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Full Length Research Paper

First field evaluation of mass trapping system for males of the lesser date moth *Batrachedra amydraula* (Meyrick) (*Lepidoptera: Batrachedridae)* in sultanate of Oman

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The Lesser Date Moth (LDM) *Batrachedra amydraula* (Meyrick) causes serious damage to date palms in the Middle East. Yield losses up to 50% have been reported in some countries. The sex pheromone is now available and could be used for monitoring in addition to the biocontrol alternative method. A first mass-trapping trial targeting LDM males was set up in the Sultanate of Oman in 2014. Results showed that the pheromone blend tested was very attractive with a minimum of 60 days activity: a total of 22,283 males were captured on 132 traps all over the season, i.e. from March to June 2014. An attack percentage between 7 to 12.5% was recorded in fruit drop counts. Bearing in mind the presence of highly susceptible cultivars in this trial, these first results look very promising. In 2015, the tests will be repeated with modified technology in order to develop a management strategy including pheromone in LDM control.

Keywords: *Batrachedra amydraula,* Lesser Date Moth, pheromone, mass trapping.

INTRODUCTION

LDM is a very important pest of date fruits. The larvae feed on the small fruit after fruit setting, i.e. "Hababouk" stage. The larvae enter from the top between the three carpels inside the young fruit (photo 1 and 2). Each larva has its independent entry pore in the fruit and may attack from three to four fruits during its lifetime. Usually, each larva eats more than a third of the fruit and it may sometimes feed on the entire content and consume seed in varieties in which this is tender, leaving only the outer fruit skin. These infested fruits wither and are either suspended from the stalks by silk threads secreted by the larvae or they fall on to the ground.

Kinawy, (2012) mentioned that LDM, *B. amydraula* (photo 3), is present in all date-producing countries and has been recorded in Saudi Arabia, Egypt, Libya, Palestine, Kuwait, Bahrain, Iran, India, UAE and Oman. The damage may reach 50% of yield in certain countries (Waluid, 2006). El-Haidari and Al-Tigany, 1977 stated that the rate of infestation of the lesser date moth in Oman ranged between 1 to 15 %. Saaidi, 1992 demonstrated by survey that the lesser date moth insect is one of the main pests attacking the date fruits in Oman, and he added that the date varieties have different susceptibility to infestation by LDM. He noted that the variety "Khalas" is one of the most susceptible varieties.

Recent identification of the sex pheromone of *Batrachedra amydraula* (Meyrick) Lepidoptera: Batrachedridae Anat levi-zada et al (2011) and re-evaluation of the candidate phenomenal composition (Anat Levi-Sada et al., 2011) combined with a practical evaluation of traps was significantly promising for an evaluation of mass trapping LDM males as a biocontrol method.

MATERIAL AND METHODS

Preliminary test: Estimation of distance of attractivity

This test was conducted at the northern edge of block 1 of the field trial on sandy fallow land where the attraction

O	O	O	O	O	O	O	O	O	O	O	O	O	O
O	O	O	O	O	O	O	O	O	O	O	O	O	O
O	T	T	T	T	O	O	O	T	O	O	O	O	O
O	T	T	T	T	O	T	O	O	O	O	T	O	O
O	T	T	T	T	O	O	O	T	O	O	O	O	O
O	T	T	T	T	O	O	T	O	O	T	O	O	O
O	T	T	T	T	O	O	O	T	O	O	T	O	O
O	T	T	T	T	O	T	O	O	O	O	O	O	O
O	O	O	O	O	O	O	O	O	T	T	T	T	O
O	O	T	O	O	O	O	T	O	T	T	T	T	O
O	O	O	O	T	O	T	O	O	T	T	T	T	O
O	O	O	T	O	O	O	O	O	T	T	T	T	O
O	T	O	O	O	O	O	T	O	T	T	T	T	O
O	O	T	O	T	O	O	O	O	T	T	T	T	O

O: Tree without trap **T:** Tree with trap

Figure 1: Block Experimental Trial Design

of pheromone lure was exclusively from neighbouring date palm trees situated to the south in the presence of a regular north wind.

A two-metre iron pole supporting a delta trap lure with a pheromone capsule (1 mg load) with openings orientated north/south was placed on day 1 (19.02.2014), 10 metres from the border and moved 5 meters northwards each time captures were observed. A first capture was observed on 20/03/2014. At the last position, 35 meters from the first date palm line, no captures were observed after 5 days on27/04/2014.

Consequently, the distance of attractivity of the pheromone was estimated at a maximum distance of 30 meters.

Pheromone traps and experimental design

Location (photo 4)

The study was located in the Nizwa Ad-Dakhliyah region on a mature 25 year old plantation planted with various cultivars at a density of 100 palm trees/ha : 10 metres X 10 metres.

MATERIALS

Large plastic (LPD) orange Delta traps (Suterra LLCUSA) were delivered by Agrimatco (Agricultural Materials Company Muscat).

Pheromone blend

- Diene compound: (4z,7z)decadien-1-yl-acetate was synthesised by M2i LifeSciences, Lacq, France.
- Monoene compound : 5z decen-1-yl-acetate was manufactured by Novagrica Hellas, Athens, Greece.
- Pheromone dispensers were formulated by Novagrica Hellas on bromobutyl septa loaded at 1 mg of the diene/monoene mixture 1/2 ratio.

Experimental design

The first target of the trial was to determine the optimum trap density: 2 blocks were selected in the plantation (Figure 1).

- 1) in front of factory (block 1)
- 2) in front of department(block 2)

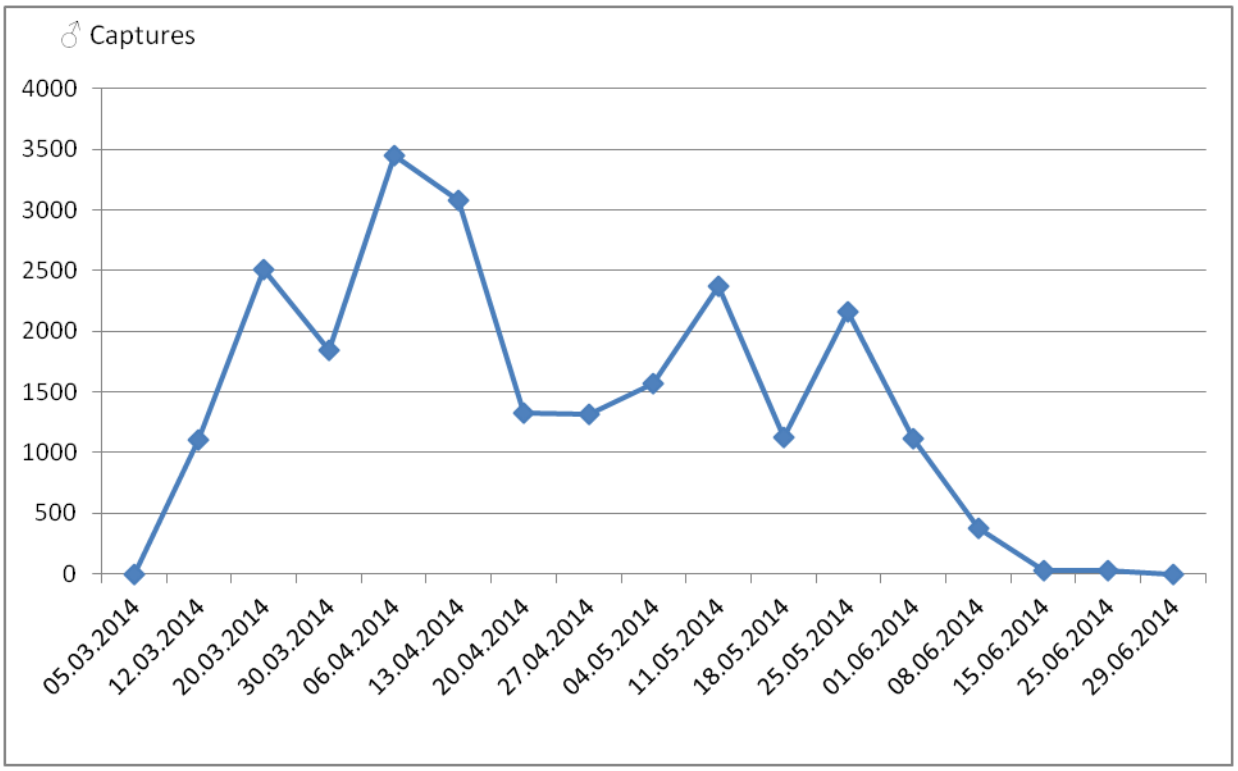
In each block the 2 external lines East/West and North/South were left untreated.

Each block contained 12 lines of 12 palms (approx 1.5 hectares), i.e. 144 trees and 24 palm trees per plot. The distance between the blocks was approximately500 meters.

A completely randomised design was used with 2 replicates per block:

- T1R1 – T1R2 =1 trap / tree (24 trees per plot)
- T2R1 – T2R2 =1 trap / 4 trees (24 trees per plot)
- T3R1 – T3R2 =1 trap / 8 trees (24 trees per plot)

Traps were placed at a height of 2 meters and fixed to



A first peak of population was observed during 1st week of April.
A second peak occurred around 3rd week of May.
The first generation peaked 4 weeks after the first emergence.
Up to 5th May, when the new capsules were installed, the first capsules remained attractive and remained persistent for more than 60 days.

Figure 2: Batrachedra flight curb

the palm trunks in order to be N/S wind-orientated. Each palm tree and each trap was individually numbered in each block.

The cultivar (variety) was specified for each tree. Traps and first capsules were placed on 5/03/2014. Capsules and sticky sheets were replaced on 5/05/2014.

Assessments

- **Captures:** LDM males trapped were counted each week from 20.03.2014 to 29.06.2014.

- **Damage:** On 4 central trees on each plot, fallen fruits were collected and the number of attacked fruits was assessed.

Dates of collection:
Early attacks 20.04.2014
Late attacks 03.06.2014

Statistical analyses

For capture data, responses to the trap density were compared using a paired t test if analysis of variants ANOVA showed significant differences. A significant level of 5% was used for all statistics.

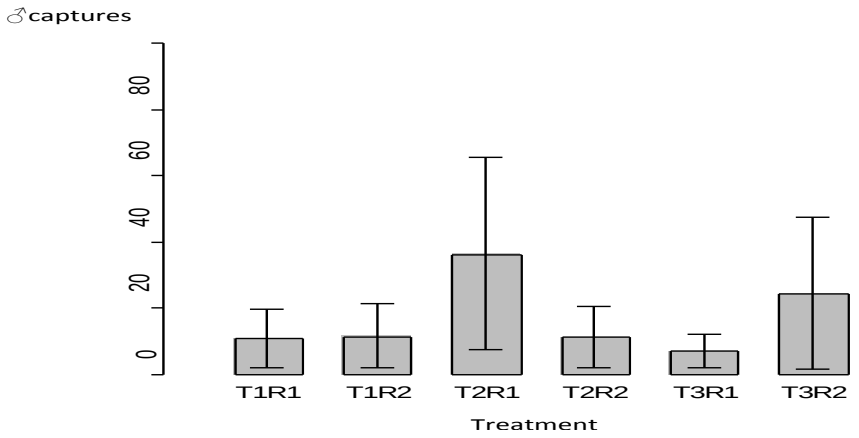
RESULTS

Captures (Table 1 in annex)

A total of 22,283 LDM males were trapped during the season :
- 13,745 in Block 1
8,538 in Block 2 (Figure 2)

Trap Density

A very high population situation was observed, and the data obtained did not present a normal distribution.
ANOVA with Welch correction (one way analysis of means, not assuming equal variances), showed that T2R1 and T3R2 plots obtained more captures than other plots (figure 3, 4).



Plot	Average	s.d.
T1R1	10.80000	8.760300
T1R2	11.60000	9.507891
T2R1	36.40000	28.984725
T2R2	11.26667	9.176575
T3R1	7.00000	4.913538
T3R2	24.40000	22.815408

Figure 3: Average ♂ captures observed : standard deviation (s.d.)

Treatment	diff	lwr	upr	p.adj
T1R2-T1R1	0.8000000	-16.7862898	18.386290	0.9999940
T2R1-T1R1	25.6000000	8.0137102	43.186290	0.0007740
T2R2-T1R1	0.4666667	-17.1196232	18.052957	0.9999996
T3R1-T1R1	-3.8000000	-21.3862898	13.786290	0.9884411
T3R2-T1R1	13.6000000	-3.9862898	31.186290	0.2241992
T2R1-T1R2	24.8000000	7.2137102	42.386290	0.0012393
T2R2-T1R2	-0.3333333	-17.9196232	17.252957	0.9999999
T3R1-T1R2	-4.6000000	-22.1862898	12.986290	0.9729261
T3R2-T1R2	12.8000000	-4.7862898	30.386290	0.2858210
T2R2-T2R1	-25.1333333	-42.7196232	-7.547043	0.0010199
T3R1-T2R1	-29.4000000	-46.9862898	-11.813710	0.0000728
T3R2-T2R1	-12.0000000	-29.5862898	5.586290	0.3566797
T3R1-T2R2	-4.2666667	-21.8529565	13.319623	0.9805460
T3R2-T2R2	13.1333333	-4.4529565	30.719623	0.2589769
T3R2-T3R1	17.4000000	-0.1862898	34.986290	0.0541657

Figure 4: Turkey multiple comparisons of mean captures 95% confidence level

CONCLUSION

The number of captures in T1R1 and T3R2 were significantly different whether the distribution was normal or not : Plots T1R1 = T3R2 > all other plots

Cultivar comparison

A test of comparison was performed for 2 varieties: cv. Khalas (designated as one of the moderately susceptible cultivar to LDM attacks and cv. Naghal, as one of the

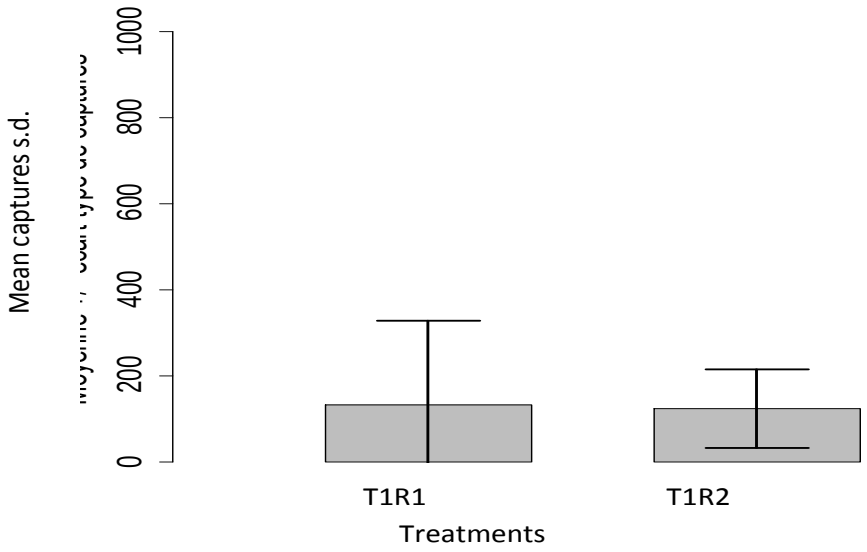


Figure 5: ANOVA test for T1R1 and T1R2 captures

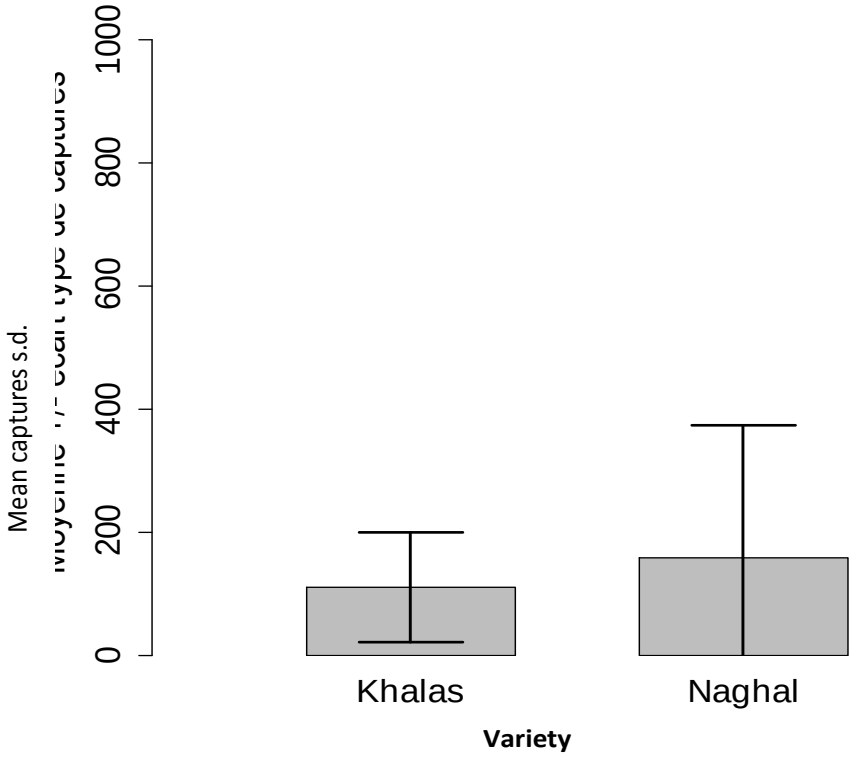
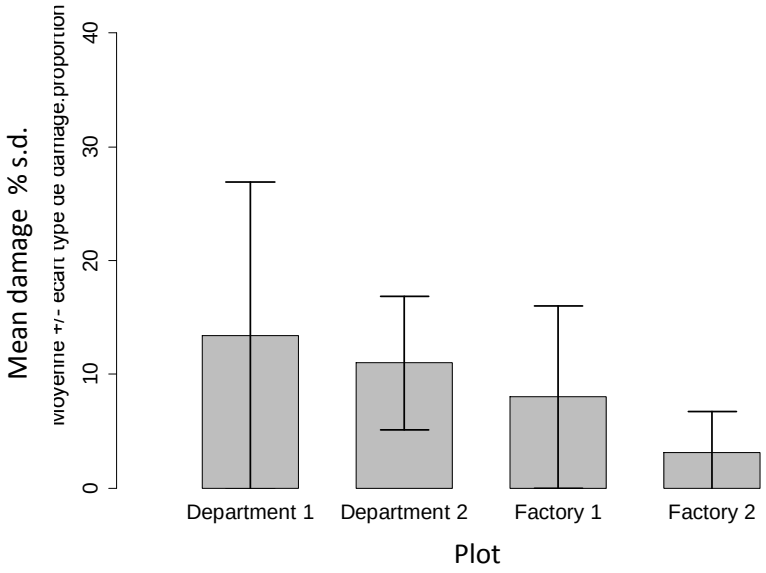


Figure 6: ANOVA test for cultivar attractivity

widespread variety in Oman. T1R1 and T1R2 plots (one trap per tree) were compared (these two plots contained a total of 31 Khalas and 17 Naghal trees).

T1R1 and T1R2 ANOVA tests for captures showed no significant difference at 5% (cf. Figure 5).

ANOVA test for varieties showed no significant difference in number of captures for Khalas and Naghal (Figure 6).



1. Early damage
2. Late damage

Figure 7: Damage: ANOVA test for damage in blocks

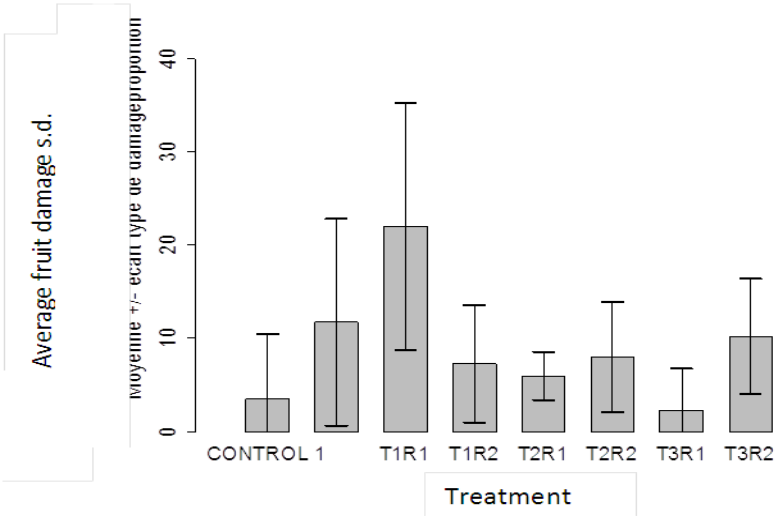


Figure 8: ANOVA damage test in treatment plots

Damages (see Table 2 en annex)

"Controls"

Controls 1 and 2 were placed on the northern border and concerned 4 central trees positioned at $^{1}/_{3}^{rd}$ and $^{2}/_{3}^{rd}$ on the line.

These two controls might not be considered as standards in the trial design. They showed a very low level of damage when compared with other treatments, which suggests some kind of disorientation or confusing effect in the immediate neighbourhood of the treated plots.

Damage Assessment

ANOVA test on blocks was not significant at 5%, even if block 2 was less attacked than block 1 (Figure 7).

ANOVA tests on treatments were significant at 5% for T3R1 compared to T1R1 (Figure 8).

DISCUSSION

The primary goal of the field trials was to confirm the attractivity of the pheromone binary blend:

4z, 7z -12 Ac / 5z – 10Ac, 1:2 in capsules loaded at 1 mg per unit.

A high activity was demonstrated for Novagrica caps placed in Delta sticky traps hung at a height of 2.8m in date palms.

The persistence of attractivity was confirmed for more than 2 months in Oman field conditions.

The LDM biological cycle showed 2 generations with peaks in mid – April and mid-May. Infestation observed during the trials was very high taking into consideration the total number of captures.

The attractivity of common cultivars Khalas and Naghal was shown to be equivalent.

Surprisingly, damage assessment tests indicated that the lowest trap density T3R1 (one trap for 8 trees) showed consistently less damage than the highest trap density T1R1 (1 trap per tree).

It may be considered that there was an indication of "confusing" effect in the field trials, despite the very high population observed.

These results will be useful for both monitoring and biocontrol strategies against LDM in middle east conditions in future.

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LDM CAPTURES

ANNEXES : Table 1

		T1R1		**T1R2**		**T2R1**		**T2R2**		**T3R1**		**T3R2**			
NIZWA 1		3874		4189		3255		1014		318		1095			**13745**
NIZWA 2		2070		2427		2736		359		698		248			**8538**
															22283
NIZWA 1															
T1R1	441	462	659	601	284	257	298	245	113	272	171	56	13	2	0	**3874**
T1R2	332	168	671	711	247	282	404	434	201	465	188	70	10	6	0	**4189**
T2R1	382	183	562	510	218	250	201	268	102	292	232	48	4	3	0	**3255**
T2R2	62	53	145	144	49	57	79	81	44	182	95	23	0	0	0	**1014**
T3R1	33	27	39	46	16	23	37	33	10	21	22	11	0	0	0	**318**
T3R2	144	54	248	136	49	45	57	89	23	138	44	68	0	0	0	**1095**
	1394	**947**	**2324**	**2148**	**863**	**914**	**1076**	**1150**	**493**	**1370**	**752**	**276**	**27**	**11**	**0**	**13745**
NIZWA 2																
T1R1	298	190	227	227	88	121	105	301	182	197	93	31	0	10	0	**2070**
T1R2	446	305	362	298	74	75	136	293	160	183	72	21	2	0	0	**2427**
T2R1	163	216	315	277	187	136	166	516	239	310	170	37	0	4	0	**2736**
T2R2	58	85	46	48	11	14	14	25	20	21	13	4	0	0	0	**359**
T3R1	97	55	145	56	90	50	54	59	18	54	13	4	3	0	0	**698**
T3R2	53	45	27	27	9	6	15	28	10	20	6	2	0	0	0	**248**
	1115	**896**	**1122**	**933**	**459**	**402**	**490**	**1222**	**629**	**785**	**367**	**99**	**5**	**14**	**0**	**8538**

Σ	2509	1843	3446	3081	1322	1316	1566	2372	1122	2155	1119	375	32	25	0	**22283**
Date	20.03.14	30.03.14	06.04.14	13.04.14	20.04.14	27.04.14	04.05.14	11.05.14	18.05.14	25.05.14	01.06.14	8.08.14	15.06.14	25.05.14	29,06,14	

ANNEXES : **Table 2:** Damaged fruit assessments

NIZWA PLOT 1			**NIZWA PLOT 2**			
27.04.2014			**Date**	**27.04.2014**		
Plot in front of the Department				**lot in front of the Factory**		
Damaged fruit	**Physiological Drop**	**Total**	**Trial**	**Damaged fruit**	**Physiological Drop**	**Total**
9	14	23	**T1R1**	8	31	39
1	30	31	**T2R1**	2	25	27
2	20	22	**T3R1**	0	16	16
1	25	26	**T1R2**	11	76	87
2	19	21	**T2R2**	0	18	18
8	46	54	**T3R2**	12	63	75
0	25	25	**CONTROL 1**	0	31	31
18	50	68	**CONTROL 2**	3	39	42

3.06.2014			**Date**	**3.06.2014**		
Plot in front of the Department				**Plot in front of the Factory**		
Damaged fruit	**Physiological Drop**	**Total**	**Trial**	**Damaged fruit**	**Physiological Drop**	**Total**
5	21	26	**T1R1**	4	48	52
3	30	33	**T2R1**	1	20	21
0	17	17	**T3R1**	0	21	21
2	14	16	**T1R2**	0	50	50
3	19	22	**T2R2**	2	24	26
2	32	34	**T3R2**	1	24	25
5	31	36	**CONTROL 1**	0	34	34
4	25	29	**CONTROL 2**	0	43	43

ANNEXES : PHOTOS

Photo 1 : Batrachedra larva

Photo M.M. Kinawy
Photo 3 : Batrachedra moth

Photo M.M. D. Kinawy

Photo 2: Batrachedra damage

Photo M.R.Guillon
Photo 4: Field Trial