

Native fungi against invasive beetle

Tanja Sostizzo and Giselher Grabenweger

Ecological Plant Protection in Arable Crops, Agroscope





Invader: Japanese beetle (*Popillia japonica*)



History of Invasion

Native to Japan

Introduced:

- 1916 North America
- 1970s Azores
- 2014 northern Italy
- 2020 first larval population in Switzerland

Risk for great parts of Europe



Host plants

Vine, berries, stone fruit, pome, corn, soy, forest trees, roses etc.

← Organic vine yard in Italy in August after heavy feeding of Japanese beetles.

Larvae

Typical white grubs

Overwinter in third larval instar

Feed on roots, preferably in lawns and meadows



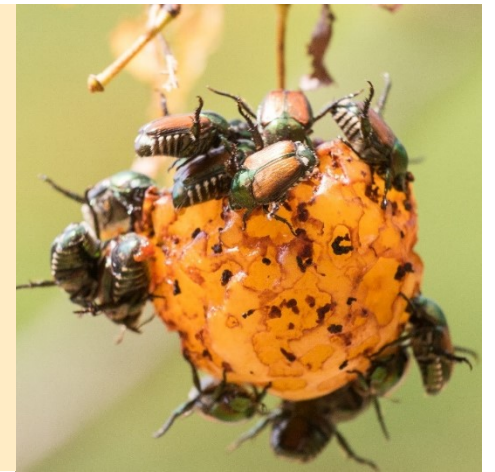
Adults

Gregarious

One year life cycle, flight season June to August

Polyphage

Feed on leafs, flowers and fruits





State of the art control of native relatives of *P. japonica*



B. brongniartii growing on cockchafer larva

Cockchafer (*Melolontha melolontha*), garden chafer (*Phyllopertha horticola*) or June beetles (*Amphimallon* ssp.) are native relatives of the Japanese beetle.

The larvae of those beetles are controlled by the application of entomopathogenic fungi *Beauveria brongniartii* or *Metarhizium brunneum*.

Within the last 20 years damage of more than CHF 20 millions could be prevented with this method!



M. brunneum growing on garden chafer larvae

The entomopathogenic fungi *M. brunneum* and *B. brongniartii* can be cultivated on sterilised barley kernels.



Barley overgrown with *M. brunneum*



No-till seeder

Fungus colonized barley kernels (FCBK) are applied with a no-till seeder.

Larvae get infected when they meet FCBK in the soil.





FCBK in soil slits



Field application of *M. brunneum* Bipesco 5 against *P. japonica* larvae in northern Italy

Set-up

9m	1	4	7	10	13	16	
9m	2	5	8	11	14	17	
9m	3	6	9	12	15	18	
	10m	10m	10m	10m	10m	10m	

 *Metarhizium brunneum* Bipesco 5 10^{14} spores/ha
 Untreated control



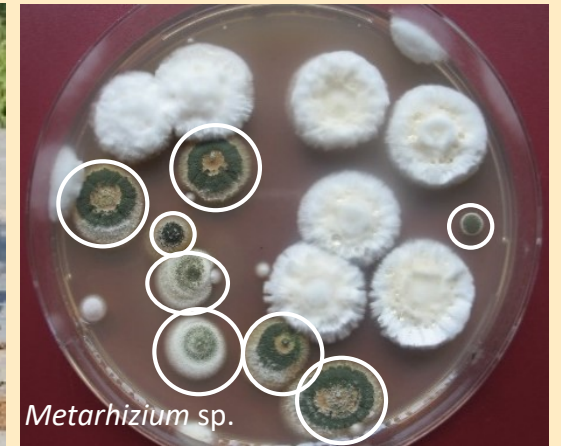
Application of FCBK with no-till seeder before flight of adult *P. japonica* → fungus is present when eggs are laid

Evaluation

	May 2019	July 2019	October 2019	May 2020
Treatment	✓			
CFU	✓	✓	✓	✓
Larvae/m ²			✓	✓



Larvae/m²: Larvae were counted in 5 soil cubes (20 x 20cm) per plot



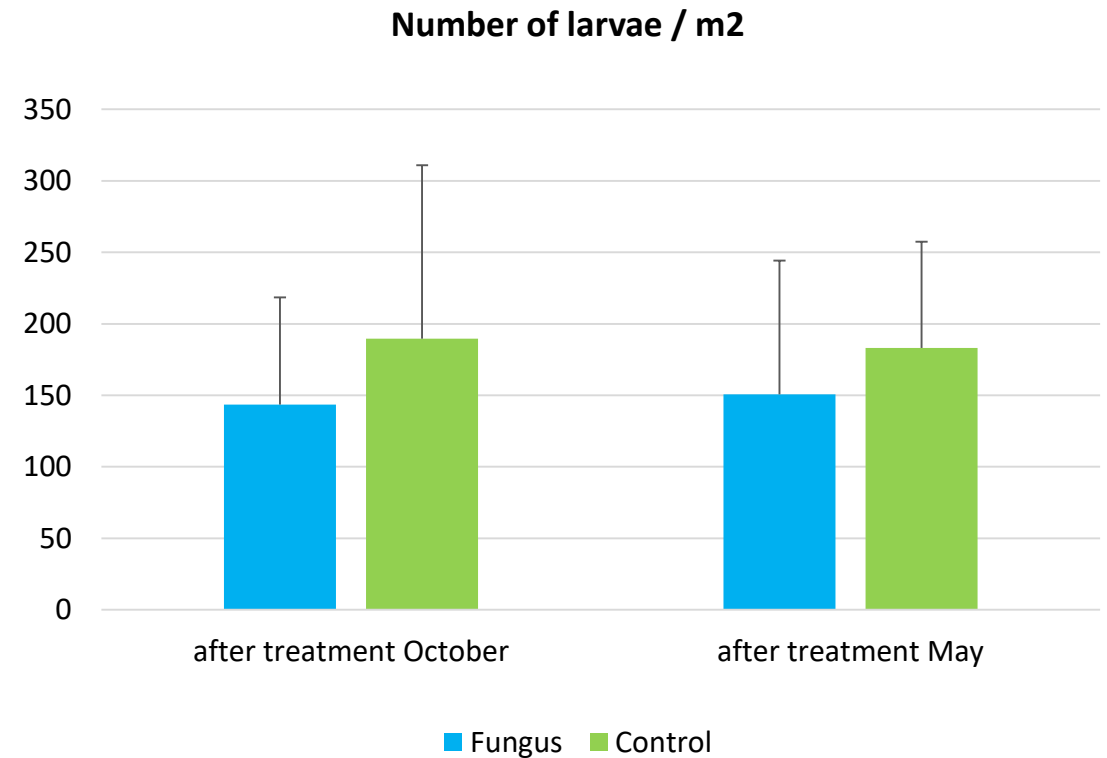
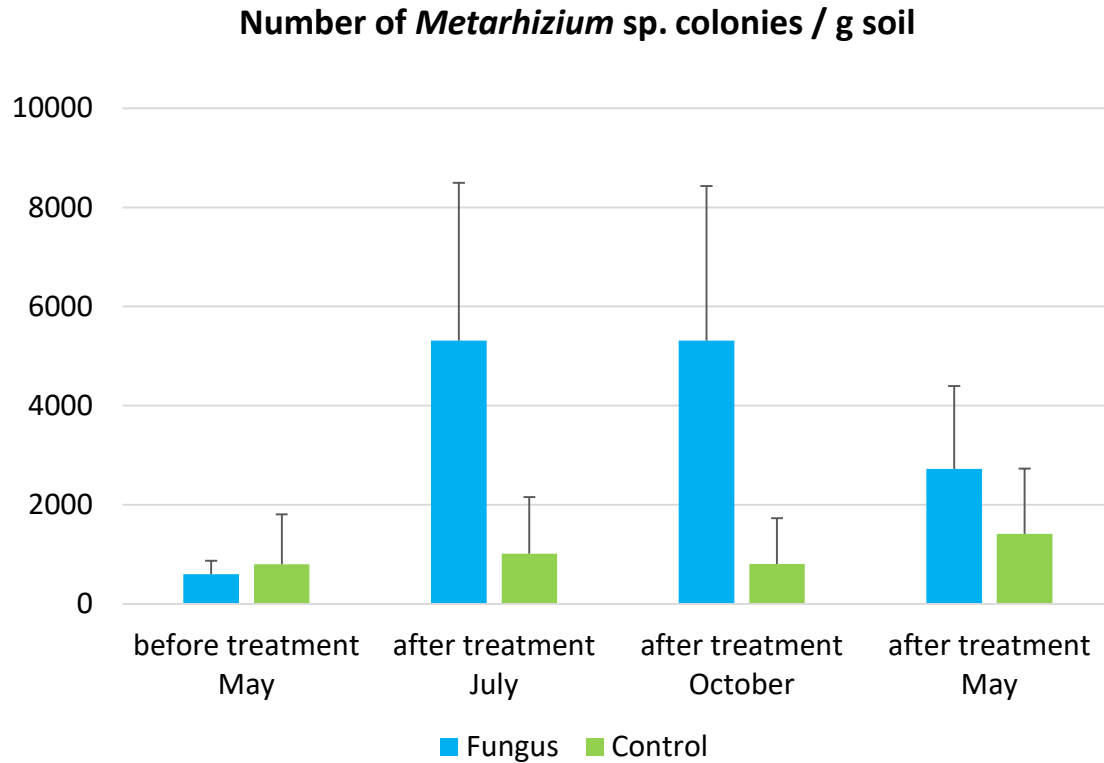
Metarhizium sp.

Colony forming units (CFU):

- 5 soil cores per plot
- Dilution plating of soil samples on selective media, counting of *Metarhizium* sp. colonies



Higher *Metarhizium* CFU counts in treated plots, no strong effect of fungus on larval population



→ No clear control effect of *M. brunneum* strain Bipesco 5 on Japanese beetle larvae under field conditions



Spray inoculation experiment *P. japonica* adults and larvae

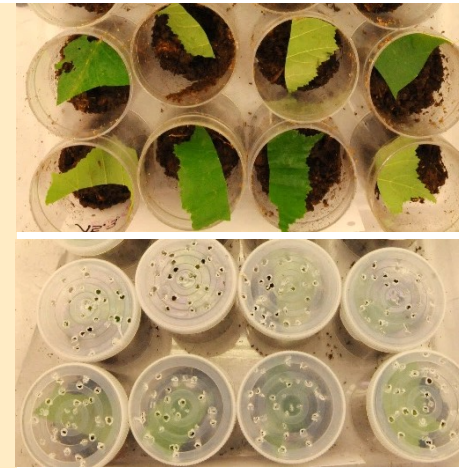
Insects were sprayed from two sides with the corresponding spore solution or Tween.

15 individuals per treatment



Beetles or larvae were held in individual containers with peat, fed with carrots (larvae) or hazel leaves (adults).

For each treatment 15 containers in 1 box



x 5 Replicates

Treatments

Description

***Beauveria brongniartii* ART 2829**

10⁷ conidia spores/ml



Specific pathogen of cockchafer, regularly applied in Switzerland to control cockchafer larvae

***Metarhizium brunneum* ART 212**

10⁷ conidia spores/ml



Used to control garden chafer and June beetle larvae in Switzerland

***Metarhizium brunneum* BIPESCO 5 (Bip 5)**

10⁷ conidia spores/ml



Standard strain, licensed in EU and Switzerland to control garden chafer, June beetle, vine weevils, wireworms

Tween 0.01%

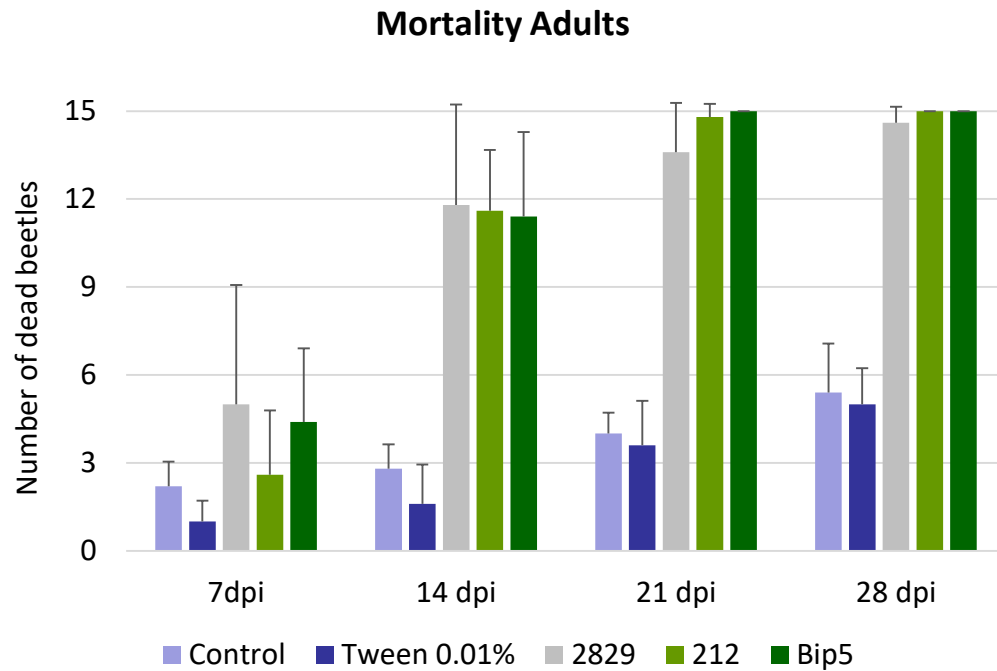
Solvent of fungal spores

Control

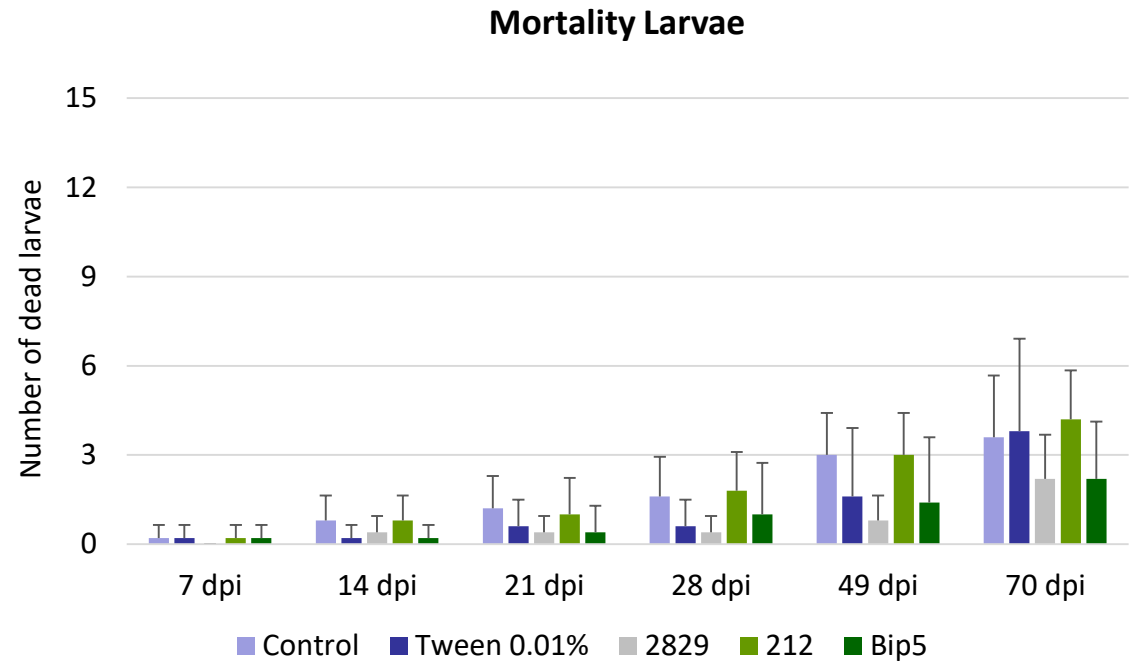
No treatment



High mortality for adults, low mortality for larvae



Adults: weekly checks for mortality over 4 weeks



Larvae: weekly checks for mortality over 10 weeks

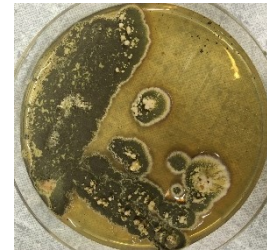
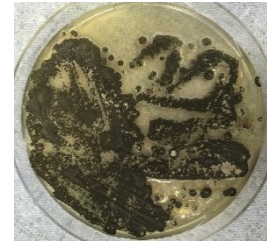


Weekly checks for mycosis and isolation of fungus

Metarhizium brunneum
sporulating on cadavers



Isolation of fungus
on selective media



Fungi isolated from mycosed cadavers were categorised in *B. brongniartii* and *M. brunneum* concerning their morphology

M. Brunneum strains ART 212 and Bipesco 5 cannot be distinguished morphologically

Beauveria brongniartii
sporulating on cadavers



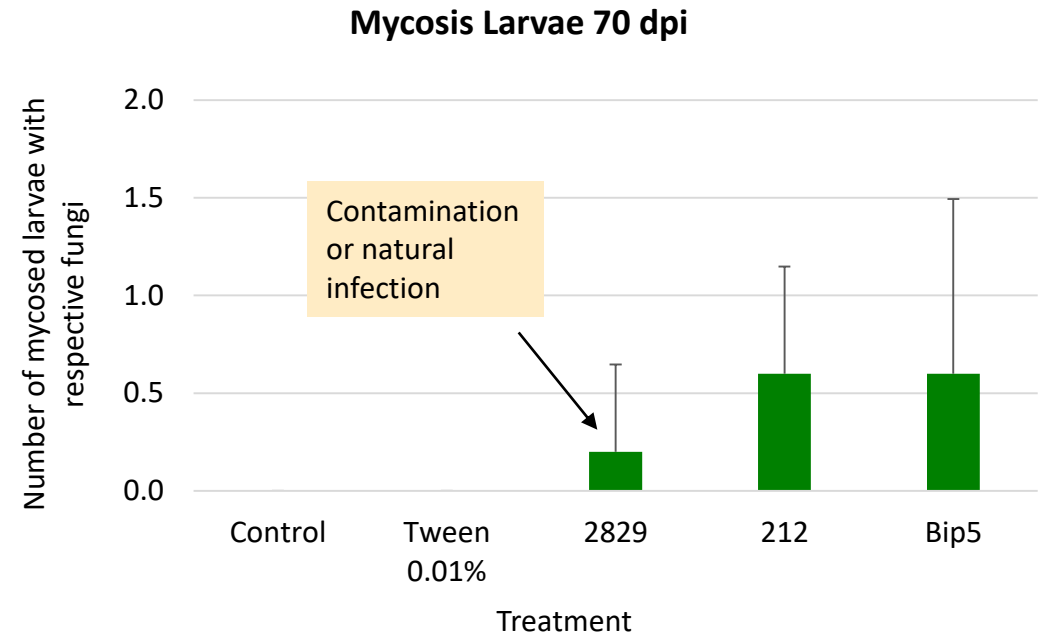
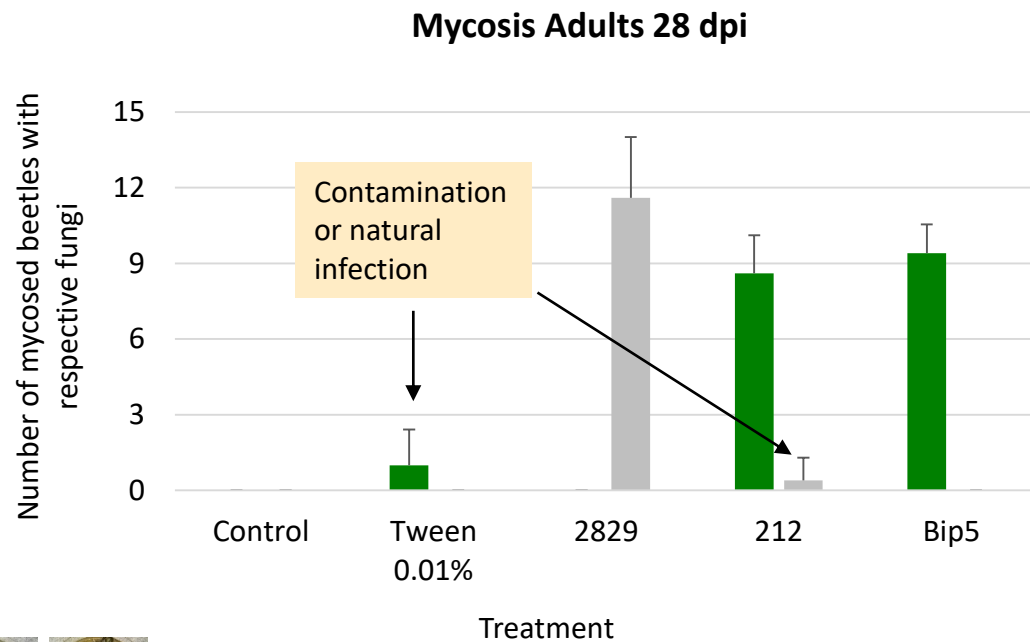
Isolation of fungus
on selective media



Selective media turns red when *B. brongniartii* releases mycotoxins.



Mycosis on more than 50% of cadavers from fungus treated adults, nearly no mycosis on treated larvae



■ *M. brunneum*



■ *B. brongniartii*

→ Adults of *P. japonica* are more susceptible to native entomopathogenic fungi than larvae



Acknowledgements



Support:

- Giovanni Bosio, Phytosanitary Service Piedmont
- Molecular Ecology, Agroscope



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Landwirtschaft BLW
Office fédéral de l'agriculture OFAG
Ufficio federale dell'agricoltura UFAG
Uffizi federal d'agricoltura UFAG

Funding:

- Federal Office for Agriculture FOAG, Switzerland
- Agroscope
- This project has received funding from the European Union`s Horizon 2020 research and innovation programme under grant agreement No 861852



Agroscope



Pictures:

Tanja Sostizzo, Christian Schweizer and Giselher Grabenweger, Ecological Plant Protection in Arable Crops, Agroscope