Short note

Reproduction of *Heterodera schachtii* on Bt-transgenic cabbage

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Plant transformation is a politically and socially controversial procedure and at the same time an increasingly common method to protect crops from pests and pathogens. Part of the controversy lies in the potential effects that transformed plants may have on non-target organisms. For example, caterpillars of *Dandaus plexippus* that feed exclusively on *Asclepius* can be harmed by pollen from Bt transgenic corn, whereby the plant produces an insecticidal protein naturally found in the bacteria *Bacillus thuringiensis*, under laboratory conditions (Losey *et al.*, 1999). Similarly, predatory ladybird insects, *Adalia bipunctata*, feeding on aphids living on snowdrop-lectin modified potatoes have shortened life spans (Birch *et al.*, 1999).

Plant-parasitic nematodes also become potential non-target organisms when plants are transformed for resistance to insects and diseases, for herbicide tolerance, or improved agronomic traits. *Brassica oleracea* was transformed to express the Bt protein Cry1Ab3, using the constitutive promoter CaMV 35S, which confers resistance to the diamondback moth, *Plutella xylostella* (Jin *et al.*, 2000). The objective of our experiment was to determine if this transformation affected the reproduction of *H. schachtii* on the transformed cabbage line.

Transgenic and non-transformed cali of *B. ole*racea cv. Superette were regenerated in Magenta boxes. Plants were transferred to individual 10-cmdiameter clay pots filled with a sterile 1:1 soil-sand mixture. Ten transformed and 10 non-transformed plants were inoculated with 1000 eggs of *H.* schachtii contained in 25-ml aliquots 4 weeks after transplanting. The cabbage plants were arranged randomly on trays in the laboratory and grown under lights. Plants were watered as needed. Six weeks after inoculation, the cabbage plants were removed from the pots and the soil gently rinsed from the roots. The clean roots were placed on nested 150 and 25 μ m opening screens. The cysts and females were dislodged from the roots with a high pressure stream of water and collected on the finer mesh screen. The cysts and females were enumerated under a dissecting microscope. After counting, the cysts and females were crushed in a glass tissue grinder to release eggs. The numbers of cysts and eggs were analyzed for variance.

The number of cysts per plant did not differ between the transformed and non-transformed cabbage (P > 0.05). The Bt cabbage averaged 142 cysts per plant, whereas the non-transformed cabbage had 131 cysts per plant. The number of eggs developing on the cabbages was similar, 876 on the transformed and 858 on the non-transformed plants. Neither the total number of eggs/plant nor the number of eggs/cyst differed between the transformed and non-transformed plants (P > 0.05).

The Bt transformation did not affect the reproduction of *H. schachtii* on the cabbage. Some proteins encoded by Bt genes are active against *Caenorhabditis elegans, Panagrellus redivivus*, and *Pratylenchus* spp., but the Cry1Ab3, a δ -endotoxin, is not known to be active against *H. schachtii* (BT toxicity database). β -exotoxins appear to have more activity against nematodes than do δ -endotoxins which are effective against insects (Devidas & Rehberger, 1992). The Cry1Ab3 protein, if it does have nematode activity, may not be expressed at sufficient levels in the plant, or at sites where the nematode feeds because of the promoter driving expression. The CaMV 35S promoter was down-regulated in syncytia of *Arabidopsis thaliana* (Urwin *et al.*, 1997) and a similar down regulation may occur in the Bt-transformed cabbage. The feeding tube of *H. schachtii* prevented ingestion of a 20-40 kDa dextrans or a 28 kDa green-fluorescent protein in previous studies (Böckenhoff & Grundler, 1994; Urwin *et al.*, 1997). The *cry1Ab3* Bt gene codes for a 65 kDa protein that may be too large to be ingested by *H. schachtii*.

Non-target effects of the Bt-transgenic cabbage were not observed on the reproduction of *H. schachtii.* Consequently, commercial deployment of the Bt-transgenic cabbage is not expected to have significant impacts on management of *H. schachtii.*

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