SOIL MICROBES AND FAUNA UNDER BT MAIZE OR AN ISOGENIC CONTROL, WITH AND WITHOUT ADDITIONAL INSECTICIDE

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Introduction

The EU-funded ECOGEN project (www.ecogen.dk) is studying the effects of Bt-expressing crops on soil biology, the continuity between glasshouse and field experimentation, and comparative effects of conventional agricultural practices. Results after the first two years of field trials with CryIAb expressing maize showed that changes to microbial (CLPP and PLFA) and microfaunal (protozoan and nematode) communities due to the Bt-trait were small and less than changes due to different (non-Bt) maize cultivars and different crops (Griffiths et al, 2005). Decomposition of wheat straw in the field was unaffected by the Bt-trait (Cortet et al., 2005). To complement these field studies this glasshouse test was undertaken.

Materials and Methods

In a factorial design were, two soils (Foulum and Varois) X two maize lines (Bt and non-Bt) X two insecticide treatments (with and without) X three plant growth stages (5 leaf, flowering and maturity), with five replicate pots per treatment in a glasshouse. A loamy-sand (Foulum) and a clay-silt (Varois) were collected from the sites where we are conducting field trials. Pots were sown with either MEB307Bt (a Mon 810 Bt-variety expressing the *Bacillus thuringiensis* Cry1Ab protein, from Monsanto) or Monumental (a registered conventional variety near-isogenic to MEB307Bt but without the Bt-trait). An insecticide used against the European corn borer, 'Decis' (Bayer CropScience, Cambridge, UK, a pyrethroid insecticide containing deltamethrin) was applied at the 5-leaf and flowering stages. We determined microbial community structure (CLPP and PLFA), protozoa and nematodes as at the field sites (Griffiths et al., 2005).

Results

The overwhelming effects were those of soil type and plant growth stage at sampling, including plant growth itself which was greater in the Foulum soil (fig. 1). The concentration of Bt-toxin in the plant was greatest in insecticide treated plants (fig. 2). There were more nematodes overall and more protozoa (amoebae) at the 5-leaf stage under the Bt than the non-Bt maize lines. There were insecticide X Bt interactions for nematode community structure (insecticide altered the structure under non-Bt maize) and microbial community structure (as measured by CLPP, Fig. 3). Table 1 indicates where significant effects were observed.

Fig. 1. Maize plants at the flowering stage.

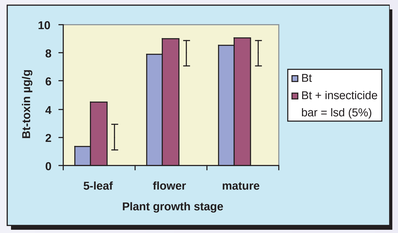

Fig. 2. Concentrations of Bt-toxin in leaves of maize grown in Foulum soil with or without insecticide application.

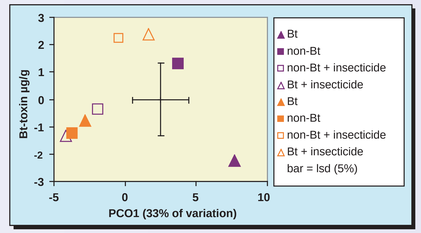

Fig. 3. Principal component plot of microbial community structure (CLPP) under maize at maturity. Symbols represent soil type (Foulum = orange, Varois = purple) and show effects of Bt-trait, insecticide and interactions.

Table 1.

	Effect due to:				
	Soil type	Growth stage	Bt	Insecticide (I)	Bt x I
Microbes – PLFA	✓	✓	×	✓	×
Microbes – CLPP	✓	✓	✓	✓	✓
Protozoa	✓	✓	✓	×	×
Nematodes	✓	✓	✓	✓	✓
Microarthropods	✓	✓	×	×	×
Plant growth	✓	✓	×	×	×
Plant Bt content	✓	✓	✓	✓	×

Discussion and Conclusions

Effects of the Bt-trait were no greater than those of the insecticide treatment which is applied as current best practice. This glasshouse experiment reached essentially the same conclusions as the field experiments, that the effect of Bt-maize was small and within the normal variation expected in agricultural systems (Griffiths et al., 2005). There is a compromise to be made between the flexibility of a glasshouse experiment (more treatments, sampling times and soil parameters can be studied than from field plots) and the fact that conditions in a glasshouse can never be the same as in the field. As an example of the benefits of the tiered approach, our observations on the effects of insecticide compared to the effects of the Bt-trait will now be included in future field samples at the ECOGEN sites. Laboratory experiments will also be undertaken to examine the positive response of nematodes and protozoa to Bt-maize, and the apparent effects of insecticide on Bt-toxin accumulation.

References

Griffiths BS et al., (2005) A comparison of soil microbial community structure, protozoa and nematodes in field plots of conventional and genetically modified maize expressing the Bacillus thuringiensis CrylAb toxin. Plant and Soil, in press.

Cortet J et al., (2005) Decomposition processes under Bt (Bacillus thuringiensis) maize: results of a multi-site experiment. Soil Biology & Biochemistry, submitted.

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