PRESENTATION BOOKLET OF SIMPLIFIED METHODS FOR THE **MONITORING OF FUNCTIONAL BIODIVERSITY** IN ORGANIC ORCHARDS

2019

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Purpose of the monitoring methods:

- **Familiarize producers with the simplified observation of beneficials**
- **Raise the awareness of producers to the natural regulations that are occurring in their orchards**
- **Engage the adaptation of plant protection practices in order to optimize these regulations**
- **When possible, observe the effect on biological control of agroecological infrastructures implemented in the orchard over space and time**
- **The state of the art does not provide threshold values of natural enemies as decision support for immediate pest management measures as pesticide application**

Purpose of evaluation of monitoring techniques

- Co-define the criteria that have to be met so that the methods can be used by the farmers and advisors
- Refine the proposed protocols for the different methods : Determine the respective advantages and the flaws of monitoring methods and their protocols and refine the protocols accordingly
- Bring out and build on the assessment of the farmers about the methods

Method :

Four monitoring methods have been selected by the EcoOrchard project after literature review and initial testing. Each producer in the EBIONET network is offered to choose one or more monitoring method among the four presented in this booklet and additional methods suggested by the stakeholders during the national workshops. The list with the additional methods are in the report of the workshop, the organizers should be available to provide protocols for these methods (for that purpose, it is possible to contact ***[put the name and contact of the national coordinator]).*** The producers and advisors will apply the method(s) in the orchards they work in. The purpose is to familiarize with the monitoring of the main beneficials and to evaluate how user-friendly the methods and instructions are. The method can be tested in several ways :

- By comparing the results of a monitoring nearby an agroecological infrastructure (AEI - e.g. a composite hedge, a flower strip, a water body, nest boxes etc) with the results of a control monitoring distant from any AEI (cf. figure below),

- In an orchard which is managed with an agroecological practice, like reduced mowing,

- In order to follow the temporal evolution of arthropods at key moments of the season, like the arrival or the peak of abundance of an insect (according to the life cycles of the aimed populations, cf. protocoles),

- To monitor the impact of a treatment on arthropods (observation before and after the treatment)

The chosen method will be used according to a sampling plan described in the sheets below.
If the methods are used to compare the presence of beneficials between two treatments (two separate zones of the same orchard or two different orchards), one being agroecological and the other being a control, it is important to make sure that the control is distant enough from any agroecological infrastructure that could confuse the result. Ideally the control should be at 50m distance of any AEI. Many factors impact the presence of insects in a plot (e.g. farming practices, landscape, variety and age of the trees), it is important to take this into account when comparing the results of monitoring that have been performed in different orchards.

Pictures shown in this handbook were all provided by Ecoorchard partners, or are copyleft versions from Internet.

Methods' description

(more information in the method sheets)

Each method targets different groups of arthropods. It is interesting to match up the use of a method with the presence of the targeted groups and with the phenological stages during which apple trees are particularly threatened by pests (more information in the protocols).

Beneficials may be sensitive to insecticide treatments such as Neem or oil. Therefore, if a plot has been treated a short time before the monitoring, it is normal to observe a small number of beneficials. It is better to carry out the monitoring in orchards with fewer applications (e.g. in orchards with varieties that are less sensitive to aphids).

I. Visual observation of the rosy apple aphid

Following IOBC* recommendations, sample 10 trees in the orchard and identify 10 clusters (i.e. corymb) on each tree (sample trees randomly and make sure not to be attracted by clusters that are already infested). List the absence or presence of aphids or fundatrix (cf. photo on the protocol) per cluster. Mark the clusters with aphids.
When the season is more advanced, complete the monitoring by opening between 10 and 20 colonies on the marked clusters in order to make the inventory of the active natural enemies and to count the number of marked colonies that have disappeared. Measures the infestation rate and the predation activity.

II. Beating (non destructive)

Sampling and marking of 10 trees per treatment (or 33 trees if the farmer is already used with IOBC guidelines). Beat one branch per tree three times over a white tray (45 x 45 cm). Vary the side of the tree that is beaten (North/South) and make sure to beat branches that have approximately the same size and with a similar strength so that the beatings are comparable. Quickly identify and count the present beneficials. Provides a representation of the arthropods population in the canopy with a favourable bias towards bigger arthropods. The method particularly targets ladybirds, green lacewings, spiders, predatory bugs and earwigs.

III. Predation card

Sheets, on which eggs of codling moth or aphids have been glued (called sentinel preys), are exposed in the orchard. After 24 hours, the proportion of sentinel that has been predated is observed. The sheets can be placed under the tree's leaves facing the ground. Mark the trees with sheets with coloured rubbon. The method indicates a potential predation service. In the case of predation sheets with aphids the presence of ants will have an impact on the predation service since they protect aphids from natural enemies. This cannot be measured using predation cards.

IV. Cardboard band-traps

Make a roll of corrugated cardboard and place it into a bottle in which the bottom has been removed. Fix the bottle vertically against the trunk right under the foliage. This method is used to count some of the natural enemies that seek refuge in the corrugated cardboard. The band is kept on the tree for 1 week. It is to be opened carefully above a container OR shaken in order to collect the present insects, which are then identified and counted. Efficient method to assess especially earwigs and spiders.

** International organization for Biological control, international network of experts for improvement of practices and integrated pest management, through common pest and diseases assessment methods.*

Summary of the proposed methods

N.B. The dates for the monitoring sessions are suggestions and they are motivated in the record sheets

Technique	Target population	Suggested protocol	Obtained results	Required equipment	Suggested dates for the monitoring
Visual observation	Aphid colonies + Active natural enemies	At 1st monitoring mark 10 clusters / tree on 10 trees per treatment or 20 trees in total. At 2nd monitoring note all remaining colonies and open up to 10-20 colonies per treatment or in total	Aphid infestation rate, natural enemy presence rate, biological control.	Marking band, a loup can be useful	1st monitoring: at BBCH 59 (Balloon stage) 2nd monitoring: At BBCH 69-70 (after petal fall).
Beating	Present beneficials	1 branch per tree beaten 3 times. 10 trees per treatment or 20 trees in total (or following IOBC guidelines 33 trees per treatment).	Counting of the present beneficials	White tray (45 x 45 cm) + stick + marking band + record sheet/pen	1st monitoring: BBCH 69 (after petal fall) 2nd monitoring: 1 month later
Predation card	Predation of the codling moth	10 cards per treatment or 20 cards in total	Predation rate of the eggs	Predation cards (supplied) + magnifying glass + marking band + stapler (not supplied)	2 passages per monitoring: set up and withdrawal (+24h) 1st monitoring: from the first egg laying period onwards 2nd monitoring : 1 month later
	Predation of the aphid	10 cards per treatment or 20 cards in total	Predation rate of the aphid	Predation card (supplied) + marking band + stapler (not supplied)	2 passages per monitoring: set up and withdrawal (+24h) 1st monitoring: shortly after petal fall (BBCH 69) 2nd monitoring: 15 days or 1 month later
Cardboard band traps	Present beneficials	10 band traps per treatment or 20 band traps in total	Counting of the present beneficials	Corrugated cardboard (20 x 10 cm) + sticky tape + marking band	2 passages per monitoring : set up and withdrawal (1 week) 1st monitoring: from mid-April onwards, e.g. at the beginning of June 2nd monitoring: 1 week later

IMPORTANT

- ➔ Think carefully about the orchard(s) that will be monitored and discuss about the choice with the organizers of the workshop
- ➔ Verify the compatibility of the chosen method with the planned agricultural interventions (mode of irrigation, plant protection treatments, use of tractors…)
- ➔ Think of measuring the time needed every time the method is being used
- ➔ Sample the trees in regular manner all over the orchard. For instance, walk along the imaginary lines of a "Z" or a cross across the orchard and sample every 3rd or 5th tree along a row.
- ➔ All needed material will be provided

NOTATION SHEETS FOR THE MONITORING OF FUNCTIONAL BIODIVERSITY

Once the monitoring method has been chosen, make a print of the sheets to carry out the monitoring and to do the notations.
Fill a blank notation sheet for each monitoring session of the season.

The first sheet is meant to help the identification of the main beneficials.
Make a colour print for the producers who have chosen the visual counting, beating and band trap methods.

Content:

Contact : ***[put the name and contact of the national coordinator)***

Ladybird (Adult)

Ladybird (Larva)

Gall mite (Larva) feeding on an aphid

Green lacewing (Larva)

Syrphid (Larva)

Earwig

Predatory bug (nymph)

Adult of predatory bug (Anthocoridea family)

Spider

Opilion

General description

Name of the farmer:

Localisation:

Describe what you want to **test** (Agroecological infrastructure or practice, effect of a treatment, key moment in the biology of an insect, etc.)

.....

.....

Attributes of the orchard

In order to test an infrastructure, a treatment or a practice, you can do a **comparative monitoring** between a treatment (orchard or zone of an orchard – that we can call "A treatment") with this infrastructure or practice and a treatment without (that we can call "B treatment"). Both areas should be as similar as possible, with minimum distance of 50 meters.

- If you choose to compare the monitoring of two different orchards, fill out the two following parts.
- If the comparison takes place in the same orchard, or if you do a monitoring without testing a practice or an infrastructure, only fill one part out.

A treatment

Planted variety:

Age of the orchard :

Surrounding landscape : ☐Simple (barely diversified vegetation, wide open spaces, etc.)
☐Intermediate
☐Complex (diversified vegetation, hedges, smaller spaces)

Production mode : ☐Organic ☐Integrated ☐Conventional

B treatment

Planted variety:

Age of the orchard :

Surrounding landscape : ☐Simple (barely diversified vegetation, wide open spaces, etc.)
☐Intermediate
☐Complex (diversified vegetation, hedges, smaller spaces)

Production mode : ☐Organic ☐Integrated ☐Conventional

If the two treatments are in the same orchard, what is the distance between them? ..... m
(should be at least 50 meters)

Visual observation of the rosy apple aphid (1/3)

You can fill this table for 1 or 2 monitorings in the same season.
As plant protection and irrigation have an impact on result, you can also indicate which practices you had before monitoring.

	1st time	2d time
Date of first monitoring		
Dates of the second monitoring		
Plant protection treatments applied 15 days before monitoring	No Fungicide : Insecticide : Herbicide :	No Fungicide : Insecticide : Herbicide :
Irrigation 7 days before monitoring	No Surface Sprinkler localized	No Surface Sprinkler localized

Time needed to make the monitoring:
☐< 30 min ☐30min to 1h ☐1h to 2h ☐> 2h
Personal perception: ☐fast ☐medium ☐long

Bring the booklet and the necessary equipment in the orchard during the monitoring.

Visual observation of the rosy apple aphid (2/3)

- ➔ Among the marked clusters, open randomly 20 colonies. If you can't find 20, try to open at least 10 (if necessary open colonies on unmarked clusters and indicate it on the notation grid).
- ➔ For each opened colony, check the box of the present beneficials. If there are no beneficials check "only aphids". If there are ants (defender of aphids against beneficials check the corresponding box

Treatment A								
Number of beneficials in the colony								
Nest #	**Ladybird**		**Green lacewing (Larva)**	**Syrphid (Larva)**	**Earwig**	**Bug**	**Ants**	**Other**
	Larva	**Adulte**						
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Visual observation of the rosy apple aphid (3/3)

Treatment B								
Number of beneficials in the colony								
Nest #	Ladybird		Green lacewing (Larva)	Syrphid (Larva)	Earwig	Bug	Ants	Other
	Larva	Adulte						
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Beating (1/3)

You can fill this table for 1 or several monitorings in the same season.
As plant protection and irrigation have an impact on result, you can also indicate which practices you had before monitoring.

	1st time	2d time	3d time	4th time
Date of beating				
Plant protection treatments applied 15 days before monitoring	No Fungicide : Insecticide : Herbicide :	No Fungicide : Insecticide : Herbicide :	No Fungicide : Insecticide : Herbicide :	No Fungicide : Insecticide : Herbicide :
Irrigation 7 days before monitoring	No Surface Sprinkler localized	No Surface Sprinkler localized	No Surface Sprinkler localized	No Surface Sprinkler localized

Time needed to make the monitoring:
☐< 30 min ☐30min to 1h ☐1h to 2h ☐> 2h
Personal perception: ☐fast ☐medium ☐long

Bring the booklet and the necessary equipment in the orchard during the monitoring.

Beating (2/3)

You can beat 33 trees per treatment if you are used to follow the IOBC guidelines. If not, it is possible to beat 10 trees per treatment. Write the number of beneficials that are present per tree.

Treatment A																																
Tree n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	**Total**
Ladybirds Larvae																																		
Adults																																		
Green lacewings Larvae																																		
Syrphids (Larvae)																																		
Earwigs																																		
Predatory bugs																																		
Spiders																																		
Opilions																																		
Other																																		
Total number of beneficials in A treatment:																																		

Beating (3/3)

Total number of beneficials on all the trees:																																
Treatment B																																
Tree n°	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	**Total**
Ladybirds																																		
Larvae																																		
Adults																																		
Green lacewings																																		
Larvae																																		
Syrphids (Larvae)																																		
Earwigs																																		
Predatory bugs																																		
Spiders																																		
Opilions																																		
Other																																		
Total number of beneficials in B treatment:																																		

Predation cards – Codling moth (1/2)

You can fill this table for one or several monitoring sessions in the same season. As plant protection and irrigation have an impact on result, you can also indicate which practices you had before monitoring.

	1st time	2d time	3d time	4th time
Date of set up of the predation cards				
Dates of the monitoring				
Plant protection treatments applied 15 days before monitoring	No Fungicide Insecticide herbicide	No Fungicide Insecticide herbicide	No Fungicide Insecticide herbicide	No Fungicide Insecticide herbicide
Irrigation 7 days before monitoring	No Surface Sprinkler localized	No Surface Sprinkler localized	No Surface Sprinkler localized	No Surface Sprinkler localized

Time needed to make the monitoring:
☐< 30 min ☐30min to 1h ☐1h to 2h ☐> 2h
Personal perception: ☐fast ☐medium ☐long

Bring the booklet, the necessary equipment and a stapler in the orchard during the monitoring.

Predation activity

Monitoring **24h** after the set up of the cards.
Per card, about 10 frozen eggs have been counted. Counting the remaining eggs gives an idea of the presence or absence of a predation activity. One predator may eat several eggs, so that the number of predated eggs is not equivalent to the number of predators.

Treatment A :

Card n°	All eggs are intact : no predation activity	<50% eggs predated : Partial predation activity	>50% eggs predated : high predation activity
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Total per class			

Treatment B:

Card n°	All eggs are intact : no predation activity	<50% eggs predated : Partial predation activity	>50% eggs predated : high predation activity
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Total per class			

Predation cards – Rosy apple aphid (1/2)

You can fill this table for 1 or several monitoring in the same season.
As plant protection and irrigation have an impact on result, you can also indicate which practices you had before monitoring.

	1st time	2d time	3d time	4th time
Date of set up of the predation cards				
Dates of the monitoring				
Plant protection treatments applied 15 days before monitoring	No Fungicide Insecticide herbicide	No Fungicide Insecticide herbicide	No Fungicide Insecticide herbicide	No Fungicide Insecticide herbicide
Irrigation 7 days before monitoring	No Surface Sprinkler localized	No Surface Sprinkler localized	No Surface Sprinkler localized	No Surface Sprinkler localized

Time needed to make the monitoring:
☐< 30 min ☐30min to 1h ☐1h to 2h ☐> 2h
Personal perception: ☐fast ☐medium ☐long

Bring the booklet, the necessary equipment and a stapler in the orchard during the monitoring.

Predation activity

Monitoring **24h** after the set up of the cards.
Per card, 10 intact aphids have been glued. Counting the remaining aphids gives an idea of the presence or absence of a predation activity. One predator may eat several aphids, so that the number of predated aphids is not equivalent to the number of predators.

Treatment A :

Card n°	All aphids are intact : no predation activity	Between 1 and 5 predated aphids : Partial predation activity	More than 5 predated aphids : Full predation activity
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Total per class			

Treatment B:

Card n°	All aphids are intact : no predation activity	Between 1 and 5 predated aphids : Partial predation activity	More than 5 predated aphids : Full predation activity
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Total per class			

Corrugated card board band traps (1/2)

You can fill this table for 1 or several monitoring in the same season.
As plant protection and irrigation have an impact on result, you can also indicate which practices you had before monitoring.

	1st time	2d time	3d time	4th time
Date of set up of the bands				
Dates of the monitoring				
Plant protection treatments applied 15 days before monitoring	No Fungicide Insecticide herbicide	No Fungicide Insecticide herbicide	No Fungicide Insecticide herbicide	No Fungicide Insecticide herbicide
Irrigation 7 days before monitoring	No Surface Sprinkler localized	No Surface Sprinkler localized	No Surface Sprinkler localized	No Surface Sprinkler localized

Time needed to make the monitoring:
☐< 30 min ☐30min to 1h ☐1h to 2h ☐> 2h
Personal perception: ☐fast ☐medium ☐long

Bring the booklet and the necessary equipment in the orchard during the monitoring.

Grading grid

Monitoring **1 week** after set up of the bottles.
In the boxes, write the number of beneficials collected in each band. You can open completely the band, or alternatively shake it 5 times in a container, but remember to always do the same.

	A treatment									
Trap n°	1	2	3	4	5	6	7	8	9	10
Earwigs										
Spiders										
Other										
Total of beneficials in the A treatment:										

	B treatment									
Trap n°	1	2	3	4	5	6	7	8	9	10
Earwigs										
Spiders										
Other										
Total of beneficials in the B treatment:										

Total number of beneficials in all the traps :	

PLURIANNUAL FOLLOW-UP

If you're interested in following your biodiversity during several years, in order to see any improvement, you may be interested in using these grids to report your 2016, 2017... results !

VISUAL OBSERVATION

infestation rate	A treatment	B treatment
2016		
2017		
2018		
2019		

BEATING

	2016	2017	2018	2019		
Total number of beneficials in A treatment:						
Total number of beneficials in B treatment:						

PREDATION CARDS

Report the number of cards for each of the 3 classes:

	Treatment A :			Treatment B :		
classes	All eggs are intact : no predation activity	Between 1 and 5 predated eggs: Partial predation activity	More than 5 predated eggs: Full predation activity	All eggs are intact : no predation activity	Between 1 and 5 predated eggs: Partial predation activity	More than 5 predated eggs: Full predation activity
2016	/10	/10	/10	/10	/10	/10
2017	/10	/10	/10	/10	/10	/10
2018	/10	/10	/10	/10	/10	/10
2019	/10	/10	/10	/10	/10	/10

CARDBOARD BANDS

	2016	2017	2018	2019		
Total number of beneficials in A treatment:						
Total number of beneficials in B treatment:						