White flies and their natural enemies



Moshe cohen

Bio-bee Sde Eliyahu Ltd.

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White flies and their natural enemies:

Two species of whiteflies. Attack flowers and vegetables crops:

***1.Bemisia tabaci*.**

2.Trialeurodes vaporariorum.

Bemisia tabaci

Trialeurodes vaporariorum

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Our Goal is:

Pest identification under field conditions using practical methods

Why the distinction between the two species in a crop is of significance?

1. **Use only magnifying glass (no ‘lab’ binocular)**
2. **Use the correct chemical for control of the pest after appropriate identification**
3. **Choose the right beneficial**
4. **Choose a selective chemical for controlling the target pest while not harming the beneficial**

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Our Goal is:

5. To know the correct relationships between the pest and the beneficial in order to prevent crop damage

6. Some pests do not have biocontrol agents. Hence we have to find pesticides that are compatible with other biocontrol agents

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Bemisia tabaci classification

Order - Hemiptera.

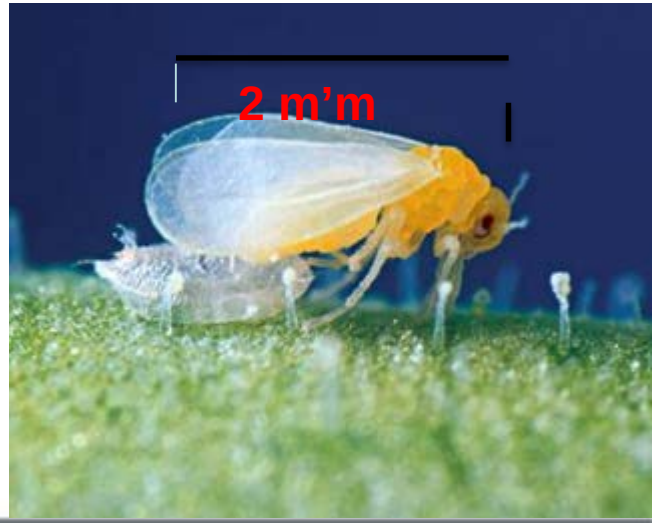
Family - Aleyrodidae.

Genus - *Bemisia*.

species - *Bemisia tabaci*.

Very large host range.

Can cause problems at high temperatures.



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Bemisia tabaci data

Direct damage - Sucking the phloem

Indirect damage – Deposition of honey dew and sooty mold

Transmits more than 100 viruses

Carries broad mites onto some plants

Bemisia tabaci direct damage

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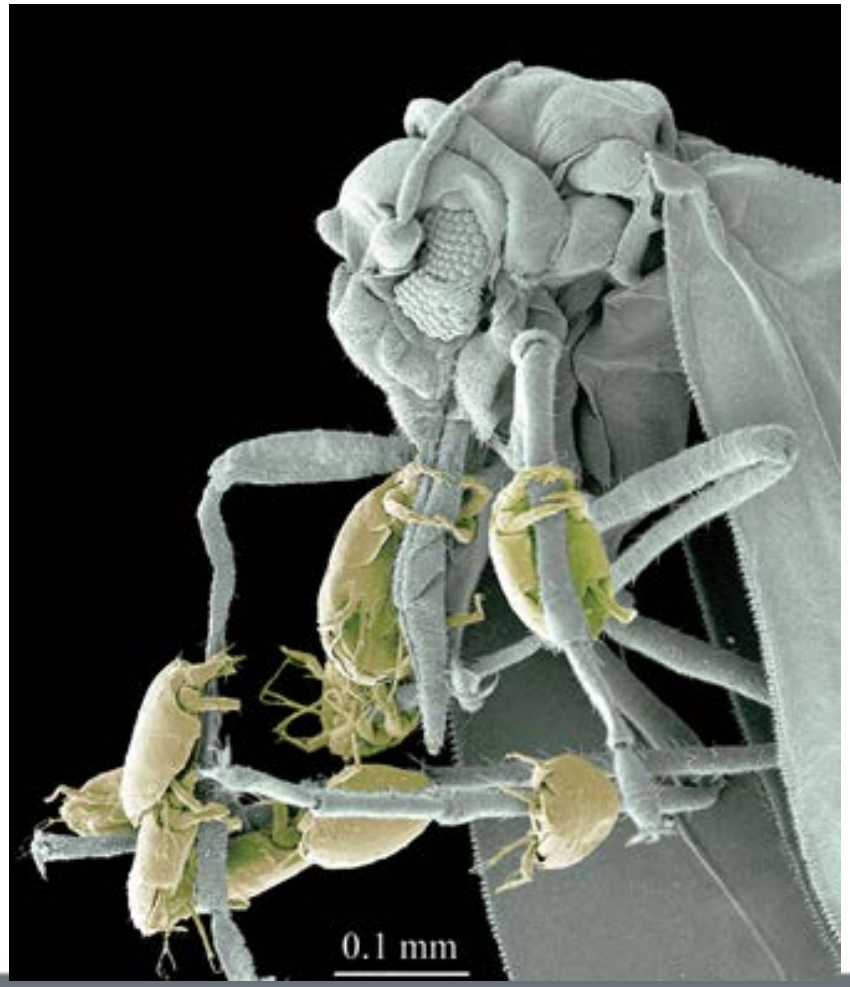
Honeydew cause sooty mould
inhibit photosynthesis

Broad mites carried on *Bemisia* legs.



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Bemisia tabaci indirect damage

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- Tomato Yellow Leaf Curl Virus (TYLCV)
- Tomato Torrado Virus (TTV)
- Tomato Chlorosis Virus (ToCV)
- Tomato Mottle Virus (ToMoV)
- Tomato Yellow Vein Streak Virus (ToYVSV) from Brazil

Tomato yellow leaf curl virus (TYLCV)

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Bemisia tabaci data:

4 larval stages – prepupa – pupa.

Laying eggs in a circle form while feeding on the underside of the leaf.

Very large host range.

Tolerant to high temperatures.

There are 24 *B. tabaci* biotypes of which 4 strains are known for resistance to different pesticides.

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Bemisia tabaci data:

In Israel there are at least 3 strains: A, B and Q

Q strain is known to be resistant to pesticides in particular the Neonicotinoids' group.

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Bemisia tabaci

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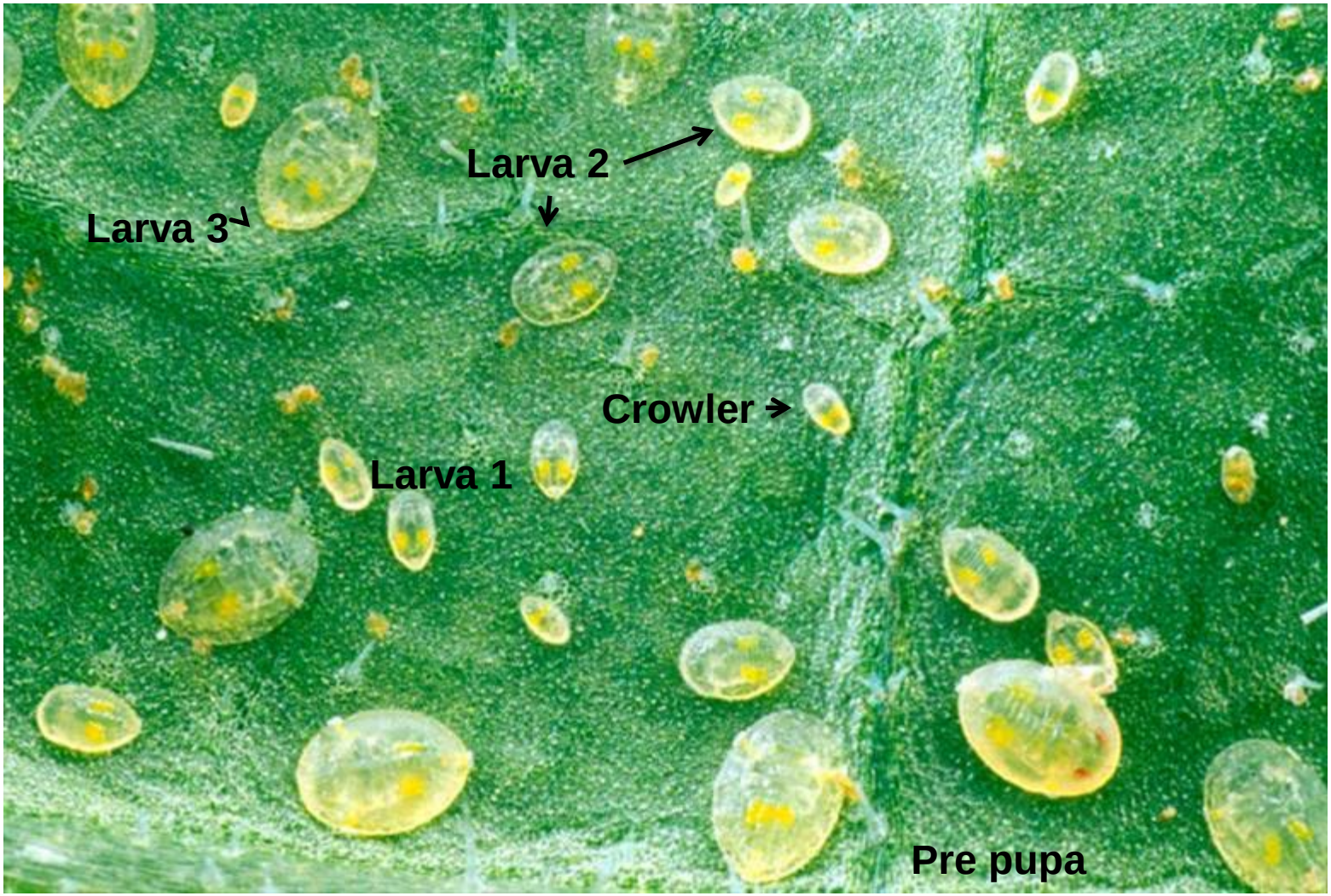
Bemisia tabaci



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Bemisia tabaci development

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Temperature	16˚	19˚	22˚	25˚	28˚
Egg - adult	137.2	66.8	38.7	37.9	23.2
Lifespan female	50.8		21.8		16
Number of eggs per female	60.2		90.9		96.3

Population growth of *B. tabaci* on Poinsettia

Temperature (^{0}C)	16	19	22	25	28
Development time (days)					
egg	34.3	17.6	12.7	10.5	7.8
Egg - adult	137.2	66.8	38.7	37.9	23.2
P.o – period (days)	4		3		2.2
Lifespan female	50.8		21.8		16

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Population growth of *B. tabaci* on Poinsettia

Temperature (^{0}C)	16	19	22	25	28
Mortality (%) Egg	19.3	9.2	2.1	1	2.8
Mortality(%) Egg - Adult	95	60.4	60.6	39.3	6.1
Sex ratio (% female)	60	63	69	79	
Number of eggs per female	60.2		90.9		96.3

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Trialeurodes vaporariorum

One of the main pests in greenhouses in temperate areas.

Can be a problem throughout the year.

Highly polyphagous.

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Life cycle of *T. vaporariorum*

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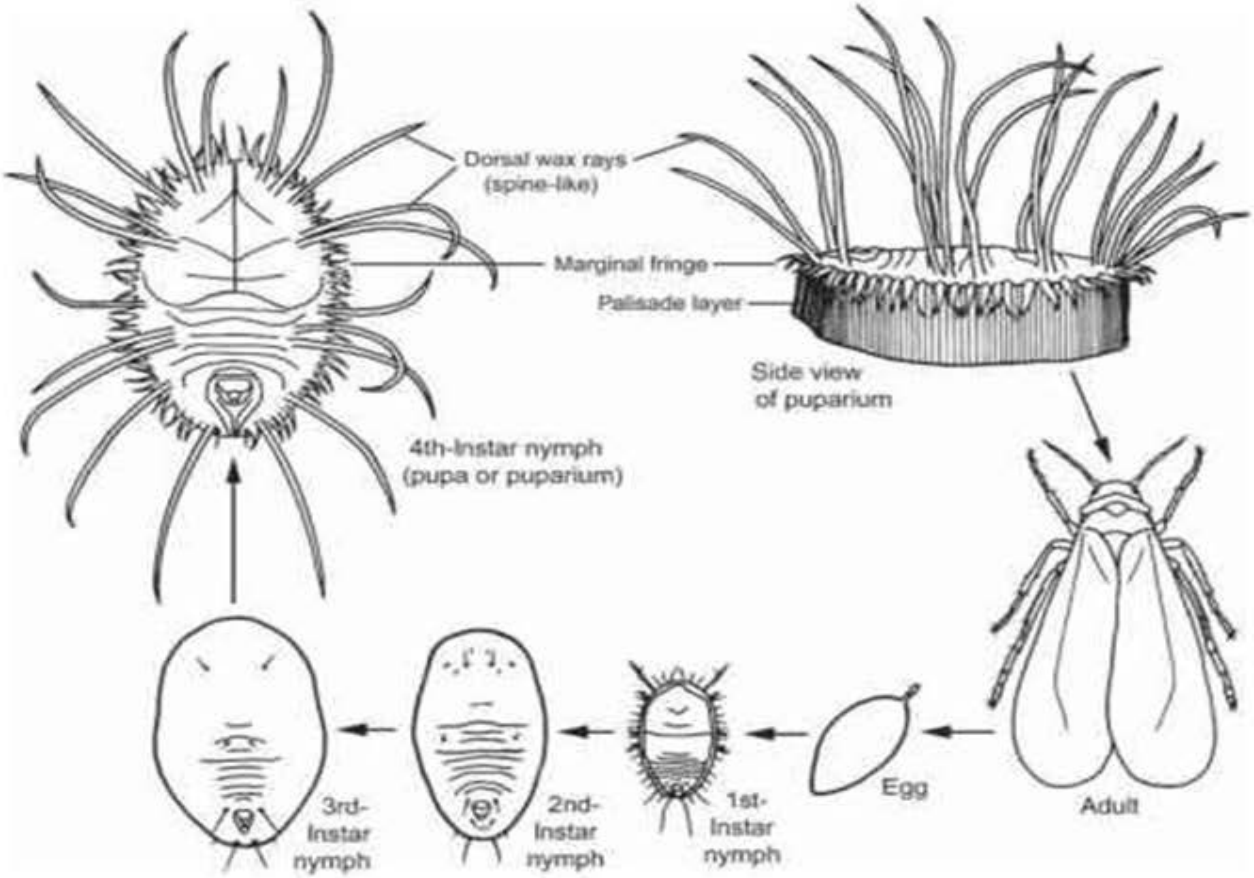

Trialeurodes vaporariorum

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- **Females can lay up to 400 egg and can live as long as 2 months**
- **Eggs hatch after 5 to 7 days**
- **Generation turnover every 30 to 45 days**

Trialeurodes vaporariorum

Eggs are fixed to the leaf with the help of a short hook (same as in *Bemisia*)

Eggs turn brown to black

Eggs are covered with a kind of waxy powder from the female wings

During the night female stop laying eggs

T. vaporariorum can also transmit viruses

Tomato infectious chlorosis virus (T.I.C.V) is transmitted only by *T. vaporariorum*

Tomato chlorosis virus (T.O.C.V).

TYLCV is not effectively transmitted by *T. vaporariorum* as by *B. tabaci*

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Trialeurodes vaporariorum

Temperature (ºC)	15	20	25	Crop
Development time egg-adult (days)	58.4	33.7	21.7	Gerbera
Survival (%)	94.9	85.8	89.7	Gerbera
Lifespan (days) Female			26	Gerbera
Number eggs per female			130	Gerbera
Number eggs per female per day			5	Gerbera

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Differences between the two species

Appearance	*Trialeurodes vaporariorum*	*Bemisia tabaci*
Developmental stages		
eggs	**1 – 2 day white, later dark brown to black**	**Light yellow – green, later light brown**
larva		
pupa		

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Differences between the two species

Differences	*Trialeurodes vaporariorum*	*Bemisia tabaci*
Adult	Larger than B.t. Appears whiter with more wax	Smaller than T.v. Appears yellower due to lesser wax
Adult		
Optimal development temp' for population	20 – 25 °c	25 – 30 °c
Lifespan	Relatively short, particularly at high temperatures	Longer than T.v. good survival at high temperatures
Distribution over the plant	On the top of the plant	Distributed over the plant

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Differences between the two species

Differences	*Trialeurodes vaporariorum*	*Bemisia tabaci*
Damage	Aesthetic damage and reduced yield due to honeydew and feeding damage	Aesthetic damage and reduced yield due to honeydew and feeding damage. Small population can transmit virus
Resistance to pesticides	Less resistant	Highly resistant
Compatible chemicals (safe for beneficials)	Buprofezin, Pyriproxyfen, Flonicamid, Metronom, Pymetrozine	The same

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Whitefly adult:

Bemisia tabaci

Trialeurodes vaporariorum

Video movie

Natural enemies of whiteflies

The most important natural enemies of whiteflies

***Encarsia Formosa* – *a* parasitoid (for *T.v*)**

***Eretmocerus mundus* – a parasitoid (for *B.t*)**

***Amblyseius swirskii* – a predatory mite**

***Orius laevigatus* – a predatory bug**

***Macrolophus pygmaeus* – a Mirid bug (not suitable to hot climate)**

***Nesidiocoris tenuis* – a Mirid bug**

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Natural enemies of whiteflies

Amblyseius swirskii - the predatory mite

A. swirskii **preys on spider mite**

A. swirskii **colony on the underside of the leaf**

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Natural enemies of whiteflies

A. swirskii preys on Whitefly and Thrips

Preys on whitefly eggs

A. swirskii egg

Preys on whitefly larva

Preys on thrips larva 1

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Natural enemies of whiteflies

A. swirskii, more

A. swirskii feeding on *Bemisia* larva

A. swirskii colony (eggs and adults).

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Natural enemies of whiteflies

A. swirskii characteristics :

- Optimal temp. range for development 25 - 28°c
- Lifespan (egg – adult) at 25 - 28°c is 5 – 6 days
- Adapted to high temp. and high humidity
- Inactive at temp. below 15°c
- Laying 2 eggs per day under optimal conditions (food, temp., humidity).
- Feeding on pollen in crops like Gerbera, sweet pepper
- Doesn't develop on the tomato plant

Natural enemies of whiteflies

Amblyseius swirskii :

- **Feeds on thrips larva stage 1 only**
- **Predation rate per day at 25°c - 5 individuals**
- **Controls whiteflies – eggs and crawlers.**
- **Whitefly honeydew is repulsive**
- **Can feed on and control red spider mites.**
- **Application: BioSwirski is packed in a 1 liter container with at least 50,000 individuals mixed with bran and the prey mite *Carpoglyphus lactis***
- **Small bag (sachet) for slow release. Contains initially 250 – 500 individuals**

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Video movie

Natural enemies of whiteflies

Encarsia formosa

- **An effective parasitoid of *T. vaporariorum***
- **Prefers to parasitize third and fourth instar larva and feed on second instar larva**

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Natural enemies of whiteflies

Encarsia formosa

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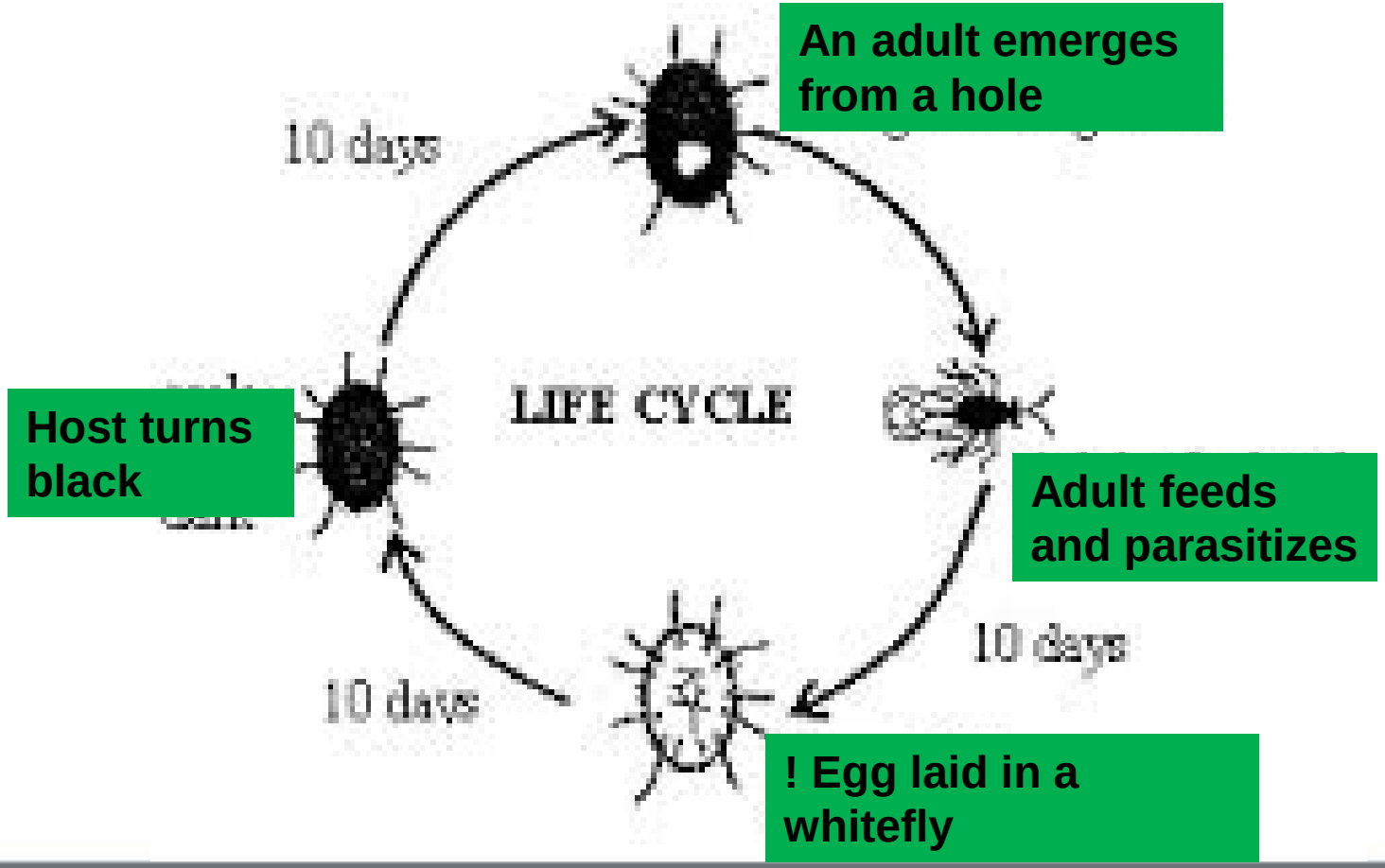
Natural enemies of whiteflies

Encarsia formosa life cycle



Natural enemies of whiteflies

E. formosa life cycle and appearance

The development of E. f consists of six stages: egg, three larval instars, a pupa and adult wasp

All stages except the adult are found inside the host

The female prefers to lay eggs in third and young fourth instar larva but can deposit her egg in any larval stage (chance of success)

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Natural enemies of whiteflies

E. formosa life cycle and appearance

Female can lay 150 eggs. Under optimal conditions, 5 – 15 eggs per day
Optimum temp. range for the parasitoid's activity: 20 - 25°c
At temp. 30°c female lives only a few days
Host feeding – number of larvae eaten per day 2 – 3
The honeydew impedes the wasp
Can search and fly long distances

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Video movie

Natural enemies of whiteflies

Eretmocerus mundus – parasitoid of *B. tabaci*

Adult

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Natural enemies of whiteflies

***E. mundus* adult in an egg laying posture**

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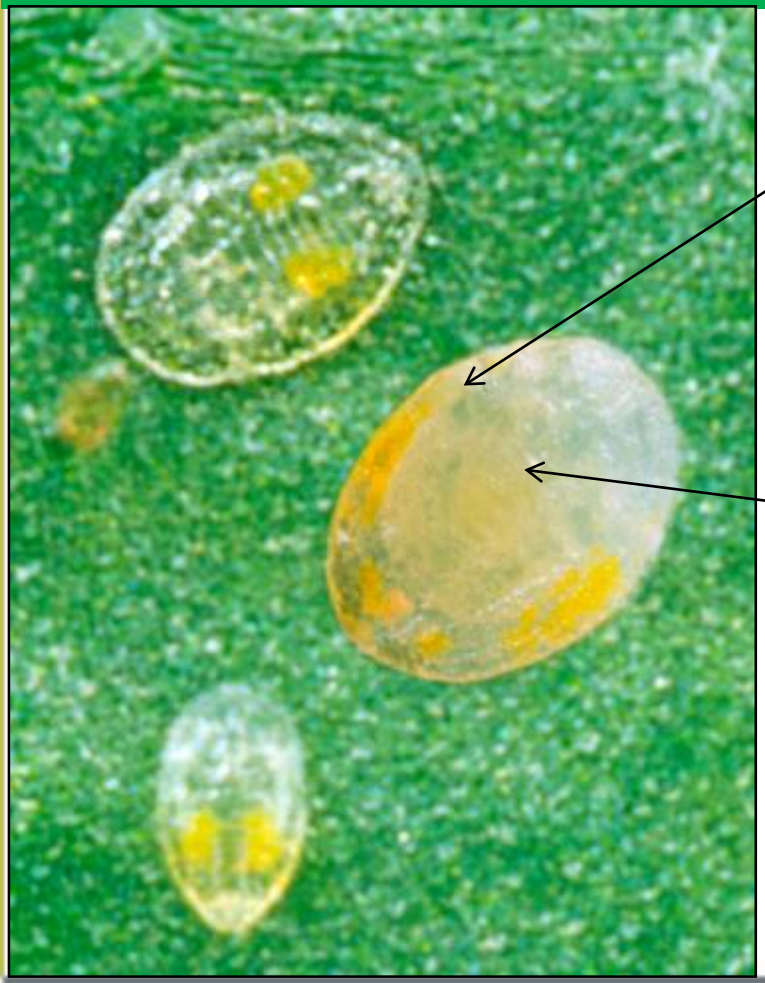
Natural enemies of whiteflies

E. mundus active parasitism signs



Bacteriosom disintegrates to body edge

White yellow turbidity

Bemisia 3rd instar larva parasetised by *E. mundus*

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E. mundus - pupae

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E. mundus pupa and adult emergence hole

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Difference between parasitized pupal skin to none parasitized

Form of emergence hole

Pupal skin color

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Encarsia species in Israel:

***E. lutea* larvae**

***E. sofia (=transvena)* pupa**

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BioNesidiocoris®

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the predatory bug *Nesidiocoris tenuis*

Nesidiocoris tenuis identification

Antennae with zebra pattern black and grey

Base of the head black collar

Filmy wings

Leaf (heart) mark on the wings

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Nesidiocoris tenuis biology

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- Solanaceae plant preference
- Development depends on temp. and photoperiod
- Optimal temp. range: 20-30˚C
- Female lays 79 eggs at 20˚C
- Located at the top of the plant
- Omnivorous, zoophytophaghe type (preventive application)

Nesidiocoris tenuis Biology

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Disadvantage:

Feeding on plant sap, might cause damage.

The bug's tendency to feed on tomato depends on prey to predator ratio and environmental conditions

Visible ring like damage on stems

Slow establishment period 4-8 weeks after release

From literature: development time

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Table 3 Nymphal development (mean ± SE) in days, proportion of mortality and sex ratio (proportion of females) for *Nesidiocoris tenuis* at different temperatures

Temperature (°C)	N	Development time	Mortality	Sex ratio
15	54	55.9 ± 0.37 a	0.372	0.463
20	48	21.2 ± 0.39 b	0.183	0.396
25	57	12.9 ± 0.36 c	0.065	0.526
30	52	9.7 ± 0.38 d	0.133	0.608
35	31	8.6 ± 0.49 e	0.483	0.645
40	142	nd	1.000	-

Mean values followed by the same letter are not significantly different, Bonferroni test $P > 0.05$.
nd, no development.

Need to control Nesidiocoris when more than 5 is found per plant

Need to reduce population of Nesidiocoris when damage occur.

Release rates

- **Introduce *Nesidiocoris tenuis* after planting**

Natural enemy	Mode of release	Rate	Interval	Frequency
Nesidiocoris tenuis	Preventive	0.5/m²	2 wk	2x
	Curative light	1/m²	2 wk	2x

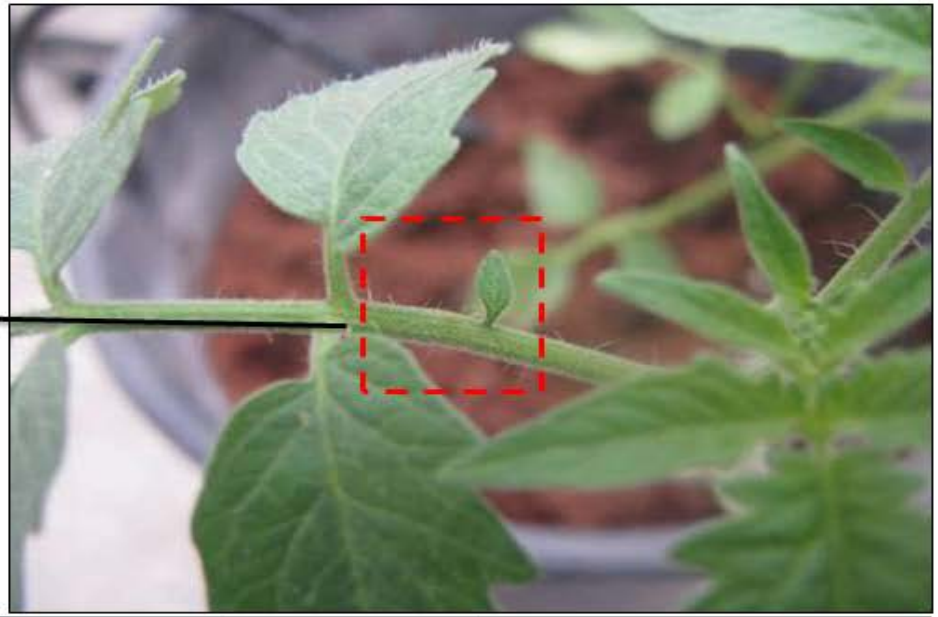
- **Introduce *Nesidiocoris tenuis* at the nursery**

Advantage:

- **Quick establishment**
- **Lower quantity needed**

Nursery strategy (continued)

Nursery strategy (continued)



Climatic condition	BioNesidiocoris®	Rate	Food addition	Release time before planting
High temperature	Young adults	1/5 plants	2 times	1 week
Low temperature	Young adults	1/2 plants	3 times	10 days

Compatible chemical

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Un limited use within I.P.M	Harmless < 25% Reduction	1
Consultation	Slightly harmful 25% - 60%	2
Consultation	Moderately harmful - 60% - 98%	3
Forbiden for use within I.P.M	Harmful - 98% - 100% reduction	4

Nesidiocoris chemical list

Trade name	Active ingredient	Stage	Dosage (%	Direct	Indirec	Residue in da	Residue in week	Pest/ Desease
Agrimec/ acrimactin	Abamectin 18% EC	Adult / Nymph	0.05	3	2		1	Spider mites
Agrimec/ acrimactin	Abamectin 18% EC	Adult / Nymph	0.1	4	4		2	Spider mites
Aligator/ Milbeknok	Milbemectin 9.3g/l EC	Adult	0.1	1				Spider mites
Apolo	Clofentezine 50g/l SC	Adult / Nymph	0.04	1				Spider mites
Baroqe / Spider	Etoxazole 110g/l SC	Adult / Nymph	0.025 - 0.03	1				Spider mites
Defender / Scelta	Cyflumetofen 215g/l SC	Adult/ nymph	0.1	1				Spider mites
Envidor	Spirodiclofen 240g/l SC	Adult / Nymph	0.04	1				Spider mites
EOS	Mineral Oil	Adult / Nymph	1%	1				Spider mites
Exmite / Kenemite	Acequinocyl 150g/l SC	Adult / Nymph	0.2 - 0.25	1				Spider mites
Floramite	Bifenazate 240g/l SC	Adult / Nymph	0.05 - 0.1	1				Spider mites
Masai	Tebufenpyrad 20% WP	Adult/Nymph	0.1	2	1		2	Spider mites
Maytkline	Pyrimidifen 100g/l SC	Adult/Nymph	0.5	1				Spider mites
Mercur/ Polo	Diafenthiuron	Adult/ nymph	0.25	3	2			Spider mites
Metaor	Fenpyroximate 5% SC	Adult/Nymph	0.15	1				Spider mites
Milbeknok	Milbemectin 9.3g/l EC	Adult/Nymph	0.1	1				Spider mites
Movento	Spirotetramat 100g/l SC	Adult/ nymph	0.04 - 0.1	1				Spider mites
Nexstar	Pyridaben 200g/l EC	Adult/Nymph	0.1	2		3		Spider mites
Nimgard	Neem oil 97% OL	Adult/Nymph	1%	1				Spider mites
Nissuron/Volcan	Hexythiazox	dult/Egg/Nym	0.04 - 0.05	1				Spider mites
Oberon	Spiromesifen 240g/l SC	Adult/Eggs	0.06 - 0.1	1				Spider mites
Omaite	Propargite 570g/l EC	Adult/Nymph	0.1	1				Spider mites
Pegasus	Diafenthiuron 250g/l SC	Adult/ nymph	0.25	3	2			Spider mites
Pelictran/ Acrital	Cyhexatin 600g/l SC	Adult/Nymph	0.05 - 0.1	1				Spider mites
Peropal	Azocyclotin 25% WP	Adult/Nymph	0.05	1				Spider mites
Pirat / Secure	Chlorfenapyr 240g/l SC	Adult/Nymph	0.05 - 0.06	4	3		2	Spider mites
Procleim	Emamectin Benzoate 19.2 EC	Adult/Nymph	0.04 - 0.05	4	2	1 - 3		Spider mites
Tamar tec	Plant oil	Adult/Nymph	3%	1				Spider mites
Tedion	Tetradifon 80g/l EC	dult/Egg/Nym	0.1 - 0.2	1				Spider mites
Torque /Tonto	Fenbutatin Oxide 550g/l SC	dult/Egg/Nym	0.1 - 0.15	1				Spider mites

Other Natural enemies of whiteflies

Delphastus pusillus

Macrolophus

Orius spp.

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Thank you for your attention