objective of this study is to determine the susceptibility of peach, *Prunus persica* L., apricot, *Prunus armeniaca* L. and pear, *Pyrus communis* L. trees to infestation with the white peach scale, *P. pentagona*, to study its seasonal activity and distribution of this insect on tree cardinal directions over a two years of study from May 2013 to Abril 2015 at Nubaria district, El-Beheira Governorate.

MATERIALS AND METHODS

This experiment was carried out at Nubaria district, El-Beheira Governorate, Egypt from March, 2013 to April, 2015. Four trees of each of; peach (var. Florida Prince), apricot (var. Canino) and pear (var. Le-cont) were chosen and marked for this study. All of these trees were grown under the same ecological conditions and homogenous in size and age (ten years-old). There were no any chemical control applied during the period of investigation.

Artificial infestation

Heavily infested branches (20 cm) by nymphal stage of WPS were collected from infested mulberry tree from Nubaria on March 1, 2013. Every branch with approximately 300 nymphs was attached to the top of each fruit tree. Upon branch drying, nymphs moved to the branches of the fruit trees and then settled down.

Sampling

Sampling was taken once every fortnight within the studied two years from beginning May 2013 (two months after infestation) till mid April 2015. Sample of four branches (15 cm each) were selected from the four different directions of each tree *i.e*. east, west, south and north. The samples were transported to laboratory in polyethylene bags for examination. They were examined by counting *P. pentagona* different stages by means of a binocular microscope to study the susceptibility of peach, apricot and pear trees for this insect and seasonal abundance in the different fruit type. Analysis of variance and LSD value for comparing the mean of each fruit type was adopted by (Snedecor, 1970).

Calculating of monthly variation rate

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 number of generations of this scale was estimated from the changes in the half-monthly nymphal stage percentages throughout the two successive years.

Distribution patterns of *P. pentagona* on the cardinal directions of fruit trees:

Directional preference was determine by applying the following formula (Mahmoud, 1981):

$F1 = E - W$

$F2 = N - S$

$\tan. Q = F2 / F1$

Where: F1: Mean number of insects in the east direction minus insect numbers in west direction, if the former is higher, and the reverse if the latter is higher. **F2:** Mean number of insects in the north direction minus insect numbers in south direction, if the former is higher, and the reverse applies if the insect number in south direction is

higher. The figure obtained represents the tangent: the corresponding values of which was obtained from the mathematical Table. **tan. Q**: Tan of the angle between the two forces.

RESULTS

Susceptibility of peach, apricot and pear trees to white peach scale, *Pseudaulacaspis pentagona* (Targioni-Tozzetti):

Results in Tables (1 & 2) showed that none of the tested fruit trees is immune to white peach scale, *P. pentagona*, but fruit trees varied widely in their susceptibility. The data showed that the populations of (WPS) were significantly different from a fruit species to other. The peach were significantly higher than apricot and pear through the two years of study. The general mean count per sample of the total population of WPS on peach, apricot and pear trees reached 136.96, 86.93 and 49.16 over the 1st season. While in the 2nd season these means reached to 170.5, 101.04 and 71.52.

Host plants often show varying degrees of susceptibility to a particular scale insect. Flanders (1970) suggested that some plants are genetically immune, some fluctuate from immune to susceptible and some are always susceptible.

Seasonal activity of *P. pentagona:*

In peach trees, during the 1st season of study (2013/2014) as shown in Table (1), it was observed that, the total population of this insect started to increase gradually to reaching the 1st peak of 211.9 individuals/branch in the mid of July. Then, the population decreased in beginning August and thereafter it increased continuously towards the 2nd peak of 262.6 individuals that was recorded in the beginning of October. Another decrease in population took place in the next month and then it increased making the 3rd peak in the beginning of January, when 112.5 individuals were recorded. The 4th peak was recorded in the beginning of April, 2014 (160.6). Concerning the data during the 2nd season of study (2014/2015) as shown in Table (2), it was clear that the total population was higher in comparison to the first season of investigation. The highest population was recorded in the beginning of June 2014, mid-August, mid-October, mid-January and beginning of April 2015, where population numbers being 202.3, 296.1, 320.6, 92.25 and 190.4 individuals / peach branch, respectively

Concerning apricot trees, the total population of *P. pentagona* had four peaks on mid May, mid July, October 1, 2013 and April 1, 2014 showing 121.8, 128.9, 184.1 and 91.25. Over 2014/2015, total population per branch was highest on May 1 (135.6), August 15 (126), October 15 (206.3) April 15 (131.1).

The obtained means of insect counts on pear were less than that observed on peach and apricot. Over 2013/2014 the observed dynamics reflected on the total population per branch had maximum values of 80.25, 77.44, 98.69 and 113.4 on May 15, August 15, September 15 and November 1, 2013. Over 2014/2015 the total individuals per branch had maximum values of 108.4, 117.2, 169 and 85.5 on May 15, September 1, October 15 and December 15, 2014 (Table 2).

Number of annual generations of *P. pentagona*:

The previous data clearly showed that, *P. pentagona* had four annual overlapping generations in peach, apricot and pear trees. This results is in agreement with Ding (2003) who showed that the mulberry white scale, *P. pentagona* had four generations a year in Gutian area, China and Nalepa and Meyer (1990) who recorded, also four generations of this insect in North Carolina. These results are disagree with

Habibian and Assadi (1989), Kreiter *et al*., (1997), and Halawa *et al*. (2015) who reported that *P. pentagona* has three annual generations and Atteya (2004) who recorded five generations.

Table 1: Fortnightly numbers of different developing stages of *P. pentagona* on peach, apricot and pear trees during the 1st year (2013/2014) at Nubaria district, El-Beheira Governorate.

Date of inspection	Peach			Apricot			Pear		
	Nymphs	Adult females	Total	Nymphs	Adult females	Total	Nymphs	Adult females	Total
1/5/2013	78.31	5.375	**83.69**	55.38	43.5	**98.88**	30	25.25	**55.25**
15/5/2013	41.56	30.56	**72.13**	77.44	44.31	**121.8**	60.13	20.13	**80.25**
1/6/2013	25.44	36.13	**61.56**	24.5	38.38	**62.88**	25.19	10.38	**35.56**
15/6/2013	48.56	43.06	**91.63**	56.5	32.94	**89.44**	26.19	15.19	**41.38**
1/7/2013	82.19	44.63	**126.8**	66.5	37.19	**103.7**	24.19	8.313	**32.5**
15/7/2013	180.8	31.06	**211.9**	96.81	32.06	**128.9**	4.25	14.25	**18.5**
1/8/2013	121.4	21.88	**143.3**	62.31	46	**108.3**	19.31	25.25	**44.56**
15/8/2013	76.69	36.56	**113.3**	63.25	43.81	**107.1**	64.13	13.31	**77.44**
1/9/2013	88.31	48.19	**136.5**	39.06	55.31	**94.38**	57	15.5	**72.5**
15/9/2013	158.2	73.13	**231.3**	73.69	43.31	**117**	70.56	28.13	**98.69**
1/10/2013	208.1	54.5	**262.6**	154.9	29.19	**184.1**	58.19	11.44	**69.63**
15/10/2013	181.2	35.44	**216.6**	96.25	26	**122.3**	30	28.56	**58.56**
1/11/2013	158.3	30.38	**188.7**	59.19	14.75	**73.94**	90.31	23.06	**113.4**
15/11/2013	131.1	53.25	**184.4**	46.56	21.25	**67.81**	40	11.06	**51.06**
1/12/2013	117.4	38.5	**155.9**	39.25	18.31	**57.56**	33.38	6.125	**39.5**
15/12/2013	74.88	24.69	**99.56**	45	15.38	**60.38**	21.06	13	**34.06**
1/1/2014	87.06	25.44	**112.5**	39.5	9.125	**48.63**	59.44	9.188	**68.63**
15/1/2014	69.56	18.31	**87.88**	29.69	13.44	**43.13**	18.38	19.19	**37.56**
1/2/2014	50.25	27.13	**77.38**	15.69	14.13	**29.81**	16.31	6	**22.31**
15/2/2014	28.63	38.44	**67.06**	4	11.44	**15.44**	6.063	7.438	**13.5**
1/3/2014	102.5	25.13	**127.6**	35.19	22.81	**58**	16.44	10	**26.44**
15/3/2014	97.13	34.81	**131.9**	59.06	26	**85.06**	14	4.25	**18.25**
1/4/2014	141.3	19.38	**160.6**	58.19	33.06	**91.25**	5.063	8.063	**13.13**
15/4/2014	128.1	14.19	**142.3**	78.06	38.5	**116.6**	39.19	18	**57.19**
Mean±SE	103.21 ±10.24	33.75 ±2.98	**136.96± 11.33**[a]	57.33± 6.31	29.59± 2.66	**86.93± 7.63**[b]	34.53± 4.73	14.62± 1.49	**49.16± 5.43**[c]
L.S.D.	23.9807								

Table 2: Fortnightly numbers of different developing stages of *P. pentagona* on peach, apricot and pear trees during the 2nd year (2014/2015) at Nubaria district, El-Beheira Governorate.

Date of inspection	Peach			Apricot			Pear		
	Nymphs	Adult females	Total	Nymphs	Adult females	Total	Nymphs	Adult females	Total
1/5/2014	33.56	63.94	**97.5**	106.1	29.44	**135.6**	69.31	31.13	**100.4**
15/5/2014	16.19	41.19	**57.38**	92.25	11.06	**103.3**	79.38	29.06	**108.4**
1/6/2014	156.1	46.25	**202.3**	55.25	10.81	**66.06**	53.94	21.06	**75**
15/6/2014	78.44	54.38	**132.8**	29.06	16.06	**45.13**	46.44	14.06	**60.5**
1/7/2014	44.38	80.13	**124.5**	31	32.44	**63.44**	9.125	10.13	**19.25**
15/7/2014	118.3	60.44	**178.8**	39.38	43.38	**82.75**	52.5	14.44	**66.94**
1/8/2014	206.2	38	**244.2**	80.06	29.56	**109.6**	56.31	22.5	**78.81**
15/8/2014	257.1	39	**296.1**	108.2	17.81	**126**	76.56	16.56	**93.13**
1/9/2014	171	57	**228**	93.19	27.63	**120.8**	85.56	31.63	**117.2**
15/9/2014	76.13	98.31	**174.4**	52.31	38.06	**90.38**	66.13	27.25	**93.38**
1/10/2014	164	56.44	**220.4**	79.44	49.19	**128.6**	47.06	32.38	**79.44**
15/10/2014	253	49.25	**302.3**	160.8	45.5	**206.3**	141.3	27.69	**169**
1/11/2014	283.4	37.19	**320.6**	150.1	40.5	**190.6**	111.5	30.56	**142.1**
15/11/2014	143.2	45.38	**188.6**	114.3	24.31	**138.6**	70.75	17.38	**88.13**
1/12/2014	106.1	38.44	**144.6**	104.5	10	**114.5**	57.75	7.5	**65.25**
15/12/2014	88.44	47	**135.4**	72.06	12.69	**84.75**	67.44	18.06	**85.5**
1/1/2015	22.38	56.13	**78.5**	20.88	21.06	**41.94**	50.38	12.31	**62.69**
15/1/2015	24.19	68.06	**92.25**	21.44	23.13	**44.56**	33.56	4.375	**37.94**
1/2/2015	50.13	28.19	**78.31**	25.06	26.44	**51.5**	40.25	2.313	**42.56**
15/2/2015	132.3	7.25	**139.6**	37.75	24.06	**61.81**	25	4.188	**29.19**
1/3/2015	154.3	3.313	**157.6**	51.38	28.44	**79.81**	22.13	3	**25.13**
15/3/2015	176.2	7.75	**183.9**	76.06	14.5	**90.56**	12.5	5.375	**17.88**
1/4/2015	148.1	42.25	**190.4**	75.19	42.06	**117.3**	20.44	4.25	**24.69**
15/4/2015	67.38	57.38	**124.8**	92.94	38.19	**131.1**	31.56	2.5	**34.06**
Mean **±SE**	123.8 ±15.75	46.78 ±4.43	**170.5± 14.66**[a]	73.69± 7.95	27.34 ±2.42	**101.04± 8.78**[b]	55.28 ±6.29	16.24 ±2.19	**71.52± 8.04**[bc]
L.S.D.	30.776								

Monthly variation of the insect population

The calculated monthly variations of *P. pentagona* population through the two successive years of investigation are tabulated in Tables (3 & 4). Data concerning the peach trees clearly show that the favorable periods for insect development and population increase were at July, September 2013 and March 2014 with MVR values

of 2.211, 1.434 and 1.8, respectively (Table 3). In the 2nd season the highest values of MVR were 2.164, 1.78 and 1.57 in June, August and March, respectively (Table 4). In apricot trees, these values were 1.527, 1.449 and 3.162 at July, October and March in the 1st season, respectively. Months of August (1.612), October (1.58) and March (1.5) were the favorable periods for population increase in Apricot trees during the 2nd season. Concerning pear trees, the favorable periods for insect development and population increase were at August, November and January with MVR values of 2.39, 1.28 and 1.44, respectively. In the 2nd season, these values were 2.971, 1.99 and 1.36 at May, August and April, respectively. Mousssa *et al.* (2010) studied ecology of *P. pentagona* at Meet-Ghamer, Dakahliya Governorate throughout two successive seasons (1997- 1999), total population activity of *P. pentagona* occurred during the two years of investigation were recorded on mid-February, early of April, July, September 1997 and early January 1998.

Table 3: Monthly variation rates of *P. pentagona* on Peach, Apricot and pear trees through the 1st year (2013/2014).

Month	Monthly Variation Rate M. V. R.		
	Peach	Apricot	Pear
May	-	-	-
June	0.983	0.69	0.568
July	2.211	1.527	0.663
August	0.757	0.926	2.392
September	1.434	0.981	1.403
October	1.303	1.449	0.749
November	0.778	0.463	1.283
December	0.685	0.832	0.447
January	0.784	0.778	1.444
February	0.721	0.493	0.337
March	1.797	3.162	1.248
April	1.167	1.453	1.573

Table 4: Monthly variation rates of *P. pentagona* on Peach, Apricot and pear trees through the 2nd year (2014/2015).

Month	Monthly Variation Rate M. V. R.		
	Peach	Apricot	Pear
May	0.994	1.083	2.971
June	2.164	0.465	0.649
July	0.905	1.315	0.636
August	1.782	1.612	1.995
September	0.745	0.896	1.225
October	1.299	1.586	1.18
November	0.974	0.983	0.927
December	0.55	0.605	0.655
January	0.61	0.434	0.667
February	1.276	1.31	0.713
March	1.567	1.504	0.599
April	0.923	1.458	1.366

Distribution patterns of *P. pentagona* on the cardinal directions of peach, apricot and pear trees:

The fortnightly mean cardinal distribution of *P. pentagona* (average no. of scales per 15 cm branch) at Nubaria district, El-Beheira Governorate, from May, 2013

to April, 2015 were determined and presented in Tables (5 ,6 & 7). During the 1st year of study analysis of variance demonstrated significant difference between the population means of the four cardinal directions. These means for each of peach and pear trees were higher for the eastern direction (202.14, and 63.21/branch), followed by northern direction (147.29 and 54.37 / branch). In contrast, west direction was the least infested site by insect. Concerning apricot trees, the northern site was the most infested site with this insect (98.53) followed by eastern direction (94.93). Over 2014/2015 the mean number per sample at the eastern direction was 230.15 and 88.57, followed by the northern direction (190.56 and 77.73) in peach and pear trees, respectively. These means for apricot trees over the 2nd year 2014/2015 were higher for the northern direction (116.39 / sample), followed by eastern site (109.01 / sample). Mohamed, (2006) mentioned that *P. pentagona* prefer north direction in peach trees which contracted the present results on peach and pear trees. This could due to the difference of the two location of study and the direction of wind that is an important factor affecting the dispersal of the crawlers.

Table 5: Average numbers and percentages of *P. pentagona* on different directions of peach trees at El-Beheira Governorate (Nubaria district) during two seasons, 2013/2014 and 2014/2015.

Direction	**1st season**		**2nd season**	
	Mean ±SE	% of the total population	Mean ±SE	% of the total population
East	202.14±14.28[a]	36.89	230.15±22.1[a]	33.73
West	89.37±9.42[c]	19.9	122.64±12.97[b]	17.97
South	109.03±10.87[c]	16.31	138.81±12.01[b]	20.34
North	147.29±13.3[b]	26.89	190.56±18.08[a]	27.93
L. S. D.	34.06		47.16	

Table 6: Average numbers and percentages of *P. pentagona* on different directions of apricot trees at El-Beheira Governorate (Nubaria district) during two seasons, 2013/2014 and 2014/2015.

Direction	**1st season**		**2nd season**	
	Mean ±SE	% of the total population	Mean ±SE	% of the total population
East	94.93±8.91[ab]	27.3	109.01±6.99[ab]	26.97
West	73.12±16.64[bcd]	21.03	94.06±9.85[ab]	23.27
South	81.1±7.21[abc]	23.32	84.69±8.91[bc]	20.95
North	98.53±8.75[a]	28.33	116.39±11.19[a]	28.79
L. S. D.	22.31		26.3	

Table 7: Average numbers and percentages of *P. pentagona* on different directions of pear trees at El-Beheira Governorate (Nubaria district) during two seasons, 2013/2014 and 2014/2015.

Direction	**1st season**		**2nd season**	
	Mean ±SE	% of the total population	Mean ±SE	% of the total population
East	63.21±7.22[a]	32.15	88.57±11.13[a]	30.96
West	35.75±4.52[c]	18.18	57.47±6.31[bc]	20.1
South	43.29±5.37[bc]	22.02	62.3±8.18[bc]	21.78
North	54.37±8[ab]	27.65	77.73±8.51[ab]	27.17
L. S. D.	18.08		24.46	

The value of angular deflection from the east site which apparently tended the highest density of population was 18°.74` and 25°.71` towards the north in peach trees through the 1st and 2nd seasons, respectively (Fig. 1). These results showed that East direction followed by North direction were preferred by the various stages of *P. pentagona* as distribution direction. In case of apricot trees the value of angular deflection from the north site which apparently tended the highest density of population was 38°.63` and 47°.44` towards the east site through the 1st and 2nd seasons, respectively (Fig. 2). Concerning pear trees these values of angular deflection were 21°.97` and 26°.38` from the east site towards the north (Fig. 3).

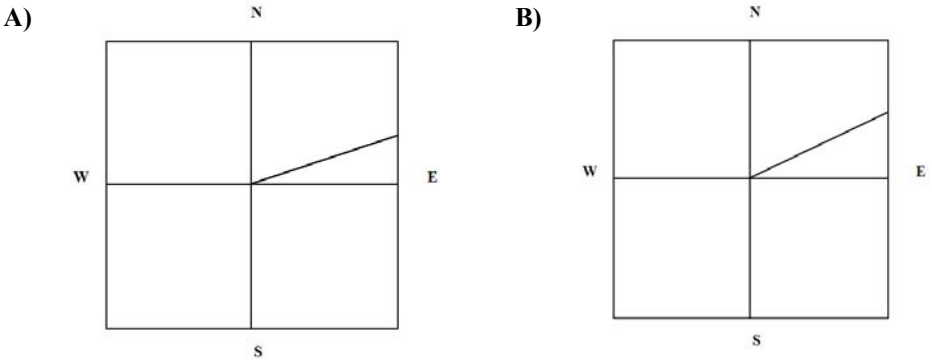

Fig. 1: Directional preference of peach trees by *P. pentagona*:
A) The 1st season of 2013/2014 at east northern 18° 74`
B) The 2nd season of 2014/2015 at east northern 25° 71`

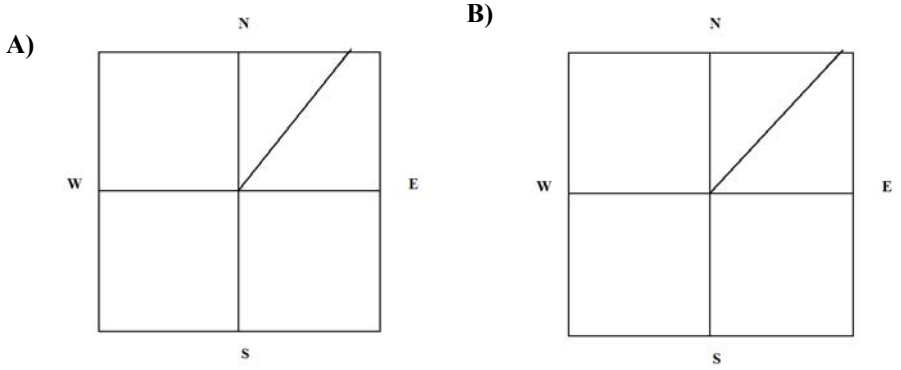

Fig. 2: Directional preference of apricot trees by *P. pentagona*:
A) The 1st season of 2013/2014 at north eastern 38° 63`
B) The 2nd season of 2014/2015 at north eastern 47° 44`

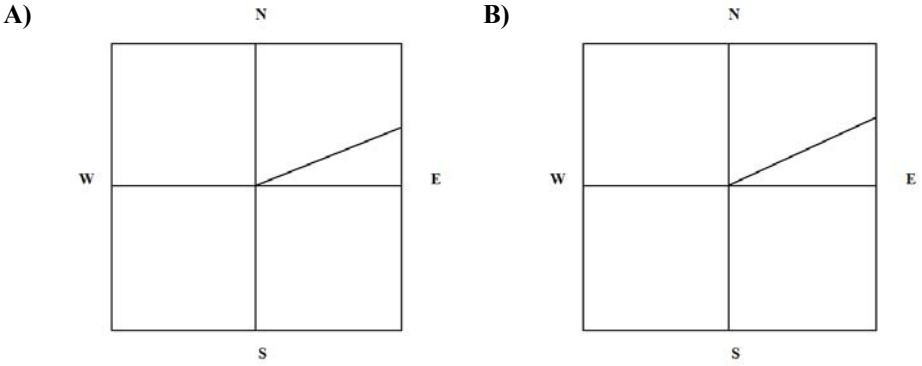

Fig. 3: Directional preference of pear trees by *P. pentagona*:
A) The 1st season of 2013/2014 at east northern 21° 97`
B) The 2nd season of 2014/2015 at east northern 26° 38`

These differences in their distributions might be attributed to the effect of the wind direction or the duration of trees exposure to the sun rays. Such deduction seems to be logic in the light of the fact of the angle of the sun, the insects on east and north sides will get more degree day accumulation than insects on west cardinal directions. These results are important in the development of pest control programs.

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ARABIC SUMMERY

حساسية بعض أشجار الفاكهة للإصابة بحشرة الخوخ القشرية البيضاء *Pseudaulacaspis pentagona* (Targioni-Tozzetti) مع بعض النواحي الايكولوجية لها

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أجريت هذه الدراسة في منطقة النوبارية في محافظة البحيرة خلال الفترة من شهر مايو 2013 الي شهر ابريل 2015 لدراسة حساسية أشجار الخوخ والمشمش والكمثري لحشرة الخوخ القشرية البيضاء. أوضحت النتائج ان هذه الأنواع الثلاث من أشجار الفاكهة غير مقاومة للحشرة. وأوضحت الدراسة أن أشجار الخوخ اعلي معنويا في حساسيتها للاصابة بهذه الحشرة يليها أشجار المشمش وأخيرا اشجار الكمثري. ومن خلال دراسة الوفرة الموسمية لتعداد الحشرة علي الثلاثة أنواع من أشجار الفاكهة تبين أن لهذه الحشرة أربعه أجيال سنوية متداخلة. كذلك تمت دراسة أنماط توزيع الحشرة في الإتجاهات الرئيسية الأربع للأشجار وتبين ان الإتجاه الشرقي هو الإتجاه المفضل للحشرة علي أشجار الخوخ والكمثري يليه الإتجاه الشمالي ثم الجنوبي ثم الغربي. بينما كان الإتجاه الشمالي هو المفضل للحشرة علي أشجار المشمش.