SUCROSE: A PLANT RESISTANCE INDUCER AGAINST *Cydia pomonella* L

Authors

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Project conducted in collaboration with:

*** ANADIAG SA**

**** ENSP – Le Potager du Roi**

***** INRA – Plant Nitrogen Nutrition**

****** INRA – Research unit 1272 - Insect Physiology: Signalling and Communication**

ANADIAG

INRA Institut National de la Recherche Agronomique

PISC Physiologie de l'Insecte Signalisation & Communication

Outline

- **Soluble carbohydrates and sugar alcohols:**
  - **Presence onto the plant surface and plant signalisation for insect oviposition**

- **Induction of modifications of plant signalisation by sugar applications at low concentrations:**
  - **Field experiments conducted through Europe:**

    Efficacy of sucrose and fructose applications against *C. pomonella*

  - **Effect of sucrose and fructose applications on leaf surface composition:**

    Analyse of the metabolite composition and plant signals *for C. pomonella*

Soluble carbohydrates: presence on the plant and signals for *C. pomonella* oviposition

Host plant selection process for oviposition by insects → Contact with legs and leaf surface scanning with the ovipositor

Soluble carbohydrates

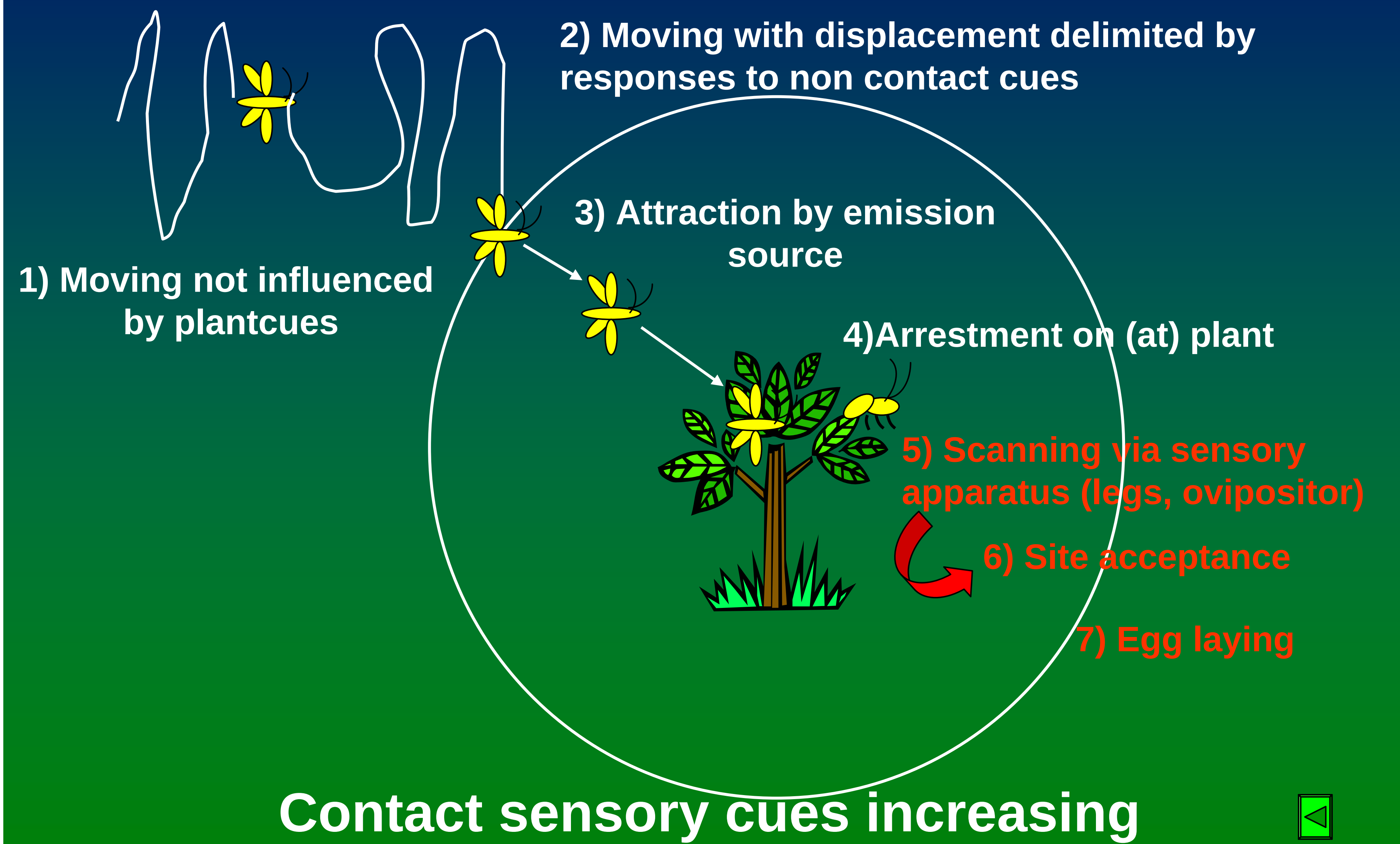
- Primary metabolites
- Photosynthetic origin
- Quantities (ng/cm²) are present at cuticle surface

→ Diffusion by transcuticular pathways

Soluble-carbohydrates and sugar-alcohols ratios influences *C. pomonella* egg laying → Female site acceptance

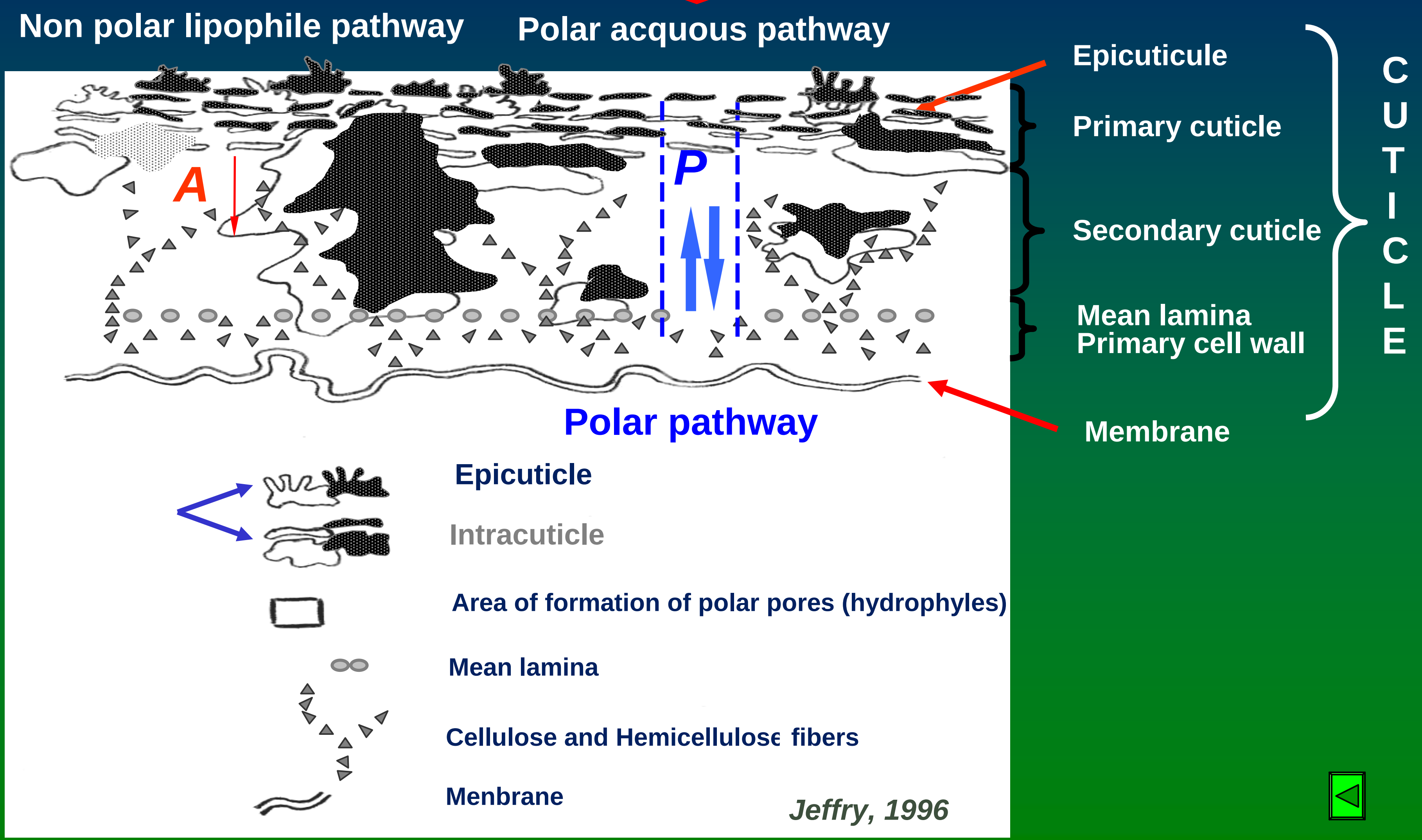
Number of eggs layed

Behavioural events leading a generalized insect to lay eggs on host plant



Transcuticle pathways of nonpolar (*A*) and polar compounds (*P*)

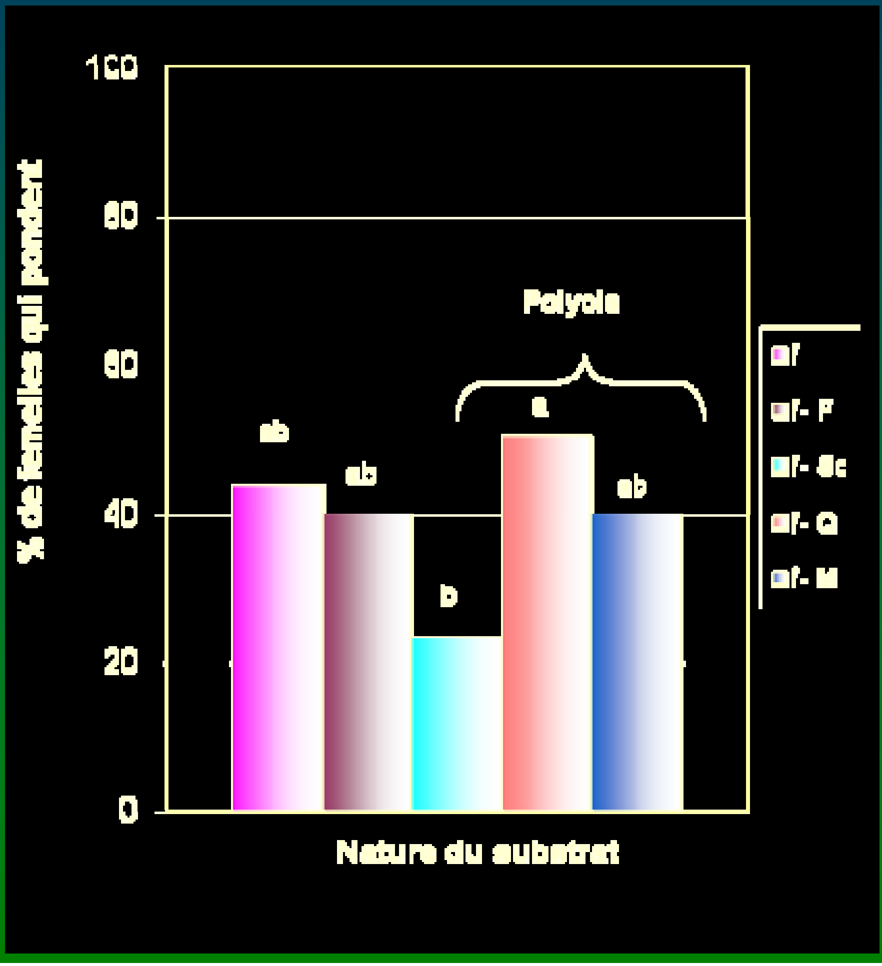
Diffusion by Polysaccharidic pathways
(Dominguez (1999))

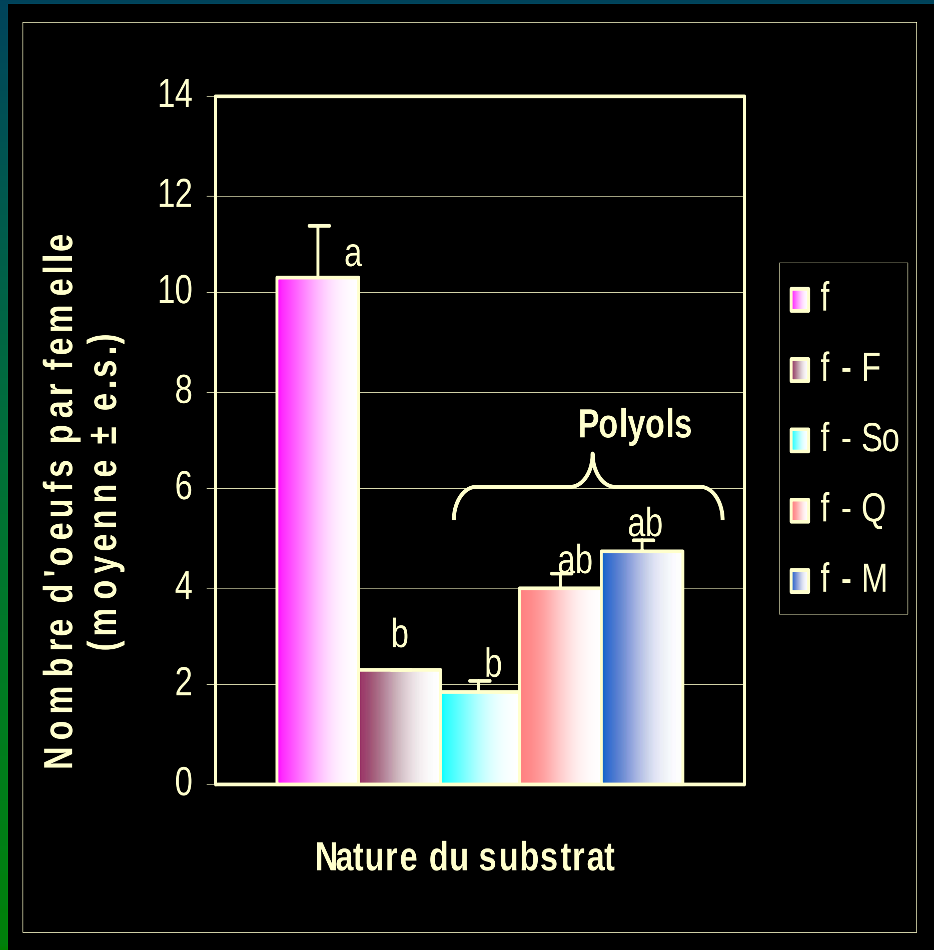


Egg laying of *Cydia pomonella* on nylon cloth substrates drench by a mixture of 6 leaf surface metabolites

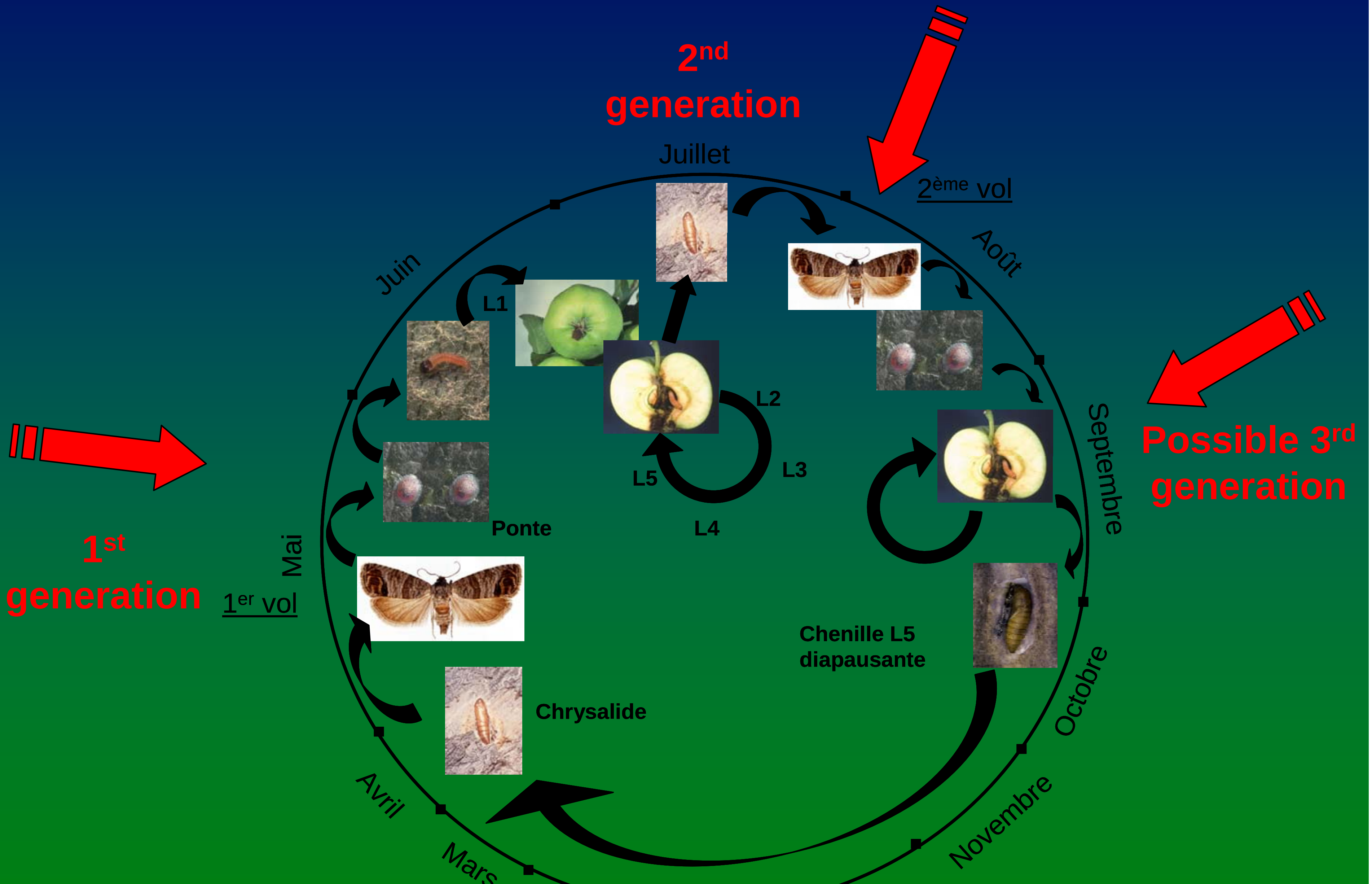
Egg-laying of *C. pomonella* after 63 minutes (3 mn after darkness) on nylon cloth substrates drench by a mixture of 6 leaf surface metabolites (f) of Golden Delicious Vs same mixture without one of the metabolite.

F : Fructose   So : Sorbitol   Q: Quebraquitol   M: Myoinositol





Cydia pomonella L : biological cycle



C. pomonella **development cycle (example 2 generations)**

Material and methods : Field trials

Sucrose or fructose applications

First application of sugars alone 20 days before forecasted oviposition period.

1st insecticide application at egg hatching.

Application timing : every 20 days.

Observations

Preliminary damage assessment (100 fruits/ plot) at the end of the 1st insect generation.

At each application assessment on safe and damaged fallen fruits.
At the end of the generation or harvest assessment on 250 fruits per elementary plot.

Statistical analysis

% of total attacked fruits and corresponding Abbott efficacy of treatments

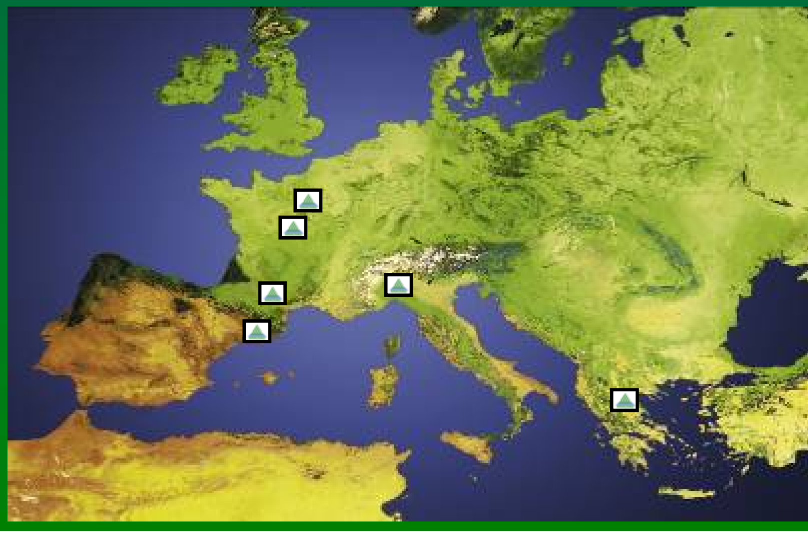
Bartlett and Student Newman & Keuls mean comparison test

Field experiments conducted in Europe

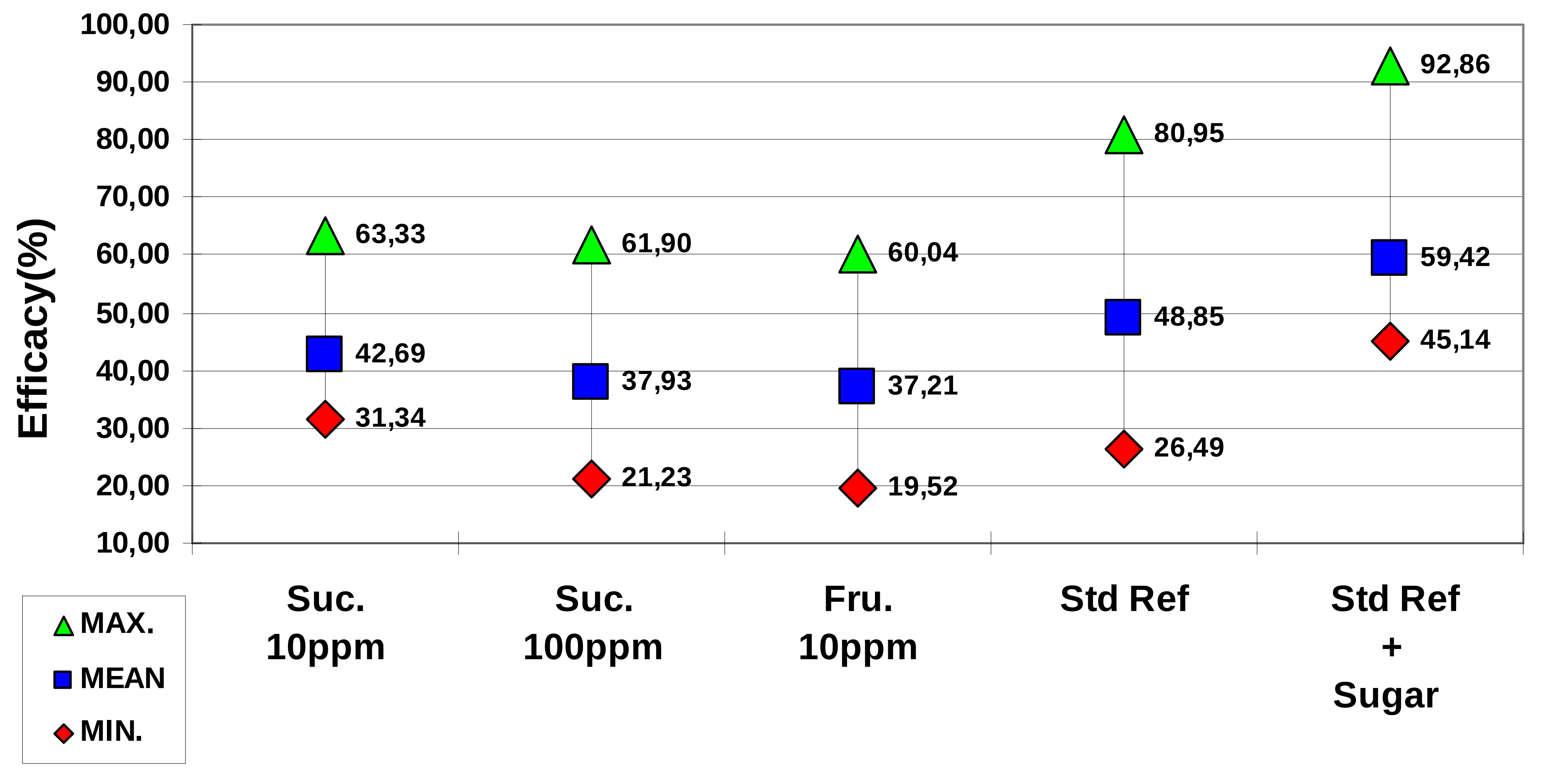
Abbott Efficacy levels calculated in % vs UTC damages

Trials	Standard references (Ref)		UTC % damages	Suc. 10ppm	Suc. 100ppm	Suc. 1000ppm	Fru. 10ppm	Fru. 100ppm	Std Ref	Std Ref + Sugar
06/FR EL	**Carpovirusine**	100ml/100L	**22,26**			**24,14 a**			**36,6 b**	**47,12 b**
	Zolone Flo	120g/100L							**26,49 a**	
08/GR ML	**Carpovirusine**	100ml/100L	**24,93**	**31,34 a**	**21,23 a**		**33,25 a**	**46,81 a**	**54,63 a**	
08/ITA ML	**Carpovirusine**	100ml/100L	**44,35**	**63,33 b**			**60,04 b**		**78,9 a**	
07/FR RY	**Imidan 50WP**	100g/100L	**1,02**	**38,1 b**	**61,9 ab**				**80,95 a**	**92,86 a**
07/FR GA	**Imidan 50WP**	100g/100L	**40,67**	**37,98 bc**	**30,66 c**				**41,55 bc**	**61,34 a**
07/GR11	**Imidan 50WP**	100g/100L	**37,58**				**19,52 d**		**46,53 abc**	**50,66 ab**
	Dursban 480 EC	100ml/100L							**30,42 cd**	
07/ITA015	**Imidan 50WP**	100g/100L	**1,75**				**36,01 a**		**54,63 a**	**45,14 a**
	Smart EW	215ml/100L							**37,75 a**	

Open field experiment locations



Mean Abbott efficacy level (%) for each type of treatment for all experiments



Leaf surface metabolite analysis: Material and methods

Bourse shoots sampling

3 samples of bourse shoots harvested in the upper part of 2 central trees per elementary plot.

Timing of harvesting on several days of sugar treated and control plants together.

Surface chemical analysis

Leaf surface washings collected and analyzed on a GC-TOF chromatography.

(software AMDIS)

Metabolome result analysis

All results were delivered on to PCA performed on 119 metabolites to determine:

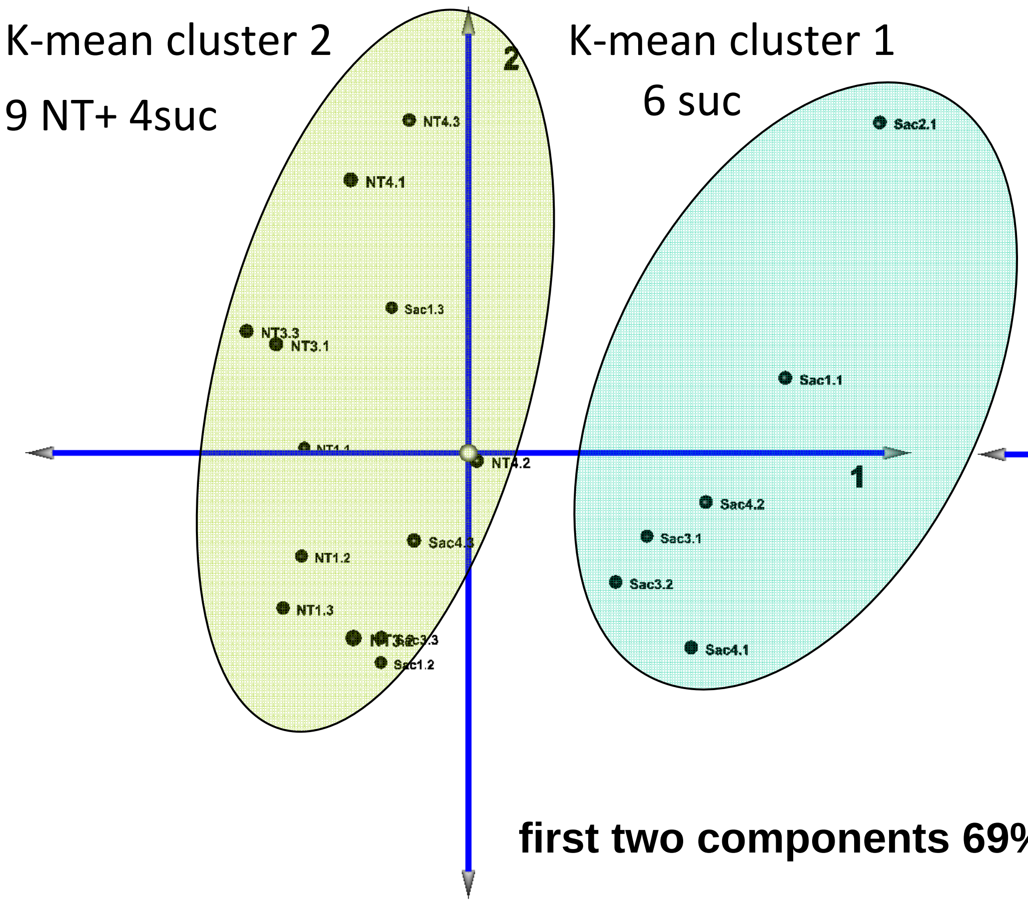
Wether the plant surface metabolite composition is modified by sugar treatment

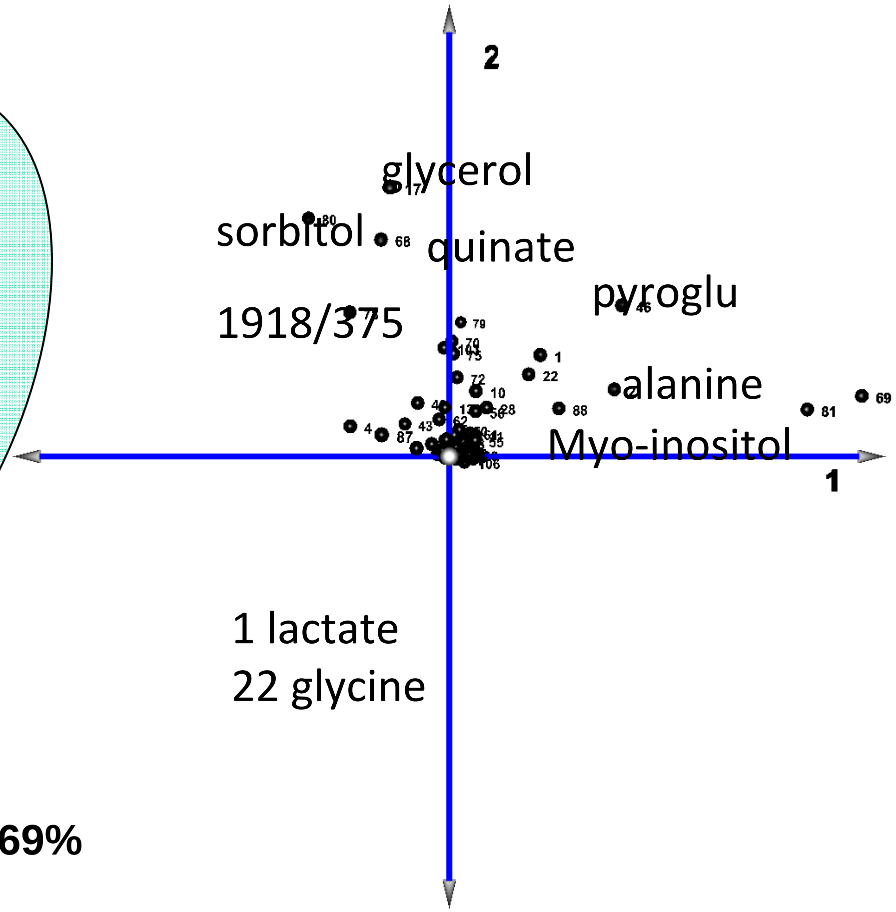
Wether those known as influencing *C. pomonella* egg laying and neonate larval behaviour are concerned

Effect of apple tree sucrose treatment (10 ppm) on the metabolite composition of the under side of the bourse shoot leaves

Mean centered (Principal components analysis)

Variety: *Golden delicious*



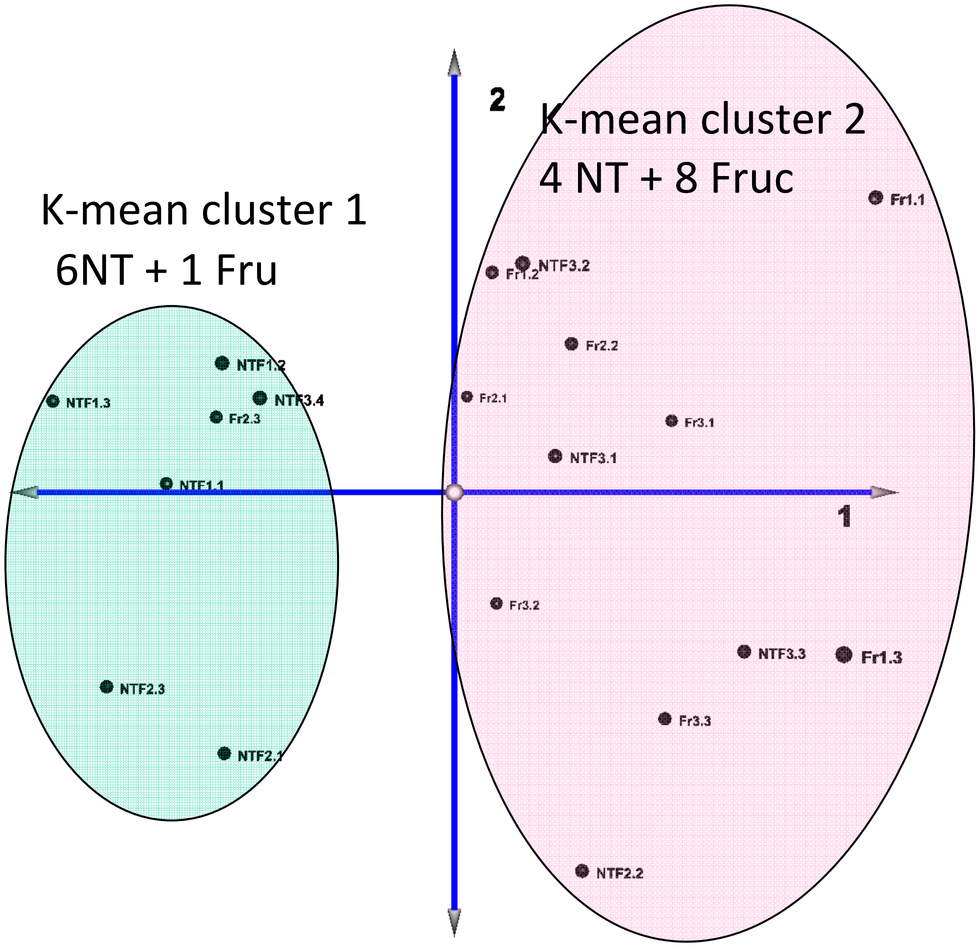


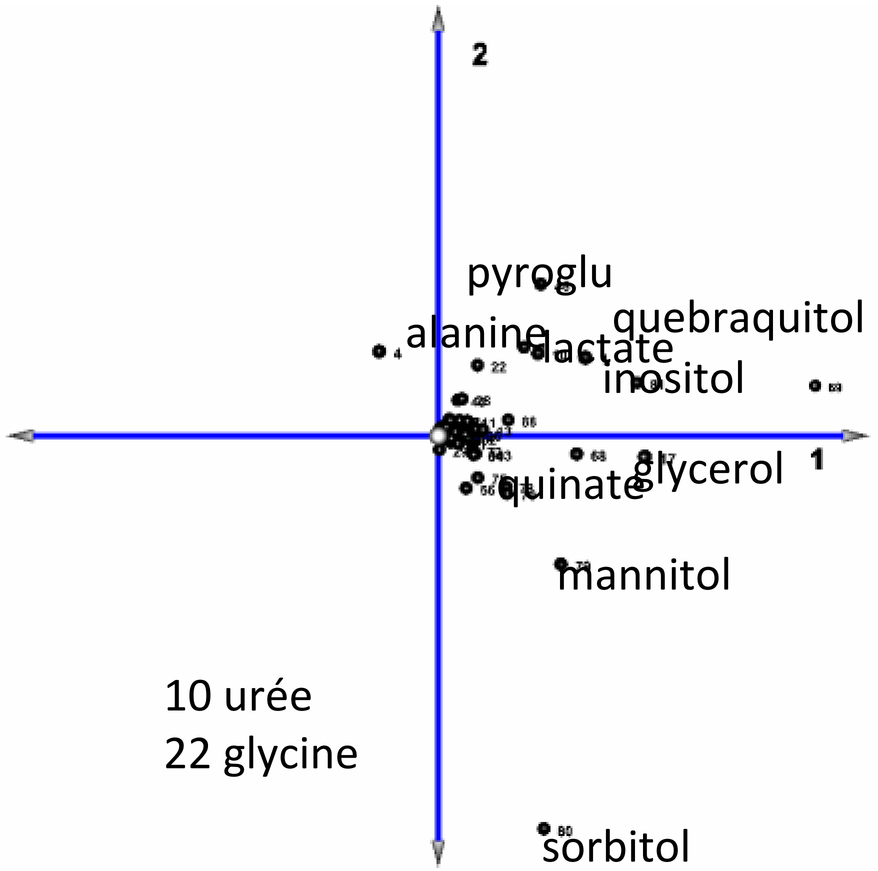
first two components 69%

Effect of apple tree fructose treatment (0,1ppm) on the metabolite composition of the under side of the bourse shoot leaves

Mean centered (Principal components analysis)

Variety: Golden delicious





first two components 67 %

Metabolites modified by applications of sucrose at 10ppm and fructose at 0,1ppm on leaf surface

Metabolites significantly modified by sucrose and fructose applications vs. None sugars treated trees

Sucrose treated (10ppm)

N°	Name	t-test
69	quebraquitol 5tms 1859.3/318	0,0009
30	1380.5/184	0,0010
81	scyllo-inositol 1949.3/318	0,0013
26	glyceric acid 1335.5/292	0,0014
47	GABA 1527.7/304	0,0017
63	2-ketogluconate 1779.8/292	0,0017
4	1145.1/235	0,0025
88	myo-inositol 2086.7/318	0,0047
23	succinic acid 1320.9/247	0,0047
14	ethanolamine 1269.8/174	0,0054
2	alanine 1109.1/116	0,0097
39	decanoic acid 1459.2/229	0,0108
17	glycerol 1278.1/205	0,0154
115	raffinose 3355.5/361	0,0164
37	1433.5/233	0,0188
57	arabinose meox 1662.9/307	0,0229
78	unk 1918.7/375	0,0248
29	nonanoic acid 1368.3/215	0,0260
36	beta-alanine 1430.7/248	0,0270
5	beta-lactate ? 1148.8/219	0,0287
49	erythronic acid 1538.6/292	0,0323
77	C19 1.006 lysine 174	0,0335
3	oxalic acid 1138.3 /147	0,0353
6	betahydroxybutyrate [938] 1162	0,0508

Fructose treated (0.1ppm)

N°	Name	t-test
30	1380.5/184	0,0001
69	quebraquitol 5tms 1859.3/318	0,0002
47	GABA 1527.7/304	0,0005
14	ethanolamine 1269.8/174	0,0011
81	scyllo-inositol 1949.3/318	0,0012
4	1145.1/235	0,0027
88	myo-inositol 2086.7/318	0,0075
2	alanine 1109.1/116	0,0095
48	1530.2/314	0,0155
36	beta-alanine 1430.7/248	0,0200
49	erythronic acid 1538.6/292	0,0260
11	Diethylene glycol ? 1245.8/117	0,0363
38	1452.9/350	0,0429
12	1247.7/127	0,0464

Conclusions

Applications of 10ppm and 100ppm solutions of sugar change the insect behaviour and significantly reduce the damages vs. untreated control.

Sucrose or fructose applied in tank mix with an insecticide enhance the efficacy of the treatment

Sugar applications modify leaf surface metabolome and metabolites known as signals for *C. pomonella* oviposition behaviour.

The Plant Resistance against Insect behavior (antixenosis) is induced by the spraying of sucrose.

THANK YOU FOR YOUR ATTENTION!

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